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RESCCUE

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Resilience Assessment Framework Tool - RAF APP

Description and implementation

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RESCCUE - RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water
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Document history

DATE	VERSION	AUTHOR	COMMENTS
15/09/2019	1.0	Pedro Lopes (LNEC)	First version of the deliverable
20/09/2019	1.1	Maria Adriana Cardoso (LNEC)	First revision of the deliverable
20/10/2019	1.2	Maria Adriana Cardoso (LNEC)	Revision of the internal and external reviewers
1/11/2019	Final	Maria Adriana Cardoso (LNEC)	Final version of the document

1. Changes with respect to the DoA

This deliverable was not initially defined in the DoA. Following the work developed in WP6 it was approved in the Amendment No. AMD-700174-21.

2. Dissemination and uptake

Public (PU). The report is fully open and will be distributed through the web. The web-based tool requires registration.

3. Short Summary of results (<250 words)

The RESCCUE RAF App materializes the Resilience Assessment Framework (RAF) developed in D6.4 in a user-friendly web interface. It provides an evaluation of city and urban services resilience to Climate Change (CC), including multi-sector interdependencies. The RAF main purpose is to assess resilience considering a multi-sectoral approach with focus on water and supporting cities by contributing to the Resilience Action Plans (RAP) development and implementation. The assessment approach directs and facilitates a structured resilience diagnosis of the cities and strategic urban sectors, following an objective driven-approach. It considers four resilience dimensions: organizational, regarding governance top/down relations; spatial, aiming at urban space and environment; functional, directed to strategic services and physical, focused on assets/infrastructures. It allows identifying data gaps, opportunities, threats, strengths and weaknesses, highlighting the areas for improvement.

The information provided by this app empowers city and urban services managers with an assessment allowing to know where they stand and to identify the resilience gaps, thus supporting decision on the most advantageous investments on the city and services when planning to cope with future challenges. Inside the user's area in the app, the user can fill, in an interactive way, detailed information about the selected city. This information is then processed, several metrics are calculated and graphical results are provided. The assessment allows to identify development levels, ranging from an integrated overview of the whole city to a more detailed assessment regarding a specific service. Data is stored in RESCCUE RAF app database and can easily be analyzed and extracted by the user. These results support the city and services managers in making effective decisions to plan city resilience enhancement.

4. Evidence of accomplishment

Report

Acknowledgment is due to all partners and other external contributors, particularly those external to the project that participated in the Barcelona, Lisbon and Bristol workshops.

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1. Introduction

1.1. Background

This document is developed as part of RESCCUE (RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water) project, which has received funding from the European Union's Horizon 2020 Research and Innovation program, under the Grant Agreement number 700174.

The Resilience Assessment Framework Tool – RAF APP description corresponds to Deliverable 6.5 of Work Package 6 (WP6) – Validation Platform and First Applications. WP6 promotes the development of a roadmap for resilience to climate change-related events in the RESCCUE cities – Barcelona, Lisbon and Bristol – having the urban water cycle in the core, based on the RESCCUE developments and on the drivers, opportunities, context, existing practices and knowledge of each city. Each city selected relevant critical hazards being those associated with urban flooding common to all of them. The specific objectives of WP6 include:

- to carry out a structured resilience diagnostic in each city, for the domains selected to all case study areas;
- to review the cities resilience diagnostic, identifying opportunities for improvement in each city and sharing cases already implemented in the cities;
- to contribute to the Resilience Action Plans complementing as appropriate, based on the resilience strategies and existing relevant information produced in each city;
- to learn and share the results in order to maximize RESCCUE impact; and
- to produce generic guidelines targeted to any other cities based on the learnings and outcomes of the demonstration in the RESCCUE cities.

The RAF App is to be used within the project to support the development of the Resilience Action Plans (RAP) by the RESCCUE cities and by all partners involved. It is also intended to be used by any city, service or organization that aims to undertake a city or service resilience assessment to climate change (CC) with focus on water or to develop a RAP. This document represents the written output of the development the Resilience Assessment Framework tool – RAF App. Together with the RAF framework (Cardoso et al., 2019); it completes the set of deliverables regarding resilience assessment in WP6.

1.2. Access to the RAF App

Please find below the information to access to the RAF App:

URL: https://resccue.lnec.pt
User: Ext_review
Password: r8v_resC)cueT2019

In case any difficulties arise, please contact macardoso@lnec.pt
(Registration is required before accessing the app through the email above)

2. RAF App overview

2.1. Tool and methodology

The RESCCUE RAF App materializes the Resilience Assessment Framework (RAF) developed in D6.4 (Cardoso et al., 2019) in a user-friendly web interface. It provides an evaluation of city and urban services resilience to Climate Change (CC), including multi-sector interdependencies. The information provided by this tool empowers city and urban services managers with an assessment, allowing to know where they stand and to identify the resilience gaps, thus supporting decision on the most advantageous investments for the city and services and planning to cope with future CC challenges.

Access to the application is made using credentials given upon request, to ensure data confidentiality. A users' manual for the RAF App was developed and is accessible from the platform, and is included as an annex of this deliverable. This web-based platform tool was developed in order to support the RAF usage and includes the entire developed framework that is described in detail in Cardoso et al. (2019).

The following sections describe the steps to be followed by a RAF App user, after access (Figure 1).

Figure 1 – Access to the RAF App

2.2. Creating a new study

The RAF is designed to be answered for an integrated assessment of the city and its services, for a given time period and for a specific hazard – this is considered as a study. While creating a new study for assessment, in the city main page (Figure 2), the user has to specify the dimensions (organisational, spatial, functional and physical) and also the services (water, wastewater, stormwater, waste, energy and mobility) to assess within the functional and physical dimensions. For the selected dimensions and services, subsequent tabs will display the correspondent RAF structure.

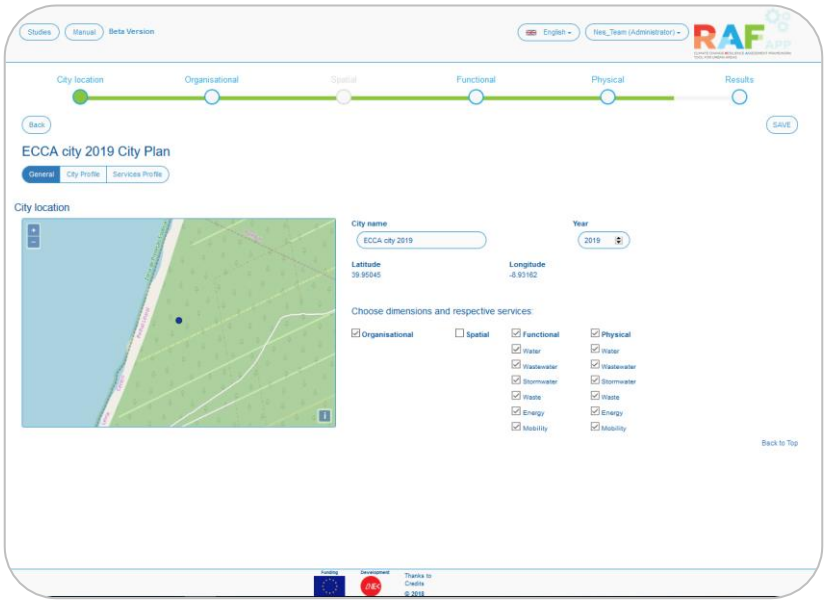


Figure 2 – City main page in the RAF App

Before getting into data input for resilience assessment, a section regarding the city and services profile is available (Figures 3 and 4).

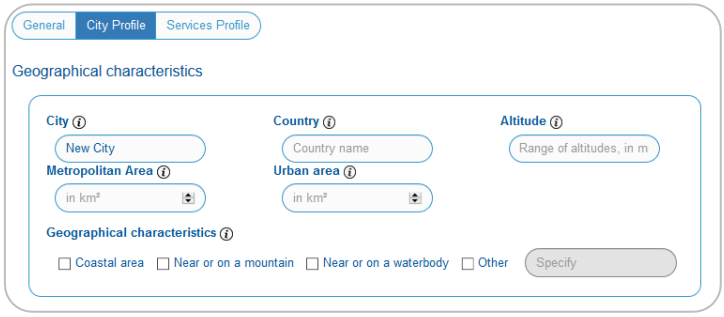


Figure 3 – City main page: City Profile tab

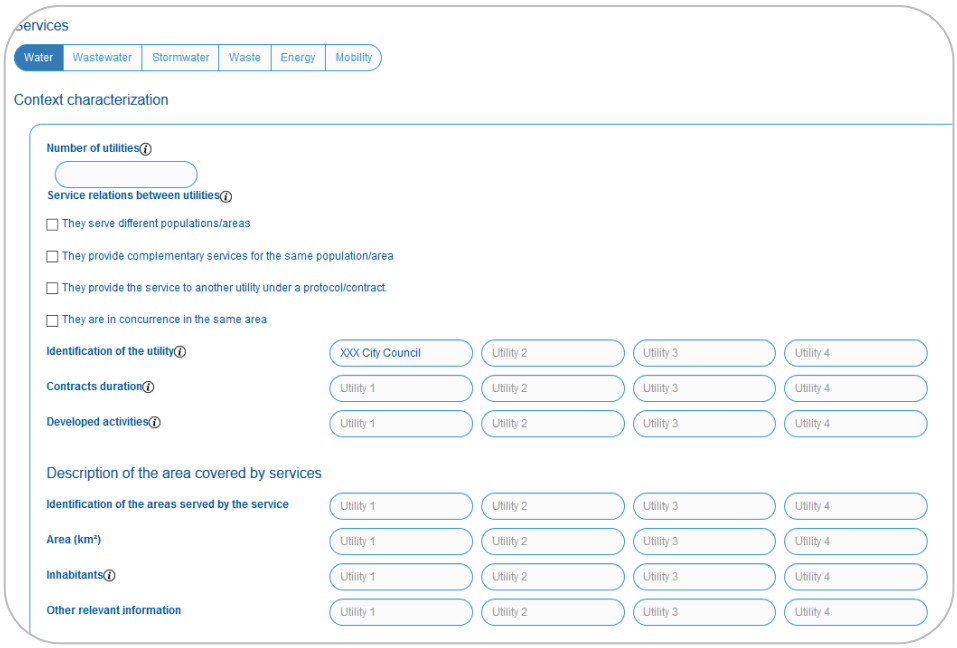


Figure 4 – City main page: Service Profile tab

2.3. Dimensions

For each selected dimension, the app allows to navigate into the correspondent RAF structure (objectives, criteria and metrics).

