DRIN CORDA

Enabling
& Transboundary Cooperation
Integrated Water Resources Management
in the extended DRIN RIVER BASIN

GEF/UNDP/GWP-Med Project "Enabling Transboundary Cooperation and Integrated Water Resources Management in the Extended Drin River Basin

In the framework of the Memorandum of Understanding for the Management of the Extended Transboundary Drin Basin

Pilot activity "Preparation of Wastewater Management Decision Support Tool"

Wastewater management solutions in the Shkodra city

Report

Annex 7: Action plan for the improvements of the wastewater collection system and stormwater management in the city of Shkodra

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The Coordinated Action for the implementation of the Memorandum of Understanding for the management of the Drin basin (Drin CORDA) is supported by the GEF Drin Project. Thus, the latter constitutes an institutional project implemented by the United Nations Development Programme (UNDP) and executed by the Global Water Partnership (GWP) through GWP-Mediterranean (GWP-Med), in cooperation with the United Nations Economic Commission for Europe (UNECE). The Drin Core Group (DCG), being the multilateral body responsible for the implementation of the Memorandum of Understanding serves as the Steering Committee of the Project. GWP-Med serves as the Secretariat of the DCG.

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1.1 General recommendations

Good water quality is essential to human health, social and economic development, and the ecosystem. However, as populations grow and natural environments become degraded, ensuring sufficient and safe water supplies for everyone is becoming increasingly challenging. A major part of the solution is to produce less pollution and improve the way we manage wastewater.[1]
Safely managed wastewater is an affordable and sustainable water source, energy, nutrients, and other recoverable materials.[2]

As a minimum, the following key principles should be included in the planning process of wastewater infrastructure[3]:

- **The regulatory framework:** Albanian/EU legal framework related to wastewater services. Wastewater infrastructure implementation must comply with existing legislative requirements. In the process, consultation with all relevant regulatory bodies in order to obtain all relevant approvals is necessary.
- **Effective knowledge management:** critical foundation for quality infrastructure planning - is flexible to using new and evolving technologies and should be updated on an ongoing basis[4].
- **The planning process:** infrastructure planning should be a continuous process. High policy planning includes strategic and regional planning, spatial (land use) planning, and river basin planning, while local infrastructure planning includes master planning, feasibility/concept planning, and detailed planning.
- **Stakeholders:** Identifying and effectively manage stakeholder relationships is critical to the successful planning and project delivery. Involving stakeholders through consultation, participation, education, joint planning, co-operation. Plan activities according to their requirements/needs: stakeholders involved in planning/project, approval stakeholders affected during implementation/construction, stakeholders that provide revenue sources, stakeholders that consume products/services without direct payment, stakeholders with special requirements. Develop and implement a stakeholder management plan/strategy.
- **Demand/flow and projections:** assessment of water demand. Design projections are fundamental to planning. Use the latest norms, regulations, and standards. Determine key parameters such as time horizon, hydraulic, and pollution loadings. Include scenario analysis to assess the impact of changing variables on the demand projections. In general, a distinction between starting, potential, and actual demand can be made.[5] Seasonal peaks must be taken into account.
- **Analysis of options: Investment decisions can be made only through** analysis that considers financial, social, and environmental impacts (positive and negative) and implementation risks throughout the lifecycle of the infrastructure.
- **Implementation:** a thorough review of potential risks and how they will be managed have to be addressed.
- **Planning outputs:** Planning should demonstrate a rigorous examination of options, costs, and risks to be undertaken; all legislative, financial, environmental, and social issues to be addressed or at least considered.

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[1] https://www.unwater.org/water-facts/quality-and-wastewater/
[2] http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/
[3] https://www.dews.qld.gov.au/__data/assets/pdf_file/0016/80053/water-sewerage-planning-guidelines.pdf
[4] https://www.nacwa.org/docs/default-source/resources---public/eum-primer-final-1-24-17.pdf
[5] https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

General management and administration problems in Shkodra city are dressed in the Table 1.

