Funded by the European Union

1 PRODUCT3: MUST-B PLANNING TOOLKIT

1.1 Brief description of PRODUCT3

The MUST-B Planning Toolkit is a block-based, planning-level decision-support tool for early-stage screening and prioritisation of decentralised stormwater and combined sewer overflow (CSO) mitigation strategies. It uses urban blocks—areas enclosed by streets—as hydrological response units. The toolkit estimates block-scale runoff and pollution potential, pre-sizes decentralised interventions such as Low-Impact Development (LID) and Nature-based Solutions (NbS), and evaluates their influence on downstream sewer performance using data-reduced hydraulic modelling. MUST-B supports scenario-based analysis, comparison of intervention strategies, and prioritisation of areas for further investigation, while relying primarily on open-source data and software.

The MUST-B Planning Toolkit is designed to work with widely available open-source geospatial data when surveyed sewer networks are unavailable, while also enabling the integration of detailed local datasets in data-rich settings. The toolkit integrates two open-source components: UrbanWaterBlocks, which supports block delineation, attribute mapping, runoff screening, and pre-sizing of decentralised measures, and pysewer, which generates synthetic drainage networks and performs hydraulic simulations using EPA SWMM. This integrated workflow enables consistent scenario analysis and comparison of decentralised intervention strategies at the neighbourhood to district scale.