To facilitate and plan the introduction of responses for each metric, within each dimension, the platform allows to select a certain set of metrics, that may correspond to a given criteria, objective or to a given metrics' relevance. The correspondent metrics are then displayed and the set of metrics with the respective pre-defined answers opens for selection and inputs. An example is presented in Figure 5.

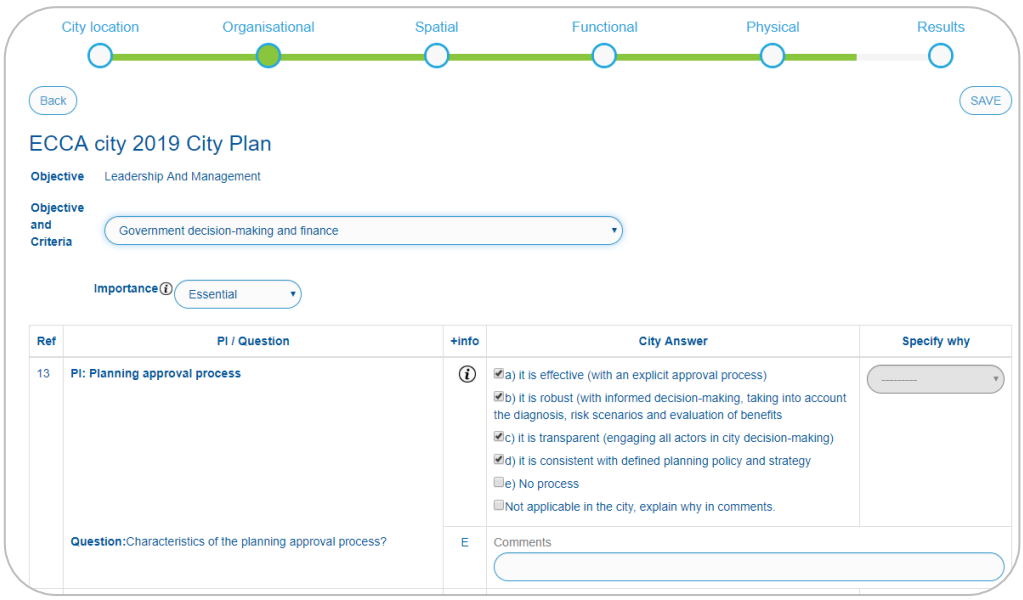


Figure 5 – Example of data insertion in the RAF App, by dimensions

2.4. Results

The RESCCUE RAF App includes a module to graphically explore the results, allowing for a user-friendly and dynamic visualization. This is also possible for the level of aggregation selected by the user, such as for the whole city (Figure 6 and 7), for a given dimension, service (Figure 8), objective or criteria, or for a given level of metrics' relevance or analysis level (Figure 9).
In every graph within the results tab, the colour translates what is under assessment. The blue corresponds to city integrated assessment, and every other different colour corresponds to a resilience dimension (red for organisational, orange for spatial, bright green for functional and petroleum green for physical).
The different tones within each colour correspond to the development level of the metric's answer: advanced, progressing or incipient. Darker tones relate to the percentage of metrics with an advanced development level, medium tones to progressing and lighter to incipient. Dark grey relates to unanswered metrics and light grey to metrics that are not applicable to the city or service.

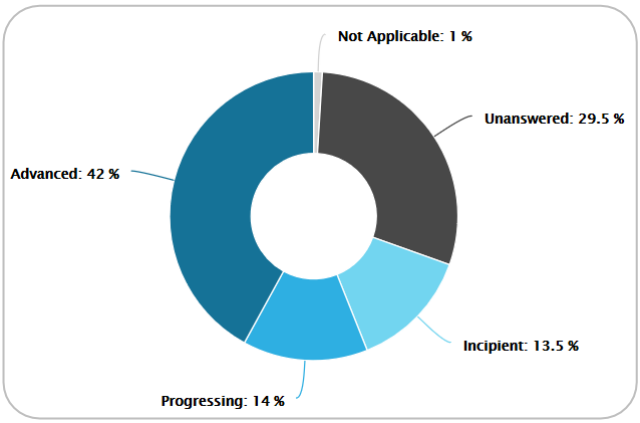


Figure 6 – RAF App results: city overall – metrics within each development level in the city

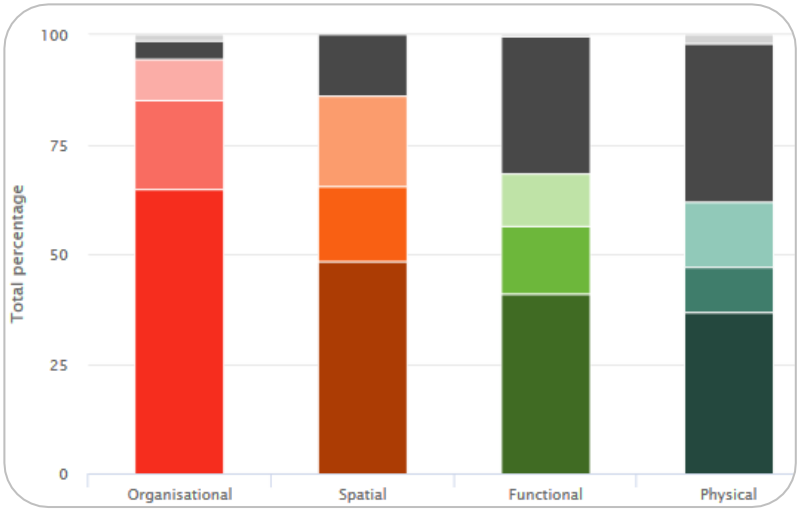
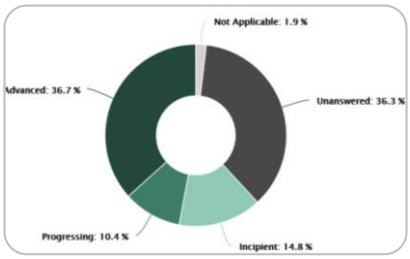


Figure 7 – RAF App results: city overall by dimension

a) Metrics within each development level in the physical dimension



b) Development levels for each service in the physical dimension

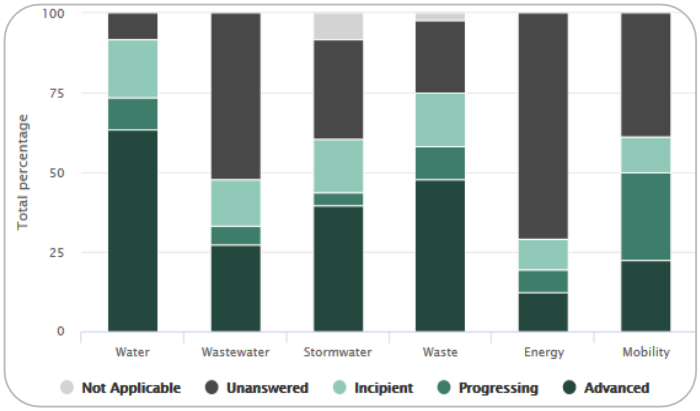
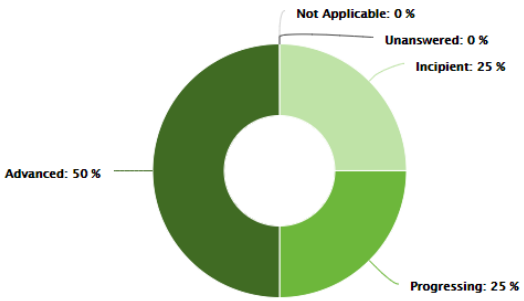
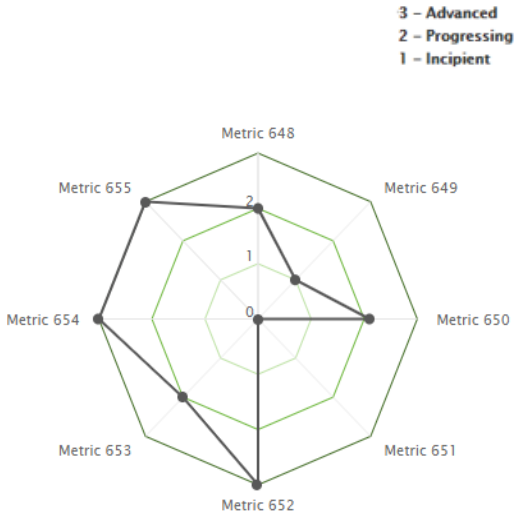


Figure 8 – RAF App results: example of a city disaggregated assessment

a) Energy service: metrics in the criterion "preparedness for CC"



b) Development level for each metric in this criterion



c) Metric within this criterion

Metric	PI
648	Service commitment with mitigation of climate change effects
649	Existence of agreed climate change scenarios and alignment with the city climate change scenarios
650	Knowledge of exposure and service vulnerability for climate change scenarios
651	Service planning for adaptation to climate change
652	Implemented measures to address climate change mitigation and adaptation
653	Planned measures to address climate change mitigation and adaptation
654	Equipment capacity of the service
655	Staffing capacity of the service

Figure 9 – RAF App results: example of a city detailed assessment

Visual comparison between different evaluation moments in time, for the same city, is available. The RAF App allows monitoring resilience progress in a given

time window, both by visually comparing the diagnosis in different years (Figure 10) and by identifying the progress through variation of the percentages for each development level.