Table 1: Proposed steps/solutions for general management and administration problems in Shkodra city

Identified problem	Suggested step/solution
Lack of data related to wastewater infrastructure	- an investigation of the existing condition of the sewerage system - an assessment of flow and pollution loads within the sewerage system under existing and future/ultimate development conditions; - an analysis of the hydraulic capacity of sewerage system; - an establishment of data system support in detail.
Lack of wastewater infrastructure (sewerage network, WWTPs)	- identification of short, medium and long-term outcomes (financial, social, environmental); - evaluation/option analysis (comparison of centralised and de-centralised system, financial evaluation of different options where appropriate, comparison of technical solutions concerning treatment processes); - determine optimal strategy/solution at the lowest financial, social and environmental cost. - communicate outcomes with stakeholders; - find source of financing for initial investment and 0&M costs (economic indicators for project overall performance; cost recovery, affordability analysis; …),
Lack of funding for O&M activities	- analysis of water tariff; - affordability analysis; - awareness raising; - capacity building.

The planning process is not linear as illustrated in the Figure 1, but more intertwined. Figure *1*: The wastewater planning process

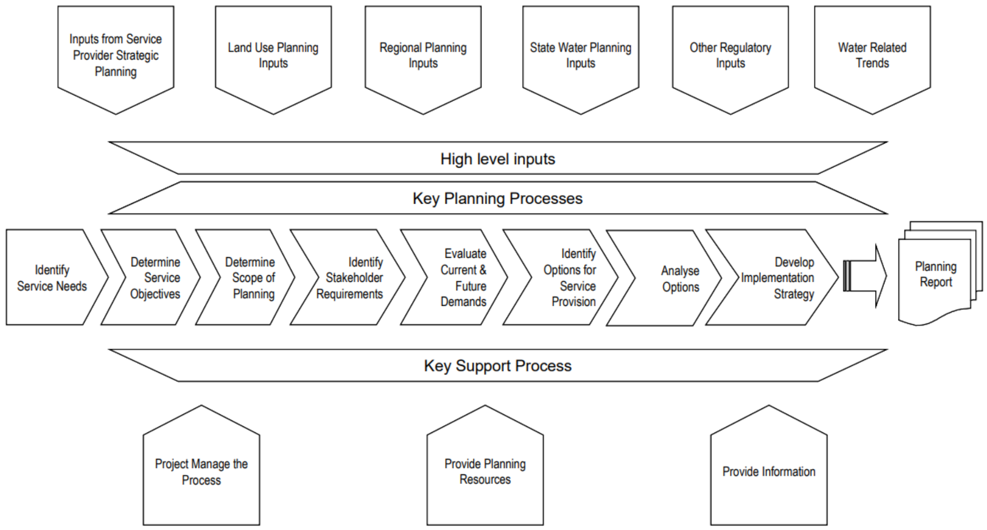


Figure 1: The wastewater planning process[6]

Below general planning recommendations are summarized:

- **Previous studies**

All studies considered must comply with existing strategic documents and plans. If necessary, an audit must be carried out.

- **Design life**

For the design life of sewage installations, reference should be made to ANNEX I to Commission Delegated Regulation (EU) No 480/2014. (Figure 2).

Figure 2: European Commission's reference period

Sector	Reference period (years)
Water supply/sanitation	30

- **Land**

In order to minimize land acquisition costs and save time, wastewater infrastructure should best be located on municipal/governmental land. Option analyses include alternatives impacted by the location.

- **Environmental considerations**

In planning, design, and construction of wastewater infrastructure, considerations should be given to the impacts on air, noise, and water pollution, and appropriate mitigation measures should be implemented. Legally binding environmental permits or similar ensures compliance with the environmental standards/requirements.

- **Flow and load estimation**

Existing data sources should be reviewed. In addition, detailed analysis and justification of accepted design values must be included. Existing municipal and industrial loads should be separated and harmonized with regional load parameters. A special focus must be on demographic dynamics and development.

[6] https://www.dews.qld.gov.au/__data/assets/pdf_file/0016/80053/water-sewerage-planning-guidelines.pdf

1.2 Sewer rehabilitation

Typical renovation/development of wastewater infrastructure includes[7]:

- replacement/extension of the sewage network (either combined or separate),
- construction /rehabilitation of wastewater treatment systems,
- construction/rehabilitation of wastewater treatment plants with more stringent treatment for the reuse of water,
- infrastructure for stormwater drainage.