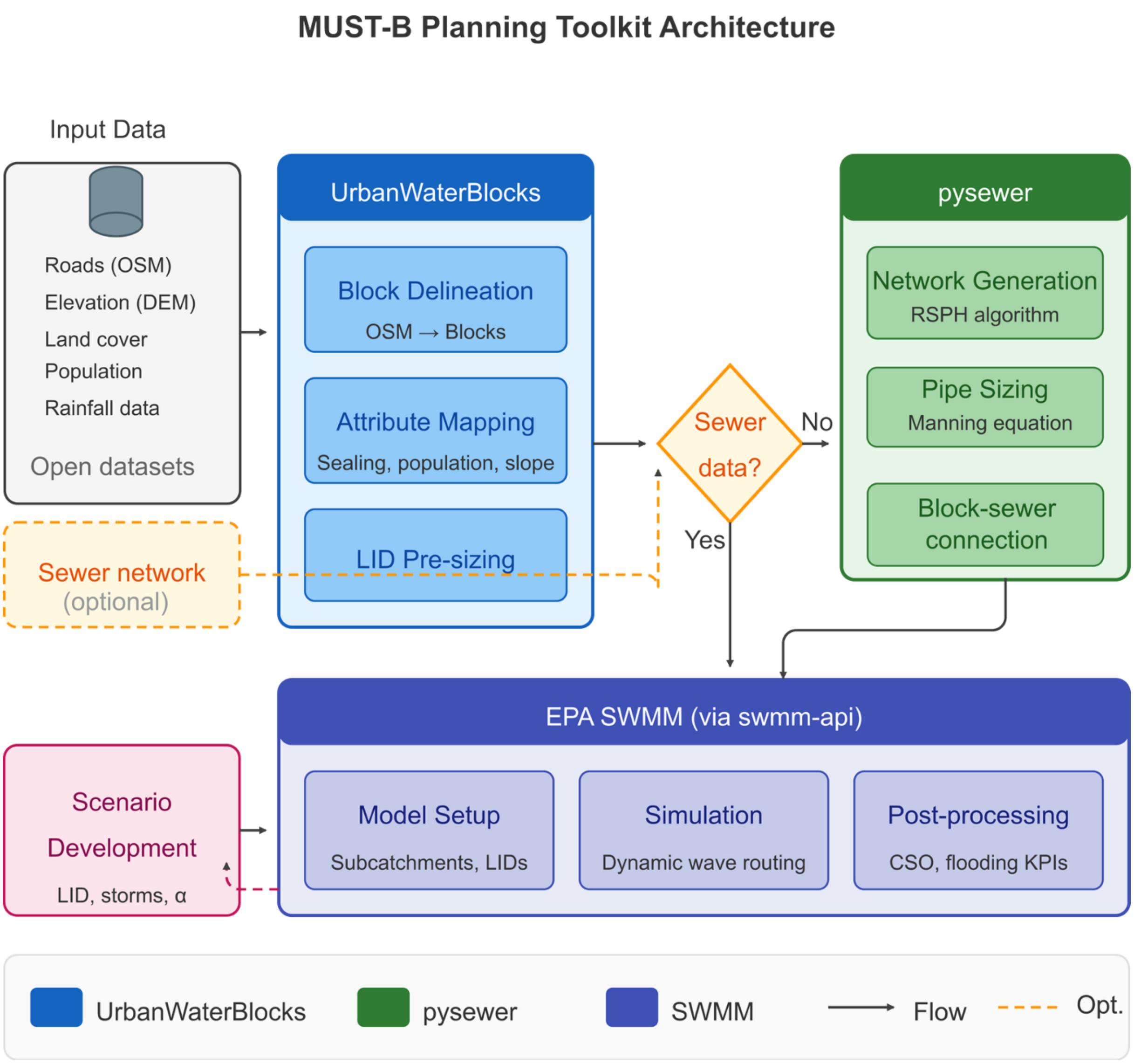

Figure 1: MUST-B planning tool architecture. Integration of the core tools and workflow developed with the WATERUN Project (See Deliverable 3.4 for more details).

1.2 Target users, benefits and answers to the EU directive

The MUST-B Planning Toolkit is intended for urban planners, water utilities, municipal engineers, consultants, and researchers involved in strategic stormwater and wastewater planning. It is particularly suited for authorities and organisations operating at the pre-feasibility or early planning stage, where multiple decentralised intervention strategies must be screened and prioritised, and where detailed sewer network data may be unavailable, incomplete, or restricted.

The toolkit enables consistent, spatially explicit assessment of decentralised stormwater and CSO mitigation strategies at the urban block scale. Key benefits include rapid identification of priority intervention areas, planning-level estimates of runoff and pollution reduction potential, and comparison of alternative scenarios under varying rainfall and connectivity assumptions. By relying on open geospatial data and data-reduced hydraulic modelling, MUST-B lowers data and resource barriers, improves transferability across cities, and supports informed decision-making at neighbourhood to city scales. It helps cities focus detailed investigations and investments where they are most likely to be effective.

In the context of the revised EU Urban Wastewater Treatment Directive (2024), which sets strategic targets to limit combined sewer overflows and encourages more integrated management of urban runoff, MUST-B provides a planning-level response by enabling cities to explore the feasible range and limits of decentralised interventions. The toolkit supports early assessment of where CSO reduction targets may be challenging to achieve, how decentralised measures can reduce loads entering sewer systems, and which areas should be prioritised for follow-up analysis and implementation. While not a compliance or design tool, MUST-B Planning Toolkit helps align urban water planning with EU policy objectives by supporting proactive, evidence-based strategies toward runoff and pollution reduction.

1.3 Requirement for implementation

Implementation of the MUST-B Planning Toolkit requires limited data and technical resources, reflecting its role as an early-stage planning and screening tool. The core requirements include access to open and widely available geospatial datasets, such as road networks for urban block delineation, digital elevation models for flow routing, land-cover or imperviousness data for runoff estimation, and basic population or land-use data for pollution load proxies. Where available, detailed local datasets (e.g. surveyed sewer networks or high-resolution land use) can be incorporated to refine results but are not mandatory.

From a technical perspective, implementation requires a GIS-capable computing environment and familiarity with Python-based open-source tools. The toolkit integrates UrbanWaterBlocks (Dev Roy et al., 2026; Lippera et al., 2025) for block generation, attribute mapping, and decentralised intervention pre-sizing, and pysewer (Despot et al., 2026; Sanne et al., 2024) for synthetic sewer network generation and preparation of hydraulic models for EPA SWMM. Users should have a basic understanding of urban drainage processes and planning objectives, but advanced hydraulic modelling expertise is not required at the screening stage. Overall, MUST-B Planning Toolkit is designed to be transferable and scalable, allowing municipalities and practitioners to apply it efficiently across neighbourhoods or entire cities with modest data and resource demands.