This tool also allows to visualise the expected resilience development level, if the measures adopted by the city are implemented in a given planning horizon, by graphically illustrating the effect on the result of the metrics that were affected by the measures (in each criterion, objective, service or dimension).

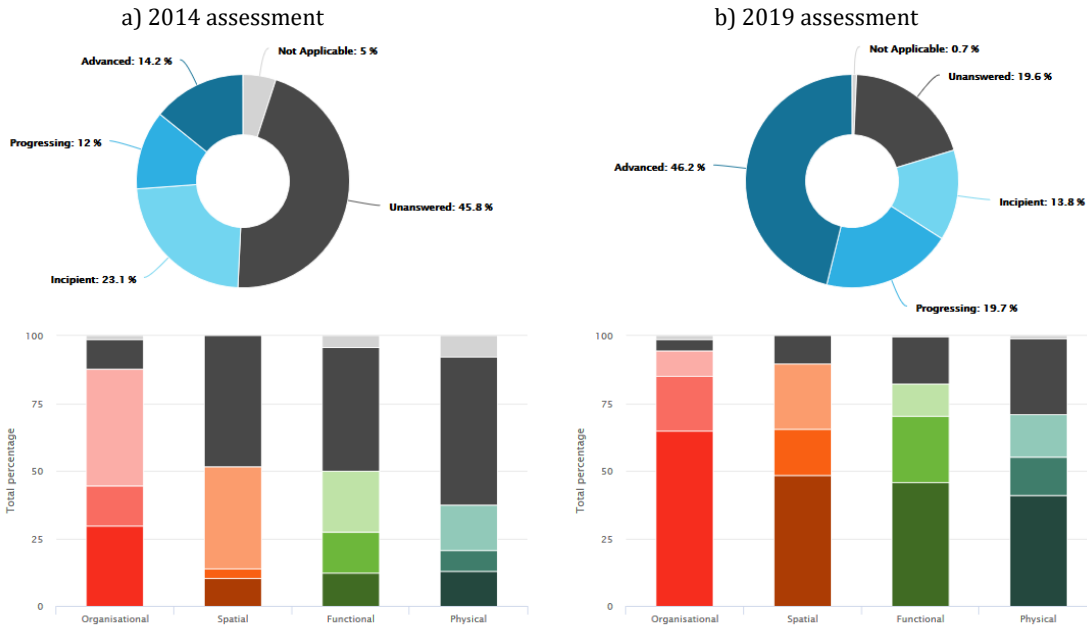


Figure 10 – RAF App results: example of a city integrated resilience progress on a given time interval

Finally, the tool provides an output in a pre-defined summary report, highlighting the most relevant graphs. Stored data can be easily analysed and extracted for further analysis.

These results support the city and services managers in making effective decisions to plan city resilience enhancement.

3. Conclusions

In summary, as a tool that explores RAF architecture, the RAF App:

- facilitates the use of the RAF framework;
- supports assessment, diagnosis and decision-making;
- monitors the progress of a city or service;
- compares different services;

- addresses the contribution of urban services to the city's resilience to climate change;
- acknowledges improvement opportunities to increase resilience;
- supports the development of resilience plans;
- facilitates communication between stakeholders.

The RAF App demonstrated to be a worthy solution to uptake the contributions from the cities, since it is a user-friendly tool facilitating metrics' inputs and providing an easy visualization of results by graphical aggregation, as well as a first identification of resilience strengths, gaps and improvement opportunities.

Given its importance, generic nature and flexible structure, the RESCCUE RAF App can be extended to other cities and, in the future, to other urban services or hazards.

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Annexes

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Annex 1 – RAF App User guide

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Resilience Assessment Framework application – RAF APP – User guide

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Contents

Overview

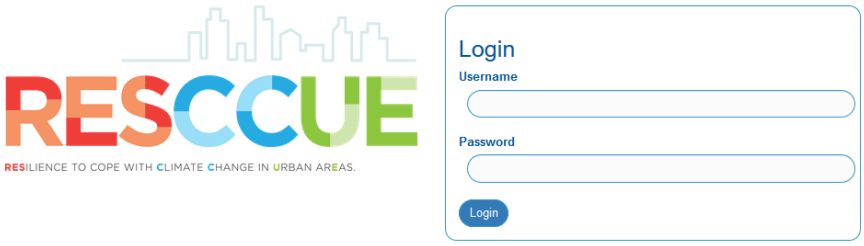
This tool provides a framework to assess urban resilience to climate change, with focus on water, considering an objective-oriented approach and four **resilience dimensions**: organisational, considering governance relationships; spatial, covering urban space and environment; functional, focused on strategic services in the city (water, wastewater,

stormwater, waste, energy and mobility); and physical, centred on infrastructure of these services. The resilience objectives are described through key criteria (expressing different points of view), which are evaluated by metrics. In this given scope, the metrics are described and associated to reference values, providing a user-friendly assessment to support a structured diagnosis. The app allows the use of a defined structure based on dimensions / objectives /criteria / metrics, specifically designed to address the referred scope.

The app can be used as a tool to support assessment, diagnosis and decision-making as well as the development of resilience plans, to monitor progress of a city or service or to compare different parts of the cities or services.

Login

A user with credentials can login into the RAF App.



Studies

After a successful login, the user will be redirected to the *studies* page, containing all his previously saved studies (for the city and year that the user has previously created or has been assigned access).

In this page the user can manage his previously saved studies:

- Create study: create a new study for the city or for another city
- Edit study: fill and change city information
- Clone city: make a copy of the study, e.g. for the city information in a previous year
- Check the city report: a summary of study results available for download
- Delete studies

If the city wants to assess different hazards existing in the city, different studies must be created. One study for each hazard.

For this, after creating a study and completing the assessment considering one selected hazard, the user has to clone the study already completed to assess a new hazard, giving a new name and editing only the hazard-related metrics. In case there is a service with no assessment for that hazard the user **deselects** the respective service in the RAF app - city location page - for the functional and physical dimensions.

For each study, the hazard under assessment needs to be identified and described in the City and Service profiles, in the hazard section.

However, for each hazard the user may have **different variables**.

So, when answering to the metrics of the scenarios (e.g., MP or MS) for one hazard (e.g. flooding), if there are differences regarding the impacts/consequences that depend on the type of variable, then the answer shall be done **for the variable that causes the most serious consequence**, and shall be indicated the variable in the comments. In this situation, it is still possible to create a different study for each variable if it deepens the assessment and facilitates the identification of solutions. However, it is not recommended in order to keep parsimony.

City main page

Upper bar

The city main page can be accessed when creating a new study or when editing a previously created study.

At the upper bar, the user has two fixed options:

- go back to studies 

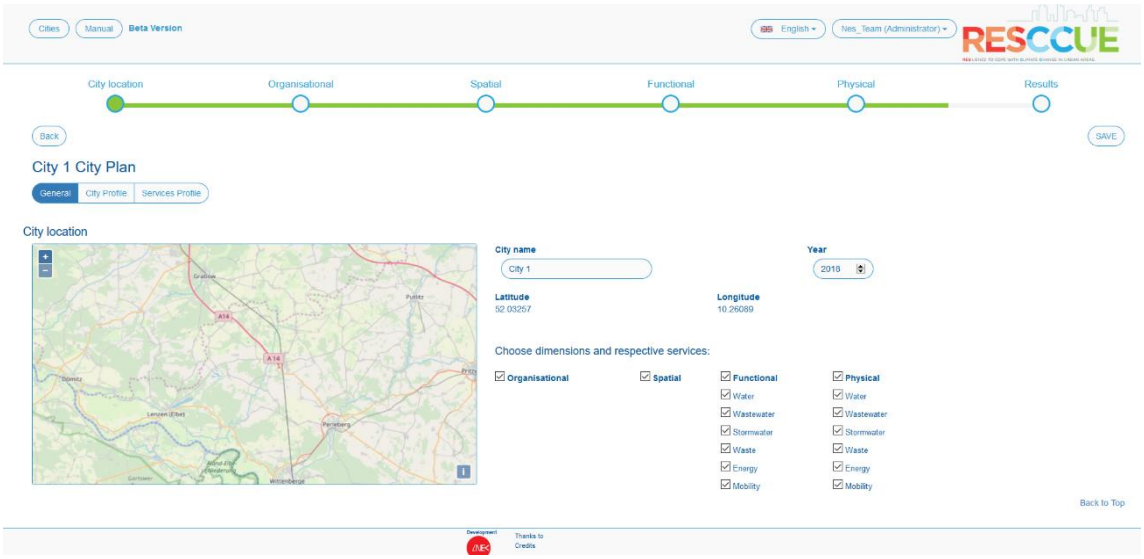
- open the App user guide 

(this document)

The top of the page also presents the navigation bar, where the user can select where to go next. This bar contains the main App structure: City location, the four dimensions, and the results.

4.1 City Location

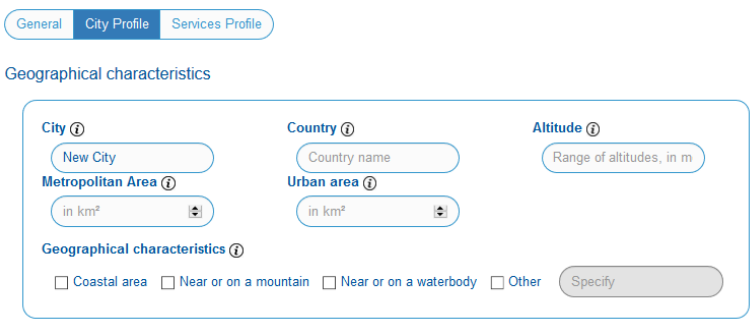
In **City Location** the user has a tab with General information, City Profile and Service Profile.