The level of technical recommendations to improve the wastewater collection system depends on the availability and quality of input data. Recommendations for Shkodra city are very general due to poor database on the wastewater network's design and operation. To define specific recommendations for the future, a collection of further data is necessary as follows:

- Location, size, level of sewer network;
- Detail operation data;
- Data on flows, infiltration rate or leakages;
- Any other relevant data (studies, plans).

The investor should create good data on existing (historical) breaks into the system and target areas of the highest problems. In choosing a method for rehabilitating sewer collection systems, it is important to understand where and why the leaks and infiltration are occurring.[8] A comprehensive approach to locating defects involves inspecting all aspects of a collection system, including manholes, sewer mains, and laterals.[9]

Justification for wastewater network rehabilitation should be made, taking into account the financial benefits of reduced operating costs expressed in EUR per annum relative to the investment cost. Rehabilitation should result in positive net present value (NPV). Reduction in infiltration also benefits the operation of the wastewater treatment plant.

Rehabilitation of sewers reduces the infiltration of water into the system and thereby relieves sewage treatment plants and increases the sewer system's capacity.[10] Groundwater and stormwater that enters a sewer system are known as inflow and infiltration.

Infiltration occurs when groundwater seeps into sewer pipes through cracks, leaky pipe joints and/or deteriorated manholes. The opposite of infiltration, the leakage of wastewater out of a sanitary sewer system through broken or damaged pipes and manholes, is called exfiltration.

Inflow is stormwater that enters the sewer system through rain leaders, basement sump pumps, or foundation drains illegally connected to the sewer. Together, inflow and infiltration place an additional burden on collection systems and wastewater treatment facilities.[11]

Both infiltration and exfiltration are issues of increasing concern within the European water industry. This is due to a growing awareness of the operational and capital costs associated with sewerage

[7] https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf
[8] https://www.avantigrout.com/images/stories/articlePics/cigmat-vipu%20white%20paper.pdf
[9] https://inbound.envirosight.com/inflow-and-infiltration
[10] Wirahadikusumah R, Abraham DM, Iseley T, Prasanth RK. Assessment technologies for sewer system rehabilitation. Automat Constr. 1998;7:259-270. DOI: 10.1016/S0926-5805(97)00071-X.
[11] https://inbound.envirosight.com/inflow-and-infiltration

collection and treatment and their impact in terms of increased pumping costs, reduced hydraulic capacity, increased frequency of overflow, sewer collapse, interference with treatment plant performance, increased surface sediment and increased groundwater pollution.[12]

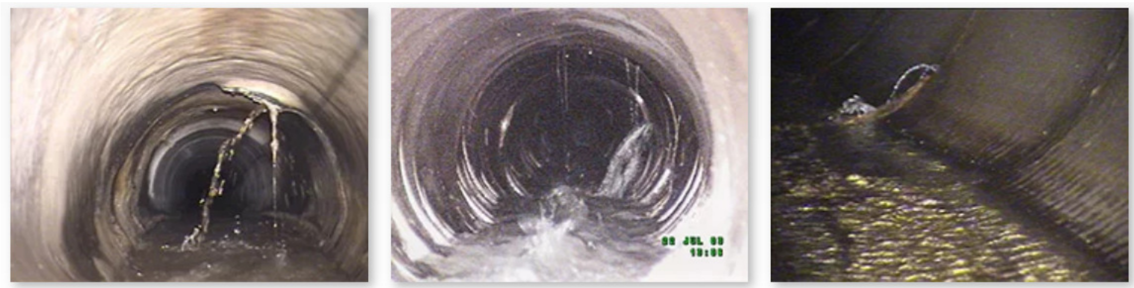


Figure 3: Sewer infiltration

The most common defects (Figure *4*), which might cause infiltration, are as follows:

- cracks,
- fractures,
- joint displacement,
- root intrusion,
- deformation,
- collapse,
- poorly constructed connections,
- abandoned laterals left unsealed.

Also, infiltration itself causes soil erosion, washing the fine soil particles into the sewer system. This soil erosion produces the problems of sinkholes, undermining the pipe supports. As a result, the pipe's structural integrity is endangered due to the washout of backfilling material.