1.4 Availability & accessibility

The MUST-B Planning Toolkit is fully based on open-source software and open or widely accessible geospatial data, ensuring broad availability and low barriers to adoption. Its core components—UrbanWaterBlocks and pysewer—are openly available and can be deployed without proprietary software licenses. This design choice supports transparency, reproducibility, and transferability across different cities and institutional contexts.

Accessibility is further enhanced by the toolkit's reliance on commonly available datasets such as OpenStreetMap, open digital elevation models, and publicly accessible land-cover and population datasets. As a result, the toolkit can be applied in both data-rich and data-scarce environments, including cities where sewer infrastructure data are unavailable due to security, institutional, or technical constraints. The accompanying manual provides structured guidance on data preparation, workflow execution, and result interpretation, enabling practitioners to apply the toolkit consistently while adapting it to local planning needs. The published version of the tools are available at the following links:

1. Pysewer: https://git.ufz.de/despot/pysewer
2. UrbanWaterBlocks: https://zenodo.org/records/17396242

1.5 Simplified protocol for the use of PRODUCT3

The process begins with the preparation of essential spatial and rainfall inputs. A city boundary is defined, and open geospatial datasets describing topography, land cover or imperviousness, and population distribution are collected. In parallel, representative rainfall inputs are defined using intensity–duration–frequency (IDF) curves or design rainfall events derived from national meteorological data.

In the next step, the urban area is discretised into blocks by converting the street network into closed polygons or by importing existing block geometries from local GIS sources. These urban blocks form the core spatial units of the toolkit. Each block is then enriched with a limited set of attributes derived from open raster datasets, including total area, sealed and unsealed surface fractions, population proxies, and topographic characteristics. As part of this step, the largest connected unsealed area within each block is identified and defined as the potential planning area for decentralised interventions, providing a conservative and realistic basis for intervention placement (Dev Roy et al., 2026; Lippera et al., 2025).

Based on the enriched block attributes, decentralised stormwater measures are pre-sized at the block scale using design storm runoff volumes. For each block, runoff generated from sealed surfaces during the selected rainfall event is compared against the available planning area to estimate the required size and achievable performance of decentralised measures such as bioretention cells or infiltration shafts (Dev Roy et al., 2026; Lippera et al., 2025). Where spatial constraints limit full retention, partial retention is quantified, allowing realistic assessment of implementation limits. This pre-sizing step is repeated for multiple rainfall scenarios or return periods to support scenario-based comparison.

Where assessment of downstream impacts is required, block-scale outputs are subsequently linked to a drainage network representation. If surveyed sewer data are unavailable, a synthetic, gravity-driven sewer network is generated using block geometry, street layout, and digital elevation data (Despot et al., 2026; Sanne et al., 2024). Each block is connected to the network through physically plausible inlet locations, and flows are routed toward defined outlet points. Alternatively, existing sewer network data can be integrated where available. Dynamic hydraulic simulations are then performed using EPA SWMM to evaluate flow routing, surcharge behaviour, and the activation of combined sewer overflows under different intervention scenarios (Despot et al., 2026).

The final step focuses on interpretation and comparison of results rather than absolute prediction. Planning-level performance indicators—such as runoff retained at source, reduction in downstream discharge or CSO volume, hydraulic stress indices, and cost per unit volume reduced—are evaluated relative to a baseline scenario. These indicators are used to identify priority blocks and neighbourhoods, compare alternative intervention strategies, and assess trade-offs between decentralised and network-based measures. The outputs support strategic planning decisions and help identify locations where more detailed analysis or design is warranted, while detailed optimisation and regulatory compliance assessments remain outside the scope of this protocol.

1.6 Decision-making capability

The MUST-B Planning Toolkit supports strategic decision-making by enabling scenario-based comparison of decentralised stormwater and CSO mitigation strategies at the urban block, neighbourhood, and catchment scales. It provides spatially explicit indicators that help identify priority areas for intervention, estimate the realistic potential of decentralised measures, and explore how these measures interact with sewer network capacity under different rainfall conditions.