The **General** contains generic information about the city: city name, year of the study, a map (where the user can select the city to originate coordinates), the dimensions under assessment (organisational, spatial, functional and physical) and the services that are being assessed (water, wastewater, stormwater, waste, energy and mobility) within the functional and physical dimensions.

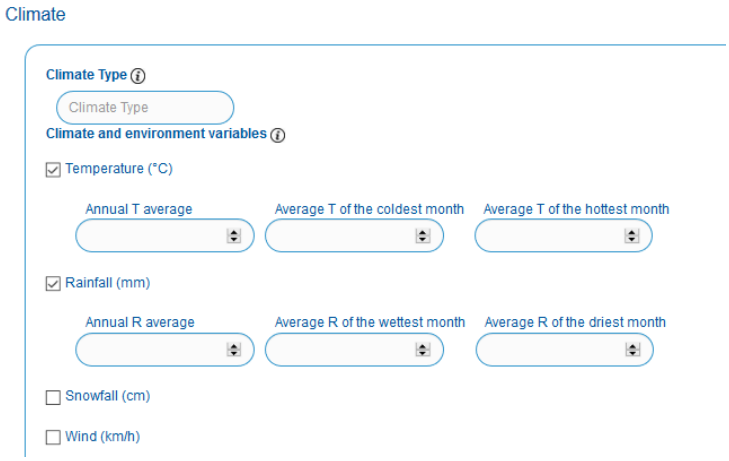
At this stage, the user has to select which dimensions and services are being assessed in the study of the city. If a dimension is selected at this stage, it will become available to access through the navigation bar and to explore the corresponding results in the end of the navigation bar. In a similar way, if a service is selected at this stage, it will appear available when entering the functional or physical dimension, whichever applicable, and also available to explore the corresponding results. In case of combined sewer systems, both wastewater and stormwater services need to be selected and answered for the applicable metrics. Those metrics that are not applicable have to be duly identified.

City profile contains information relevant for understanding the city context and the results of the resilience assessment. The information in **city and service profile** is the starting point for the assessment, with some metrics where the user has to specify what will be considered in the assessment.

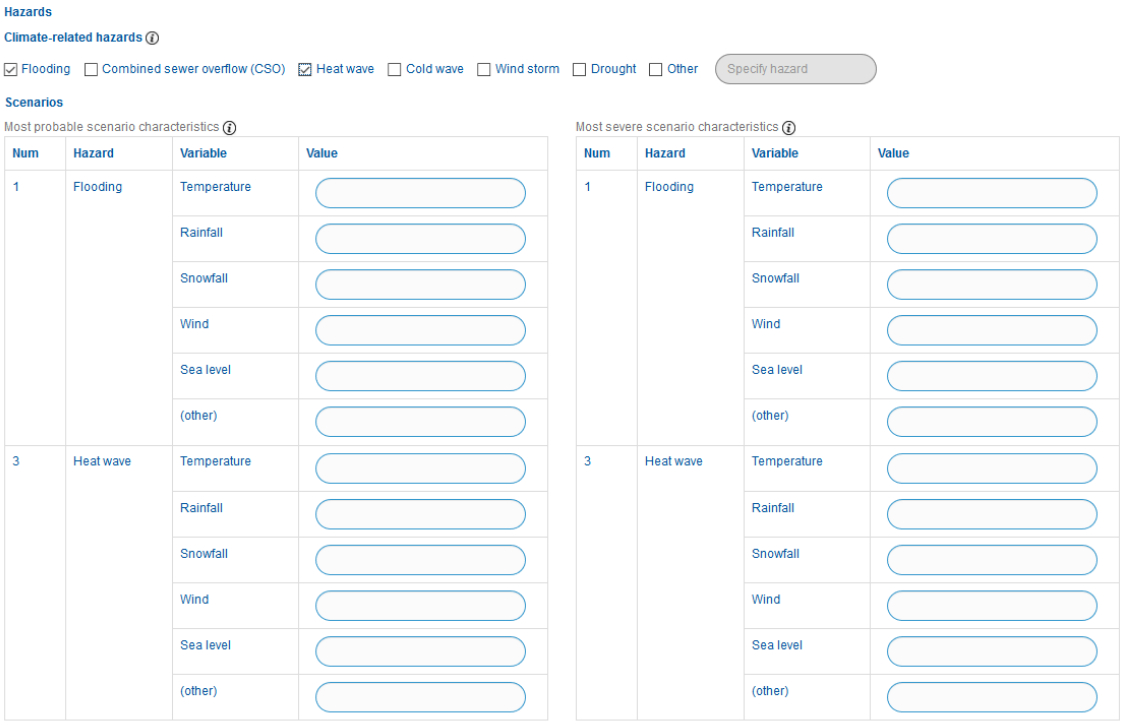


In this section, the city context is presented in several boxes (Geographical characteristics, Climate, Population, Economy & governance and Built environment & infrastructures). The available fields have some guidelines in grey, and a button (ⓘ) to look for more details/explanations.

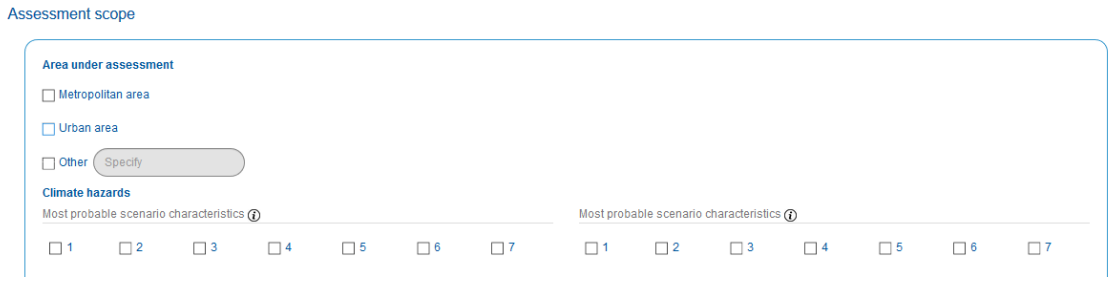
In the Climate box, some fields, when selected, unfold into other fields to complete. E.g.: if the user has data about some of the presented variables (temperature and rainfall), when selecting, more fields will unfold to complete with detailed data. Any comments should be provided in the answer field.



In the Hazards section, the selected hazards are numbered and unfold into a table with variables. A value with the same units used above (Climate and environment variables section) should be provided.

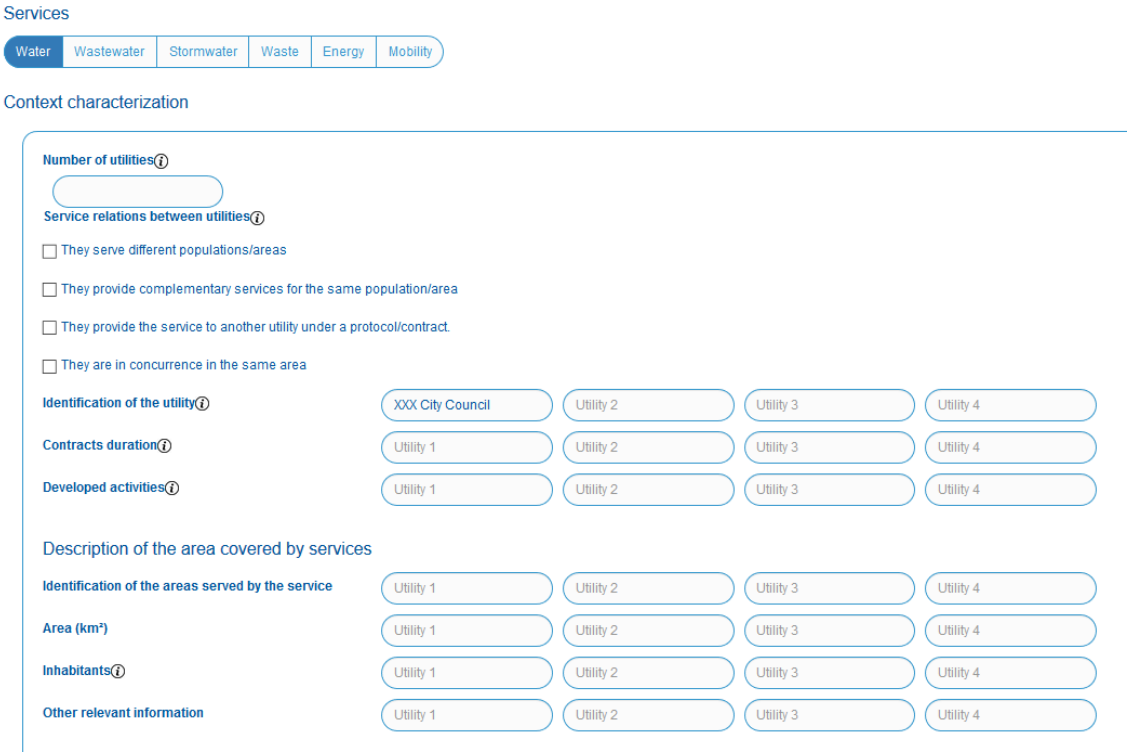


In the last box (Assessment scope), the user has to select the numbers correspondent to the selected hazards (Hazards section).