While storm events are not considered a cause of infiltration, they can trigger a rise in groundwater levels and increase infiltration flows. The highest infiltration flows are observed following significant storm events or following prolonged periods of precipitation.[13]

[12] http://apuss.insa-lyon.fr/c001_sewer_infiltration_exfiltration_and_interactions_with_sewer_flows_and_groudwater_quality.pdf
[13] https://www.avantigrout.com/images/stories/articlePics/cigmat-vipu%20white%20paper.pdf

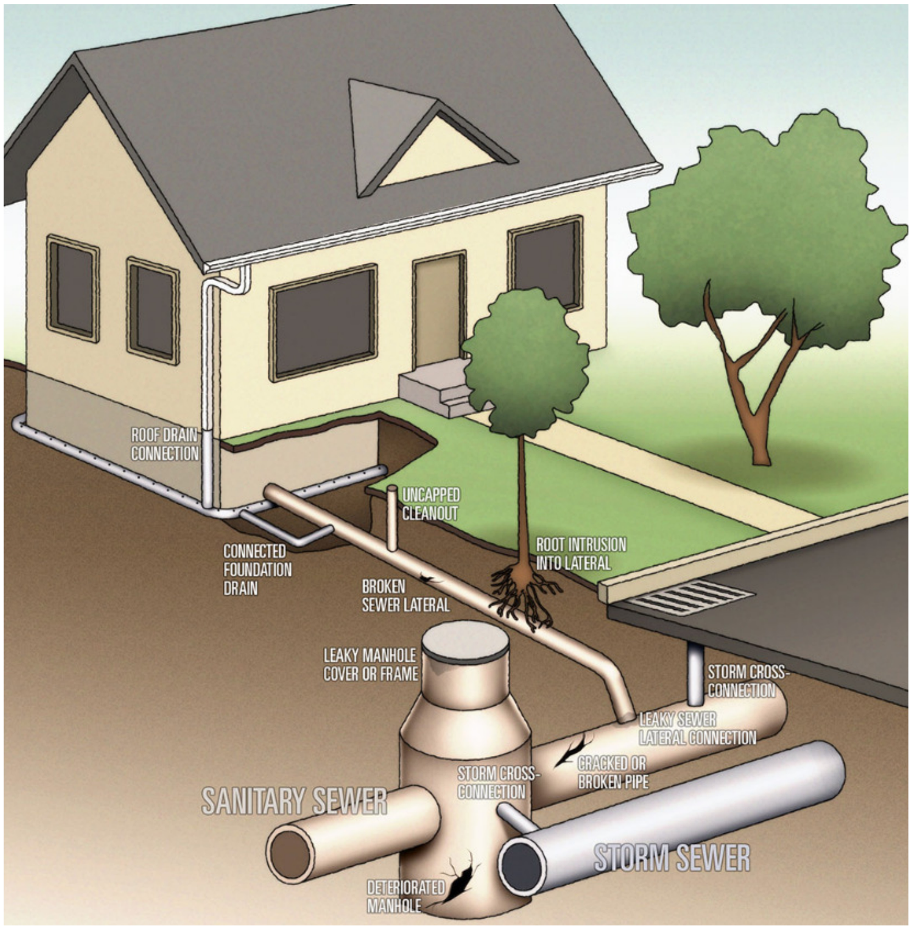


Figure 4: Common examples of infiltration in a city sanitary and storm sewer system[14].

Reference should be made to the following EU Norms:

- EN 13508-2 + A1: Investigation and assessment of drain and sewer systems outside buildings - Part 2: Visual inspection coding system
- CSN EN 1610 - Construction and testing of drains and sewers
- EN 752: Drain and sewer systems outside buildings,
- EN 752-2: Drain and sewer systems outside buildings. Performance requirements
- EN 752-3: Drain and sewer systems outside buildings. Planning
- EN 752-4: Drain and sewer systems outside buildings. Hydraulic design and environmental considerations
- EN 1295: Structural design of buried pipelines under various conditions of loading,
- EN 1610: Construction and Testing of Drains and Sewers
- EN 1916: Concrete pipes and fittings, unreinforced, steel fibre and reinforced
- EN 1917: Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced

and other wastewater related EU norms:

- EN 12255-1: General constructions principles
- EN 12255-3: Preliminary treatment

[14] http://www.sehinc.com/news/how-identify-and-reduce-inflow-and-infiltration-collection-system

- EN 12255-7: Biological fixed film reactors
- EN 12255-10: Safety principles
- EN 12255-11: General data required
- EN 12566-1/A1 June 2004: Small wastewater treatment facilities up to 50 Equivalent-inhabitant - Part 1: prefabricated septic tanks.
- EN 12566-2 November 2005: Small wastewater treatment facilities up to 50 Equivalent-inhabitant Part 2: Systems for infiltration into the soil
- EN 12566-4 Avril 2008: Small wastewater treatment facilities up to 50 Equivalent-inhabitant – Part 4: Septic tanks assembled in situ from a kit of prefabricated elements;
- EN 12566-5 (Project); Small wastewater treatment facilities up to 50 Equivalent-inhabitant - Part 5: Filtration systems for pre-treated effluent

1.3 Proposed steps/solutions

1.3.1 Problem detection

Inflow and infiltration issues can be identified through:

- Lift station pumps run for a long time after a rain event (it turns more frequently) - stormwater has entered the sanitary sewer system;
- Manhole overflowing/spills after a rainfall event;
- Flooding of basements;
- High flow measured at WWTP corresponding to precipitation events or high groundwater conditions.

The first step is to identify the location of infiltration into the sewer network:

- flow monitoring
- manhole and pipe inspections, e.g.:
    - 3D technology
    - smoke testing
    - dye testing
    - closed-circuit television inspection (CCTV)

1.3.2 Network rehabilitation program

There is currently a widespread concern regarding the condition of our aging sewer collection networks. According to Sægrov et al.[15], European cities spend an annual average of € 5 billion on sewer rehabilitation, with the tendency to increase the annual budget due to the aging process of the sewers. Sægrov et al.[16] also claims that the rationale behind rehabilitation decisions is unclear, and decisions are only made after failures occur.[17] Following the construction completion of the new infrastructures of sewerage, sewerage rehabilitation planning is a significant effort. The traditional "find and fix" approach is not cost-effective and may not even improve the sewer network's overall performance. Cost-effective sewer network rehabilitation programs should be developed based on the infrastructure data, inspection data, and cost data. GIS presents an adequate and powerful tool

[15] Sægrov S, Schilling W (2004a). Computer Aided Rehabilitation of Sewer and Stormwater Networks (CARES), 2nd International Congress "Advanced Management of Urban Drainage", Barcelona, Spain, 25-26 October 2004
[16] Sægrov S, Schilling W (2004b). Computer Aided Rehabilitation of Sewer and Stormwater Networks (CARES), COST (European Cooperation in the field of Scientific and Technical Research) 624 Final Meeting, Aix-en-Provence, May 23 –25
[17] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.575.741&rep=rep1&type=pdf

for sewer rehabilitation and cost planning[18]. Different optimization models to find an appropriate renovation strategy consisting of a rehabilitation method and a substitute material for each pipe failure under a limited budget is being developed and used.

It is vital that the program prioritizes the pipe renewal decisions (incl. risk assessment) and addresses both capital and operational expenditure. The seriousness of damage dictates action required (immediate action required/no action required). Besides, leaking in sensitive areas has a higher priority than leaking in non-sensitive areas. Following the program, the detailed design process and implementation can be performed. One of the options is also the application of multi-criteria analysis. For example, the next key indicators are presented for the evaluation of technical state and the proposal of the reconstruction program for sewer network[19]:

- network age,
- network status according to the results of a camera survey,
- sewer material,
- sewer dimension,
- sewer significance for city infrastructure,
- surcharge "capacity" characteristics of the sewer network.

Long-term planning of water and sewer network reconstructions belongs to key objectives for water utility companies. That is why the network reconstruction plans become essential documents that affect the whole system's long-term behavior under operation and the financial results at water utility organizations. Simultaneously, the development of a reconstruction plan is influenced by uncertainties originating from a lack of information about the condition of this infrastructure. Consequently, the best available technology and know-how are to be utilized once the optimal long-term investment plan in terms of cost/effect is to be achieved[20].