Rather than producing detailed design outputs, the toolkit is intended to inform planning decisions at stages when uncertainty is high but strategic flexibility is greatest. It allows decision-makers to compare alternative intervention strategies, assess trade-offs between performance and cost, and identify locations where regulatory targets—such as CSO reduction objectives—may be difficult to achieve without further action. By focusing on relative differences between scenarios and highlighting structurally important areas and bottlenecks, MUST-B Planning Toolkit helps prioritise follow-up studies, guide investment strategies, and support evidence-based urban water management planning.

1.7 Application to WATERUN case studies

This section presents application case studies ordered to reflect the primary focus of the MUST-B Planning Toolkit on combined sewer overflow (CSO) and overflow mitigation. The Santiago de Compostela case is presented first, as it directly targets CSO reduction in a monitored combined sewer system. Subsequent cases illustrate its application in separate systems and data-scarce contexts, highlighting its transferability across contrasting urban and infrastructural settings.

Common Steps Across Case Studies:

1. Block generation from road networks
2. Attribute mapping from raster data
3. Synthetic network generation (where applicable)
4. Scenario analysis for LID deployment—bioretention cells and infiltration shaft as chosen technologies. These technologies were modelled without underdrains to isolate the infiltration-driven performance.
5. Performance evaluation against targets

Santiago de Compostela (Spain)

Santiago de Compostela (Cancelón catchment) represents a dense, historic urban area characterised by limited space for conventional infrastructure upgrades and a combined sewer system prone to overflow during intense rainfall events. As a UNESCO World Heritage site, interventions are constrained by heritage protection, making decentralised strategies particularly relevant. The case study investigates how urban blocks can be used as hydrological response units to support early-stage planning of low-impact development (LID) measures, focusing on their potential to reduce combined sewer overflow (CSO) volumes under realistic spatial constraints.

The analysis applies block-scale LID pre-sizing and routes runoff through a synthetic combined sewer network to evaluate CSO behaviour under design storms derived from IDF analysis. Results show that substantial reductions in CSO volume can be achieved through decentralised interventions, even when only a fraction of the available space is utilised. The modelling approach reproduces key system dynamics at planning scale and enables identification of efficient intervention ranges, supporting early-stage decision-making before detailed design. This case demonstrates the value of data-reduced, block-based modelling for screening feasible CSO mitigation strategies in complex urban environments.

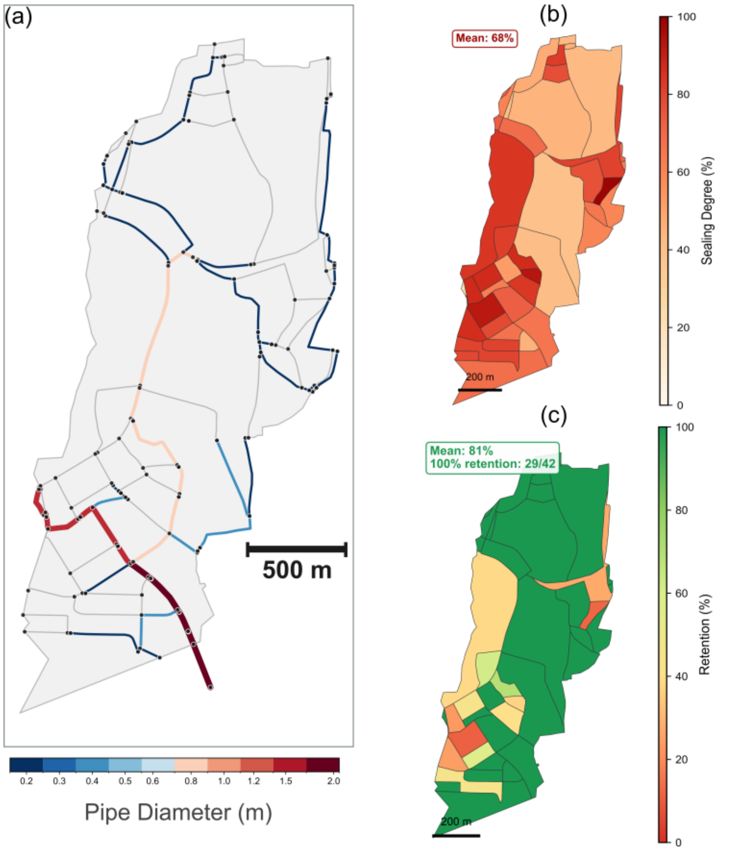

Figure 2: Santiago de Compostela (Cancelón catchment). Synthetic sewer network layout (a), spatial distribution of imperviousness (b), and block-scale runoff retention potential (c)l. Together, these layers illustrate how urban structure, surface characteristics, and decentralised interventions interact to influence CSO generation and mitigation at planning scale.