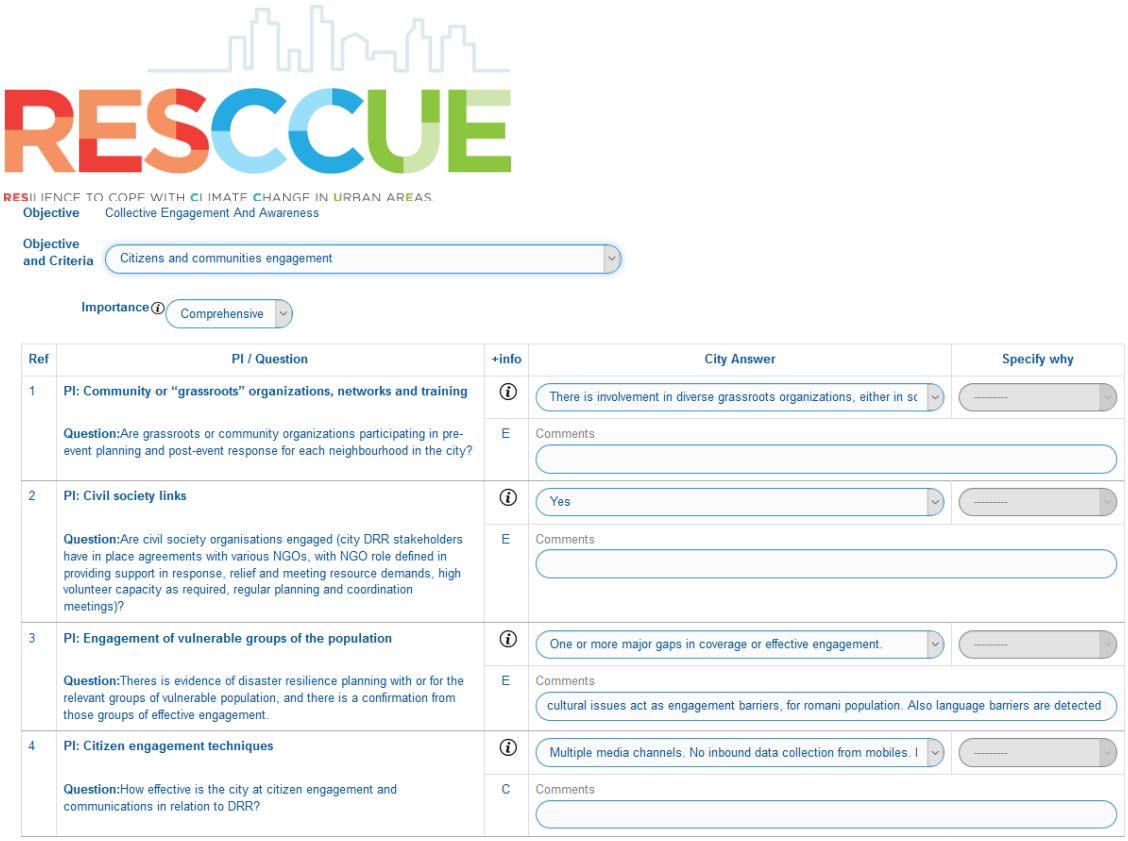
In **Service profile**, first the user has to select the service(s) to be assessed. For this, relevant information to both service and service infrastructure is presented.

For most of the metrics, there are four fields to be completed by the utilities in charge. If the service is managed by a single utility, only the Utility 1 field should be used.



4.2 Dimension tabs

In the tab inside each selected dimension, a box with a dropdown menu is available (Objective and criteria box). This is where the user may select the criterion within the objective to be assessed. Once the criterion is selected, the corresponding objective will appear above.



The table that is displayed (see above picture) shows the metrics included in the selected criterion. A table with all the metrics within the dimension is available when selecting **ALL** in dropdown menu in the Objective and criteria box.

When this option is selected (ALL), a Search box is available to find a specific metric through some keywords.

Each metric has a reference number (left column), a given name (performance indicator, PI) and question, additional information (+info) and boxes for the city answer, additional comments or specifications in case the metric does not apply.

The user can filter the metrics by **importance,** to assess a specific set of metrics. Metrics importance can be:

- **Essential**: Integrates any city assessment, applicable to any city.
- **Complementary**: Integrates evaluation of specific or detailed city aspects.
- **Comprehensive**: To a comprehensive assessment of the city, may not be applicable to all cities

As metrics importance reflects an in deeper assessment path, a sequential inclusion of metrics is done when using the importance filter (box with a drop down menu):

- When selecting the **Essential (E)** filter, the user sees only the metrics with a **performance indicator (PI)** classified as E.
- When selecting the **Complementary (C)** filter, the user sees the metrics with a **PI** classified as E and C.
- When selecting the **Comprehensive (CH)** filter the user sees all metrics**.**

The user can find the information above selecting

Each metric has also an ⓘ for the metric explanation (in the +info column).

There are three types of metrics to answer:

- Metrics with only one answer option to pick (“select option”)
- Metrics with multiple options to pick (“select all applicable”)
- Metrics to answer with an estimated figure (open field)

All metrics have the option “Not applicable in the city, explain why in comments.” and a box to insert additional comments is provided.

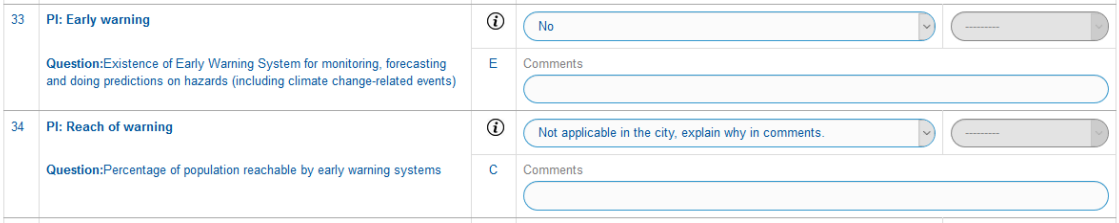
In case no option is selected, a dropdown menu (the Specify why box) is available to specify the reason why the metric is not answered.

This framework has some metrics that precede other i.e. condition the existence of others. The conditioning relation between metrics is available in the annex of this manual.

When answering any of the metrics that condition others, verify whether the answer that you provide conditions the possibility of the dependent metrics to be answered. In such case, ensure the respective dependent metrics are answered as Not Applicable. See example below.

In this case, if the answer for metric 33 is yes, the dependent metric (34) must be answered.

If the answer is no, the dependent metric will be considered as Not Applicable (this option must be selected).

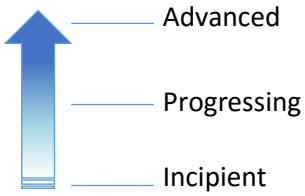


Specifically, in Functional and Physical dimensions, firstly the service(s) to assess must be chosen.

Before moving to other dimension or to the results tab, it is recommended to save your data by clicking in SAVE button, at the top right corner SAVE

Results

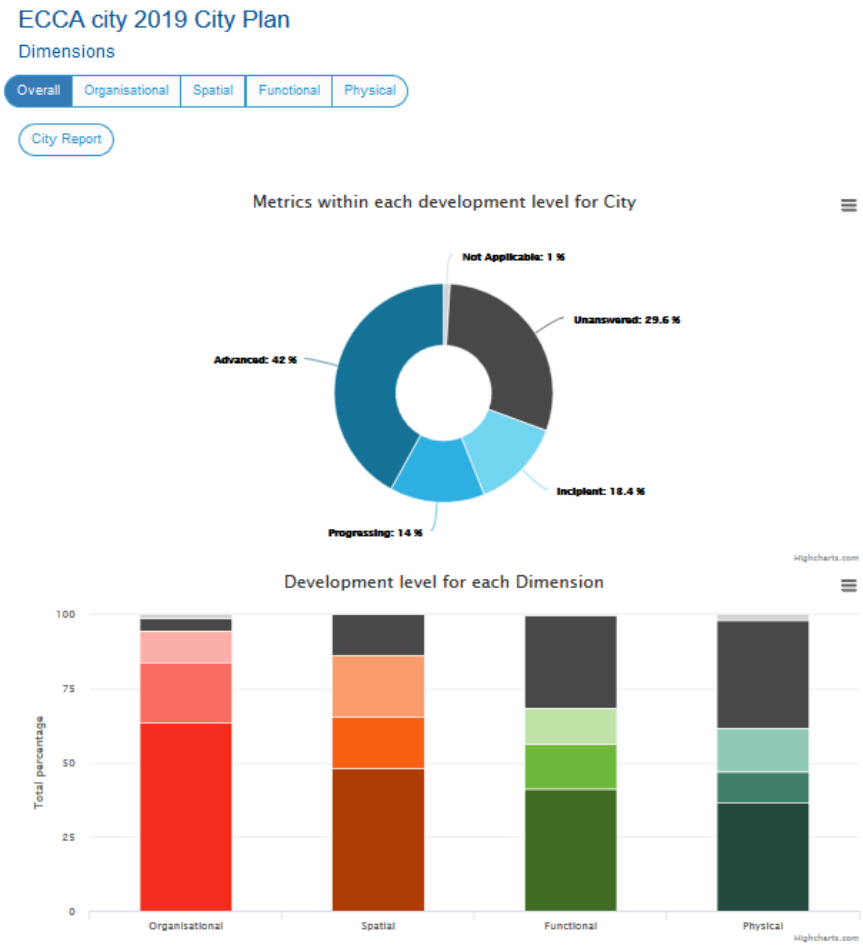
Depending on the answers to the metrics, each metric/criteria/objective/dimension is classified with a **development level**: Advanced, Progressing or Incipient.



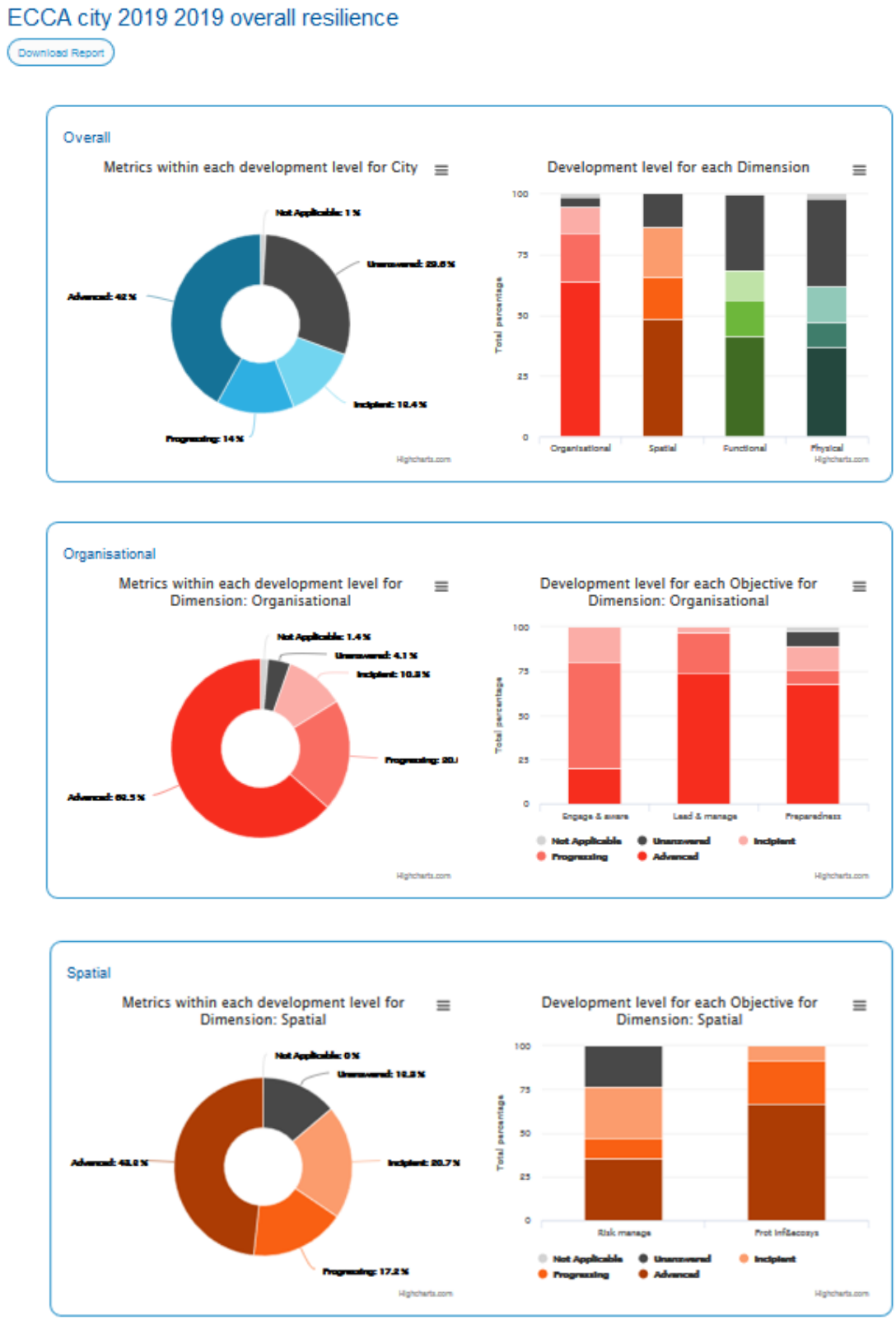
- **Advanced** metrics are those with higher development level, identified in graphs with a darker color.
- **Progressing** metrics have an intermediate development level and are identified in graphs with a color between the darker and the lighter.
- **Incipient** metrics have a lower development level and are identified in graphs with a lighter color.

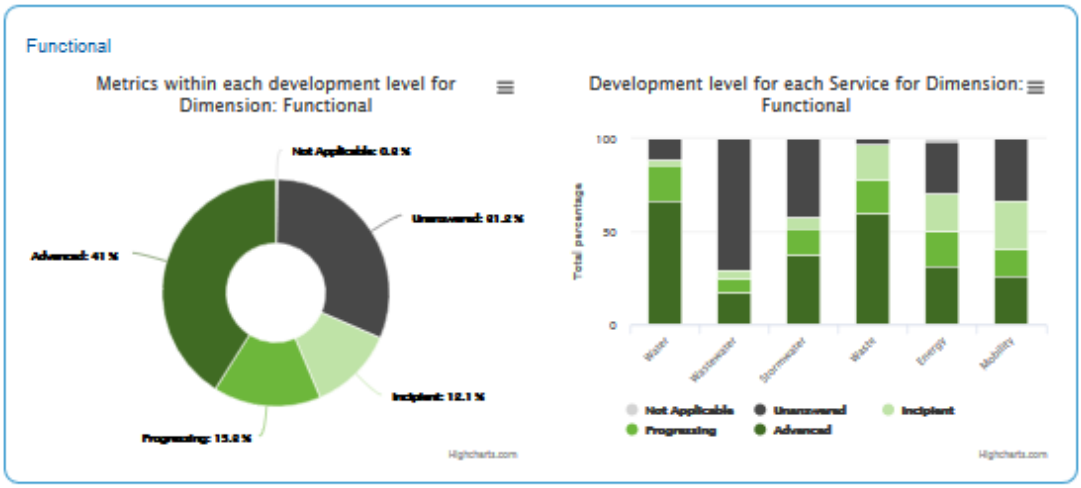
The first section presents the **overall** results, gathering all dimensions' results. The user can see the overall city results in two charts (as % of all metrics of the assessment):

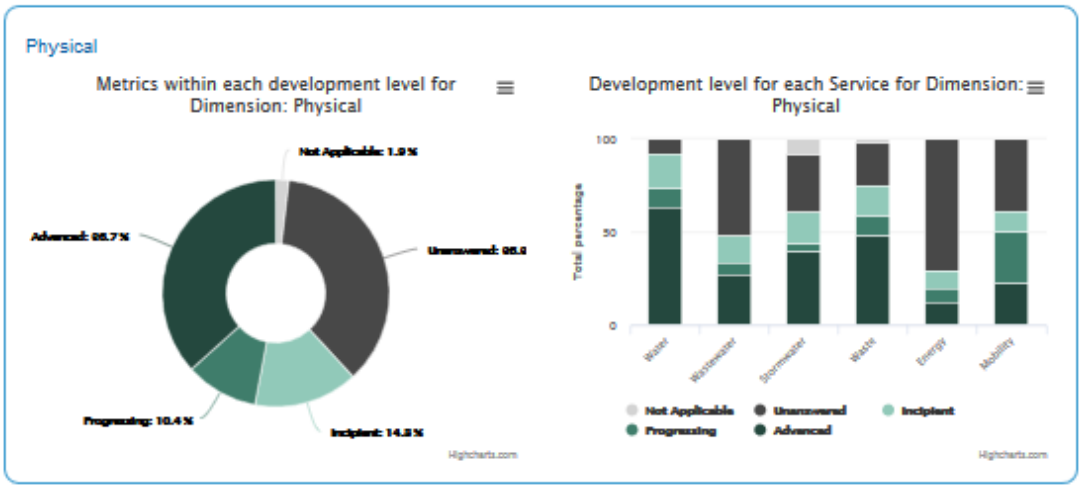
- Metrics in advanced, progressing or incipient level considering all resilience dimensions in the city, and also the unanswered and not applicable metrics (donut graph)
- Metrics in each development level by dimension (bar graph)



In **City Report,** the user can get a summary of city results (overall city results and overall results by dimension). The pdf file is available to download.







The user can choose to see more detailed results entering each dimension and using the available filters.

By selecting one dimension it is possible to see the results by service (if previously chosen for assessment), objective, criteria, importance and level.

- The **assessment level** can be
  - Strategic: metrics associated with higher level of decision making in the city and long term view decisions;
  - Tactical: metrics associated with intermediate decision making and implementation levels in the city and medium term view decisions.

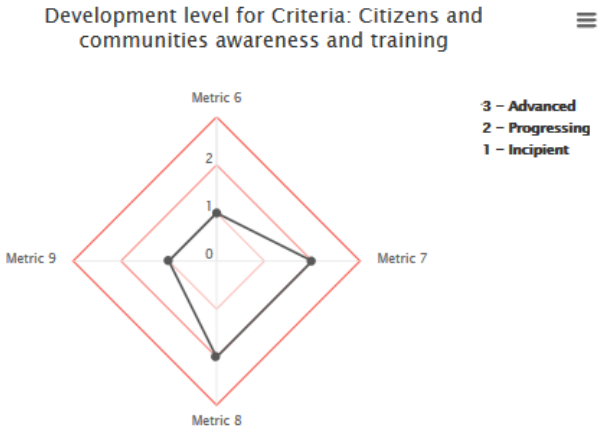
Either in overall or within one dimension, it is possible to compare the current study results with another study (e.g. the same city in a previous year) using the option "**Compare with**".

In each dimension, the user may ask for the correspondent metrics table. This table will present all metrics within the dimension, the correspondent city answers and the associated

development level. This metrics table is available to download (.xls file). The user can export any chart or table selecting .

- Graph types are the same when selecting results within each dimension:
  - Organisational: overall dimension (donut) and results by objectives (bar graph)
  - Spatial: overall dimension (donut) and results by objectives (bar graph)
  - Functional: overall dimension (donut) and results by services (bar graph)
  - Physical: overall dimension (donut) and results by services (bar graph)

The user can cascade down, into more detail. For instance, when selecting results by objective, the graphs display the results for the overall objective (donut) and by criteria (bar graph). When the user is in the most detailed display of the results, i.e., selecting results by criteria, the graphs shows the overall criteria with a new graph type (spider graph for every metric within the criteria).



Specifically in this graph, when the user moves the mouse around, the metric's development level is presented in a box along with the metric's performance indicator (PI).

As in the other graphs, the spider graph also has an associated table with detailed information about the metrics within the selected criteria.

Final notes

To keep the changes made by the user, it is recommended to SAVE before leaving to "studies" or to select the "Results" tab in the Navigation Bar, otherwise everything changed by the user will not be recorded:

- Data will be temporarily kept when the user edits the answers and skips between dimension tabs without saving;
- The user should **Save** when skipping between objectives or dimension tabs, if the user really wants to save permanently those changes.