Aarhus (Denmark)

Aarhus (Risvangen district) represents a well-developed urban area served by a separate stormwater system designed to safely convey runoff and discharge it through defined stormwater outlets to receiving waters, including the Bay of Aarhus. The existing system reflects a resilient and carefully engineered design, with a primary focus on flood protection of buildings and public space. In this context, the model applied here is not intended to reproduce monitoring data or represent the detailed design of the existing system. Rather, it provides a simplified, planning-scale representation of the contributing area to support early-stage scenario screening. In consultation with Aarhus Vand, it is also acknowledged that infiltration-based decentralised interventions are constrained by local soil conditions and a high groundwater table, and are therefore not considered a primary strategy in this case.

The analysis uses block-scale hydrological representation and synthetic network modelling to explore how decentralised interventions can supplement the existing drainage system. In consultation with Aarhus Vand, infiltration-based solutions were considered unsuitable due to local soil conditions and a high groundwater table. The focus was therefore placed on retention-based measures and their ability to reduce discharge volumes at stormwater outlets. Results show that decentralised interventions can significantly reduce downstream discharge and complement system performance, even in a well-functioning network. This case highlights how the toolkit supports exploration of cost–performance trade-offs and identifies feasible solution ranges, contributing to the broader objective of limiting pollutant transport to sensitive water bodies through reduced stormwater discharge.

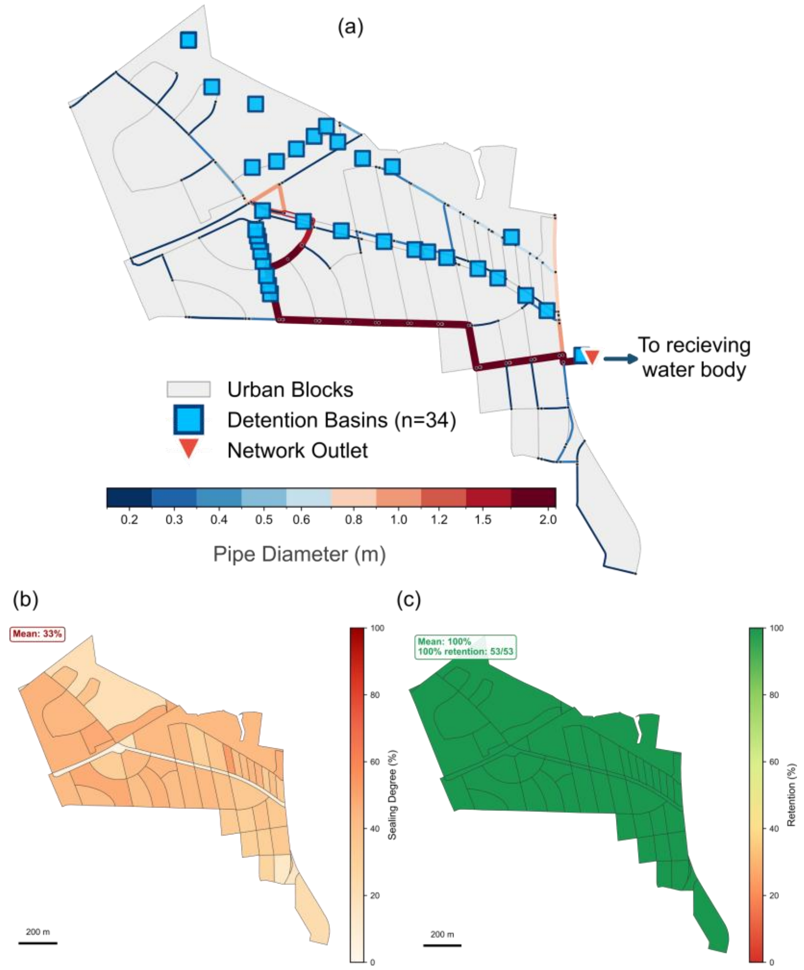

Figure 3: Aarhus (Risvangen district). Synthetic stormwater network (a), spatial distribution of imperviousness (b), and block-scale runoff retention potential using bioretention cell dimensioned for a 100-year return period (c). The figure illustrates how decentralised interventions interact with an existing separate stormwater system to reduce discharge at defined stormwater outlets to receiving waters.