The user should be aware that skipping to the "Results" tab will save automatically all the changes made. If the user wants to exit the study and discard the changes:

- The user should not move to "Results" neither use the Save button;
- The user should move directly to Studies.

Either in the dimensions or in results tabs, the **back** button will always redirect the user to City Location.

Metrics dependencies

Organisational

Metrics	Dependencies
O16 (if 3/2/1 selected)	O17
	O18
O24 (If 3 or 2 selected)	O25
	O26
	O27
	O28
	O29
O38 (if yes)	O39
O30 (if 3/2/1 selected)	O36, O40, O46, O48
O44 (if yes)	O45
O51 (if yes)	O52
	O53
O58 (if 3/2/1 selected)	O59, O60
O63 (if yes)	O64
O54 organisational (if 3/2/1 selected)	S06, S07, S08, S09, S16, S17, S27, S28; FMob12, FMob13, FMob14, FMob15, FMob16, FMob17, FMob35, FMob36, FMob38, FMob39,FMob40, FMob41, FMob42

Spatial

Metrics	Dependencies
S01 (if yes)	S02
S09 (if yes)	S10
S14 (if 3 or 2 or 1 selected)	S15
S22 (if yes or partially)	S23, S24

Functional - Water

Metrics	Dependencies
FWts01 (if yes/partially)	FWts02
	FWts03
FWts06 (if yes)	FWts07
FWts56 (if 3/2/1 selected)	FWts57
FWts48 (if 3/2/1 selected)	FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, FWts41, FWts42, FWts49, FWts58 to FWts67; PWts20, PWts36, PWts37, PWts38, PWts41, PWts42, PWts43, PWts44, PWts45, PWts46, PWts47, PWts48, PWts49

Functional - Wastewater

Metrics	Dependencies
FWwt01 (if yes/partially)	FWwt02
	FWwt03
FWwt06 (if yes)	FWwt07
FWwt53 (if 3/2/1 selected)	FWwt54
FWwt45 (if 3/2/1 selected)	FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21, FWwt38, FWwt39, FWwt46, FWwt55, FWwt56, FWwt57, FWwt58, FWwt59, FWwt60, FWwt61, FWwt62, FWwt63; PWwt20, PWwt35, PWwt36, PWwt37, PWwt40, PWwt41, PWwt42, PWwt43, PWwt44, PWwt45, PWwt46, PWwt47, PWwt48

Functional - Stormwater

Metrics	Dependencies
FSwt01 (if yes/partially)	FSwt02
	FSwt03
FSwt06 (if yes)	FSwt07
FSwt46 (if 3/2/1 selected)	FSwt47
FSwt38 (if 3/2/1 selected)	FSwt14, FSwt15, FSwt16, FSwt17, FSwt18, FSwt31, FSwt32, FSwt39, FSwt48, FSwt49, FSwt50, FSwt51, FSwt52; PSwt20, PSwt35, PSwt36, PSwt37, PSwt40, PSwt41, PSwt42, PSwt43, PSwt44, PSwt45, PSwt46, PSwt47, PSwt48

Functional - Waste

Metrics	Dependencies
FSlw01 (if yes/partially)	FSlw02
	FSlw03
FSlw06 (if yes)	FSlw07
FSlw51 (if 3/2/1 selected)	FSlw52
FSlw43 (if 3/2/1 selected)	FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19,FSlw20, FSlw36, FSlw37, FSlw44, FSlw53, FSlw54, FSlw55, FSlw56, FSlw57, FSlw58, FSlw59, FSlw60; PSlw18, PSlw35, PSlw36, PSlw37, PSlw40, PSlw41, PSlw42, PSlw43, PSlw44, PSlw45, PSlw46, PSlw47, PSlw48

Functional - Energy

Metrics	Dependencies
FEne01 (if yes/partially)	FEne02
	FEne03
FEne06 (if yes)	FEne07
FEne46 (if 3/2/1 selected)	FEne47
FEne38 (if 3/2/1 selected)	FEne14, FEne15, FEne16, FEne17, FEne18, FEne31, FEne32, FEne39, FEne48, FEne49, FEne50, FEne51, FEne52; PEne16, PEne30, PEne31, PEne32, PEne35, PEne36, PEne37, PEne38, PEne39, PEne40, PEne41

Functional - Mobility

Metrics	Dependencies
FMob01 (if existing)	FMob02
	FMob03
	FMob06
	FMob07
	FMob08

Physical - Water

Metrics	Dependencies
PWts01 (if yes/partially)	PWts02
	PWts03
	PWts04
PWts01 (if yes/partially)	PWts36, PWts47

Physical - Wastewater

Metrics	Dependencies
PWwt01 (if yes/partially)	PWwt02
	PWwt03
	PWwt04
PWwt01 (if yes/partially)	PWwt35, PWwt46

Physical - Stormwater

Metrics	Dependencies
PSwt01 (if yes/partially)	PSwt02
	PSwt03
	PSwt04
PSwt01 (if yes/partially)	PSwt35, PSwt46

Physical - Waste

Metrics	Dependencies
PSlw01 (if yes/partially)	PSlw02
	PSlw03
	PSlw04
PSlw01 (if yes/partially)	PSlw35, PSlw46

Physical - Energy

Metrics	Dependencies
PEne01 (if yes/partially)	PEne02
	PEne03
	PEne04
PEne01 (if yes/partially)	PEne30, PEne39

Physical - Mobility

Metrics	Dependencies
PMob01 (if yes/partially)	PMob02
	PMob03
PMob01 (if yes/partially)	PMob24

Organisational

Old REF	**NEW REF**
1	O01
2	O02
3	O03
4	O04
5	O05
6	O06
7	O07
8	O08
9	O09
10	O10
12	O11
13	O12
14	O13
15	O14
16	O15
17a	O16
17b	O17
17c	O18
18	O19
19	O20
20	O21
21	O22
22	O23
23a	O24
23b	O25
23c	O26
23d	O27
24	O28
25	O29
26	O30
27	O31
28	O32
29	O33
30a	O34
30b	O35
31	O36
32	O37
33	O38
34	O39
35	O40
36	O41
37	O42
38	O43
39a	O44
39b	O45
40	O46
41	O47
42	O48
43a	O49
43b	O50
44a	O51
44b	O52
44c	O53
45	O54
97	O55
98	O56
99	O57
49	O58
50	O59
51a	O60
51b	O61
52	O62
53a	O63
53b	O64
54	O65
55a	O66
55b	O67
56a	O68
56b	O69
57	O70
58	O71
59	O72
60	O73
61	O74

Spatial

Old REF	**NEW REF**
100a	S01
100b	S02
101	S03
102	S04
103	S05
104	S06
105	S07
106	S08
107a	S09
107b	S10
107c	S11
108	S12
109	S13
110	S14
111	S15
114	S16
115	S17
118	S18
119	S19
120	S20
121	S21
122	S22
123	S23
124	S24
125	S25
126	S26
127	S27
128	S28
129	S29

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Functional WATER		Functional WASTEWATER		Functional STORMWATER		Functional WASTE		Functional ENERGY		Functional MOBILITY	
Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**
300	FWts01	400	FWwt01	500	FSwt01	600	FSlw01	700	FEne01	800	FMob01
301	FWts02	401	FWwt02	501	FSwt02	601	FSlw02	701	FEne02	801	FMob02
302	FWts03	402	FWwt03	502	FSwt03	602	FSlw03	702	FEne03	802	FMob03
303	FWts04	403	FWwt04	503	FSwt04	603	FSlw04	703	FEne04	803	FMob04
304	FWts05	404	FWwt05	504	FSwt05	604	FSlw05	704	FEne05	804	FMob05
305	FWts06	405	FWwt06	505	FSwt06	605	FSlw06	705	FEne06	805	FMob06
306	FWts07	406	FWwt07	506	FSwt07	606	FSlw07	706	FEne07	806	FMob07
307	FWts08	407	FWwt08	507	FSwt08	607	FSlw08	707	FEne08	807	FMob08
308	FWts09	408	FWwt09	508	FSwt09	608	FSlw09	708	FEne09	809	FMob09
309	FWts10	409	FWwt10	509	FSwt10	609	FSlw10	709	FEne10	810	FMob10
310	FWts11	410	FWwt11	510	FSwt11	610	FSlw11	710	FEne11	811	FMob11
311	FWts12	411	FWwt12	511	FSwt12	611	FSlw12	711	FEne12	812	FMob12
312	FWts13	412	FWwt13	512	FSwt13	612	FSlw13	712	FEne13	813	FMob13
313	FWts14	413	FWwt14	513	FSwt14	613	FSlw14	713	FEne14	814	FMob14
314	FWts15	414	FWwt15	515	FSwt15	614	FSlw15	715	FEne15	819	FMob15
315	FWts16	415	FWwt16	517	FSwt16	615	FSlw16	717	FEne16	820	FMob16
316	FWts17	416	FWwt17	519	FSwt17	617	FSlw17	719	FEne17	821	FMob17
317	FWts18	417	FWwt18	521	FSwt18	619	FSlw18	721	FEne18	822	FMob18
318	FWts19	419	FWwt19	523	FSwt19	621	FSlw19	723	FEne19	823	FMob19
319	FWts20	421	FWwt20	525	FSwt20	622	FSlw20	725	FEne20	824	FMob20
320	FWts21	422	FWwt21	527	FSwt21	623	FSlw21	727	FEne21	825	FMob21
321	FWts22	423	FWwt22	529	FSwt22	624	FSlw22	729	FEne22	829	FMob22
322	FWts23	424	FWwt23	531	FSwt23	625	FSlw23	731	FEne23	830	FMob23
323	FWts24	425	FWwt24	533	FSwt24	627	FSlw24	733	FEne24	831	FMob24
324	FWts25	426	FWwt25	534	FSwt25	628	FSlw25	734	FEne25	832	FMob25
325	FWts26	427	FWwt26	535	FSwt26	629	FSlw26	735	FEne26	833	FMob26
326	FWts27	428	FWwt27	538	FSwt27	631	FSlw27	738	FEne27	834	FMob27
327	FWts28	429	FWwt28	539	FSwt28	632	FSlw28	739	FEne28	835	FMob28
328	FWts29	431	FWwt29	540	FSwt29	633	FSlw29	740	FEne29	836	FMob29
329	FWts30	432	FWwt30	541	FSwt30	634	FSlw30	741	FEne30	837	FMob30
330	FWts31	433	FWwt31	542	FSwt31	635	FSlw31	742	FEne31	838	FMob31
331	FWts32	434	FWwt32	543	FSwt32	638	FSlw32	743	FEne32	839	FMob32
332	FWts33	435	FWwt33	544	FSwt33	639	FSlw33	744	FEne33	840	FMob33
333	FWts34	438	FWwt34	545	FSwt34	640	FSlw34	745	FEne34	841	FMob34
334	FWts35	439	FWwt35	546	FSwt35	641	FSlw35	746	FEne35	842	FMob35
335	FWts36	440	FWwt36	547	FSwt36	642	FSlw36	747	FEne36	843	FMob36
338	FWts37	441	FWwt37	548	FSwt37	643	FSlw37	748	FEne37	848	FMob37
339	FWts38	442	FWwt38	549	FSwt38	644	FSlw38	749	FEne38	859	FMob38
340	FWts39	443	FWwt39	550	FSwt39	645	FSlw39	750	FEne39	860	FMob39
341	FWts40	444	FWwt40	551	FSwt40	646	FSlw40	751	FEne40	865	FMob40
342	FWts41	445	FWwt41	552	FSwt41	647	FSlw41	752	FEne41	866	FMob41
343	FWts42	446	FWwt42	553	FSwt42	648	FSlw42	753	FEne42	867	FMob42
344	FWts43	447	FWwt43	554	FSwt43	649	FSlw43	754	FEne43		
345	FWts44	448	FWwt44	555	FSwt44	650	FSlw44	755	FEne44		
346	FWts45	449	FWwt45	556	FSwt45	651	FSlw45	756	FEne45		
347	FWts46	450	FWwt46	557	FSwt46	652	FSlw46	757	FEne46		
348	FWts47	451	FWwt47	558	FSwt47	653	FSlw47	758	FEne47		
349	FWts48	452	FWwt48	559	FSwt48	654	FSlw48	759	FEne48		
350	FWts49	453	FWwt49	561	FSwt49	655	FSlw49	761	FEne49		
351	FWts50	454	FWwt50	563	FSwt50	656	FSlw50	763	FEne50		
352	FWts51	455	FWwt51	565	FSwt51	657	FSlw51	765	FEne51		
353	FWts52	456	FWwt52	567	FSwt52	658	FSlw52	767	FEne52		
354	FWts53	457	FWwt53	569	FSwt53	659	FSlw53	769	FEne53		
355	FWts54	458	FWwt54	570	FSwt54	660	FSlw54	770	FEne54		
356	FWts55	459	FWwt55			661	FSlw55				
357	FWts56	460	FWwt56			663	FSlw56				
358	FWts57	461	FWwt57			664	FSlw57				
359	FWts58	462	FWwt58			665	FSlw58				
360	FWts59	463	FWwt59			667	FSlw59				
361	FWts60	464	FWwt60			668	FSlw60				
362	FWts61	465	FWwt61			669	FSlw61				
363	FWts62	467	FWwt62			670	FSlw62				
364	FWts63	468	FWwt63								
365	FWts64	469	FWwt64								
366	FWts65	470	FWwt65								
367	FWts66										
368	FWts67										
369	FWts68										
370	FWts69										

Physical WATER		Physical WASTEWATER		Physical STORMWATER		Physical WASTE		Physical ENERGY		Physical MOBILITY	
Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**	Old REF	**NEW REF**
1300	PWts01	1400	PWwt01	1500	PSwt01	1600	PSlw01	1700	PEne01	1800	PMob01
1300b	PWts02	1400b	PWwt02	1500b	PSwt02	1600b	PSlw02	1700b	PEne02	1800b	PMob02
1300c	PWts03	1400c	PWwt03	1500c	PSwt03	1600c	PSlw03	1700c	PEne03	1800c	PMob03
1300d	PWts04	1400d	PWwt04	1500d	PSwt04	1600d	PSlw04	1700d	PEne04	1801	PMob04
1301	PWts05	1401	PWwt05	1501	PSwt05	1601	PSlw05	1701	PEne05	1802	PMob05
1302	PWts06	1402	PWwt06	1502	PSwt06	1602	PSlw06	1702	PEne06	1803	PMob06
1303	PWts07	1403	PWwt07	1503	PSwt07	1603	PSlw07	1703	PEne07	1804	PMob07
1304	PWts08	1404	PWwt08	1504	PSwt08	1604	PSlw08	1704	PEne08	1804b	PMob08
1304b	PWts09	1404b	PWwt09	1504b	PSwt09	1604b	PSlw09	1704b	PEne09	1804c	PMob09
1304c	PWts10	1404c	PWwt10	1504c	PSwt10	1604c	PSlw10	1704c	PEne10	1804d	PMob10
1304d	PWts11	1404d	PWwt11	1504d	PSwt11	1604d	PSlw11	1704d	PEne11	1804e	PMob11
1304e	PWts12	1404e	PWwt12	1504e	PSwt12	1604e	PSlw12	1705	PEne12	1804f	PMob12
1304f	PWts13	1404f	PWwt13	1504f	PSwt13	1604f	PSlw13	1706	PEne13	1806	PMob13
1305	PWts14	1405	PWwt14	1505	PSwt14	1605	PSlw14	1707	PEne14	1807	PMob14
1306	PWts15	1406	PWwt15	1506	PSwt15	1606	PSlw15	1710	PEne15	1810	PMob15
1307	PWts16	1407	PWwt16	1507	PSwt16	1607	PSlw16	1711	PEne16	1811	PMob16
1308	PWts17	1408	PWwt17	1508	PSwt17	1610	PSlw17	1712	PEne17	1812	PMob17
1309	PWts18	1409	PWwt18	1509	PSwt18	1611	PSlw18	1714	PEne18	1814	PMob18
1310	PWts19	1410	PWwt19	1510	PSwt19	1612	PSlw19	1714c	PEne19	1819	PMob19
1311	PWts20	1411	PWwt20	1511	PSwt20	1614	PSlw20	1715	PEne20	1820	PMob20
1312	PWts21	1412	PWwt21	1512	PSwt21	1614c	PSlw21	1716	PEne21	1821	PMob21
1314	PWts22	1414	PWwt22	1514	PSwt22	1615	PSlw22	1716b	PEne22	1823b	PMob22
1314c	PWts23	1414c	PWwt23	1514c	PSwt23	1616	PSlw23	1716c	PEne23	1824	PMob23
1315	PWts24	1415	PWwt24	1515	PSwt24	1616b	PSlw24	1720	PEne24	1825	PMob24
1316	PWts25	1416	PWwt25	1516	PSwt25	1616c	PSlw25	1720b	PEne25	1826	PMob25
1316b	PWts26	1416b	PWwt26	1516b	PSwt26	1617	PSlw26	1720c	PEne26	1827	PMob26
1316c	PWts27	1416d	PWwt27	1516c	PSwt27	1619	PSlw27	1721	PEne27	1828	PMob27
1317	PWts28	1419	PWwt28	1517	PSwt28	1620	PSlw28	1723b	PEne28	1828b	PMob28
1319	PWts29	1420	PWwt29	1519	PSwt29	1620b	PSlw29	1724	PEne29	1829	PMob29
1320	PWts30	1420b	PWwt30	1520	PSwt30	1620c	PSlw30	1725	PEne30	1829b	PMob30
1320b	PWts31	1420c	PWwt31	1520b	PSwt31	1621	PSlw31	1726	PEne31	1829e	PMob31
1320c	PWts32	1421	PWwt32	1521	PSwt32	1622	PSlw32	1727	PEne32	1829f	PMob32
1321	PWts33	1423b	PWwt33	1523b	PSwt33	1623b	PSlw33	1728	PEne33	1829g	PMob33
1323b	PWts34	1424	PWwt34	1524	PSwt34	1624	PSlw34	1728b	PEne34	1829h	PMob34
1324	PWts35	1425	PWwt35	1525	PSwt35	1625	PSlw35	1729	PEne35	1831	PMob35
1325	PWts36	1426	PWwt36	1526	PSwt36	1626	PSlw36	1729b	PEne36	1832	PMob36
1326	PWts37	1427	PWwt37	1527	PSwt37	1627	PSlw37	1729c	PEne37		
1327	PWts38	1428	PWwt38	1528	PSwt38	1628	PSlw38	1729d	PEne38		
1328	PWts39	1428b	PWwt39	1528b	PSwt39	1628b	PSlw39	1730	PEne39		
1328b	PWts40	1429	PWwt40	1529	PSwt40	1629	PSlw40	1731	PEne40		
1329	PWts41	1429b	PWwt41	1529b	PSwt41	1629b	PSlw41	1732	PEne41		
1329b	PWts42	1429c	PWwt42	1529c	PSwt42	1629c	PSlw42				
1329c	PWts43	1429d	PWwt43	1529d	PSwt43	1629d	PSlw43				
1329d	PWts44	1429e	PWwt44	1529e	PSwt44	1629e	PSlw44				
1329e	PWts45	1429f	PWwt45	1529f	PSwt45	1629f	PSlw45				
1329f	PWts46	1430	PWwt46	1530	PSwt46	1630	PSlw46				
1330	PWts47	1431	PWwt47	1531	PSwt47	1631	PSlw47				
1331	PWts48	1432	PWwt48	1532	PSwt48	1632	PSlw48				
1332	PWts49										