Amman (Jordan)

Amman (Al-Zuhour catchment) represents a steep, topographically complex urban area characterised by rapid runoff generation and flash flooding during intense rainfall events. The existing stormwater system conveys runoff toward downstream storage and outfalls at the Al-Zuhour Triangle, where recent infrastructure upgrades—including a 2100 m³ underground detention tank and a 750 m³ bioretention system—provide flood relief to downstream areas. Despite these measures, the catchment remains hydraulically challenging due to strong elevation gradients and fast flow concentration.

The case study applies a data-reduced, block-based representation to evaluate how decentralised interventions can supplement the existing system and reduce runoff pressures during design storms. Results show that targeted block-scale measures significantly reduce surface flooding and downstream discharge, with performance improvements achieved even when combined with simplified network configurations. The analysis highlights that a limited number of blocks dominate runoff contributions, making targeted interventions more effective than uniform implementation. This case demonstrates how the toolkit supports early-stage screening in data-scarce and complex urban environments, identifying where decentralised measures provide the greatest added value to existing infrastructure.

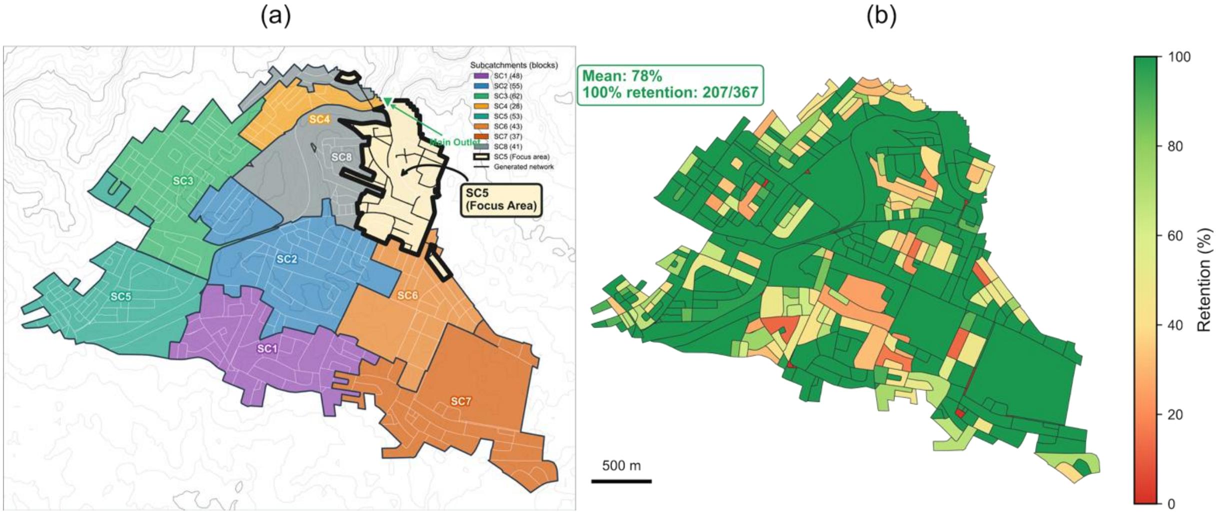

Figure 4: Amman (Al-Zuhour catchment). (a) Block-scale delineation and drainage structure at the Al-Zuhour Triangle, illustrating runoff pathways toward downstream storage and outfalls. (b) Spatial distribution of bioretention performance (T100, 120-min design storm), showing block-scale variability in runoff retention and highlighting priority areas for intervention.

1.8 Developer and contact information

The MUST-B Planning Toolkit was developed by the Helmholtz Centre for Environmental Research – UFZ GmbH, Leipzig, Germany.

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