1.3.3 Rehabilitation actions

The most basic solution to reduce infiltration due to failing pipes is to excavate a pipe and replace it. However, doing so is costly and poses massive disruptions, both for traffic on roads (under which most sewer mains are installed) and residential customers. For this reason, less-disruptive trenchless technologies are preferred for sewer rehab.[21]

In Table 2, the advantages and disadvantages of new pipe installation are presented.

Table 2: Advantages and disadvantages of pipe replacement with a new pipe[22]

Option	Advantages	Disadvantages
New pipe installation	• Completely new pipe • Longer lifetime • Modification of diameter is possible • Simple and well-known technology	• Large surface area disturbed • Risk of damaging other pipes and cables during excavation • Disturbance of traffic • Expensive • Time consuming

When to replace show pipe, it is decided when complete structural damages occur, mainly when pipelines close to the surface or open areas with no obstacles are found. It is done using techniques

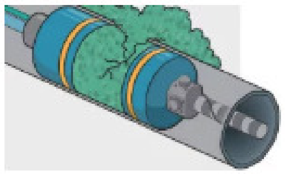
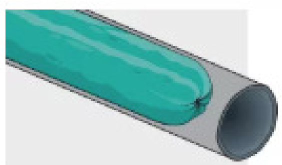
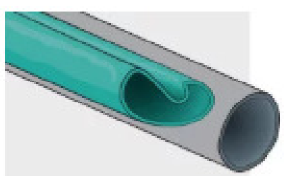
[18] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.575.741&rep=rep1&type=pdf
[19] http://documents.irevues.inist.fr/bitstream/handle/2042/35770/22404-072MET.pdf?sequence=1
[20] http://documents.irevues.inist.fr/bitstream/handle/2042/35770/22404-072MET.pdf?sequence=1
[21] https://inbound.envirosight.com/inflow-and-infiltration
[22] https://www.avantigrout.com/images/stories/articlePics/cigmat-vipu%20white%20paper.pdf

such as sliplining, pipe bursting, and mechanical spot repair. Materials such as thermoformed pipe, shotcrete, gunite, cured-in-place pipe, and grout in place pipe are utilized. Trenchless rehabilitation is a cost-effective approach to the repair or replacement of underground pipes.[23] In Table 3, he infiltration reduction techniques (trenchless technologies) are illustrated.

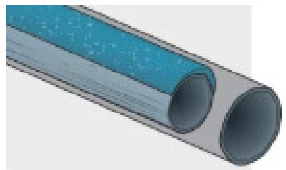
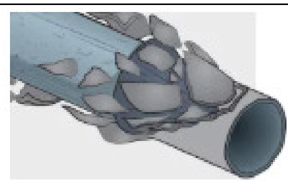
Maintaining a collection system is complicated, requiring operators to balance available resources with the system's needs, particularly when weighing localized rehab (spot repair) against comprehensive (end-to-end) alternatives.[24] Sometimes the end-to-end repair is inevitable, but sometimes there are cheaper methods.

[23] https://www.trenchlesspedia.com/definition/3005/trenchless-rehabilitation
[24] https://inbound.envirosight.com/prt-spot-repair-vs-end-to-end

Table 3: Trenchless rehabilitation methods in sewer collection systems and underground structures[25]

Options	Picture[26]	Description	Advantages	Disadvantages	Areas of Application
POINT REPAIR: spot repairs are able to address localized defects less expensively, faster, and often with less disruption than end-to-end methods.					
Chemical Grout		Impregnation of the soil surrounding the pipe with a curable compound, thus effectively sealing the soil. Chemical grout can be used to stop leaks in pipe joints and cracks, as well as leaks around lateral connections and leaks in manholes.	• No excavation • Very flexible • Repair limited to damaged area • Quick • Economical • Longevity • Stops I/I • Stabilizes soil outside the pipe	• No structural repair to the pipe itself, except for stabilization of the supporting soils outside the pipe.	• Repair of sewer line joints • Manhole infiltration • Lateral infiltration • Underground structures • Tunnels • Parking Structures • Subways
Other point repair technologies: mechanical point repair, cement grount, rerounding					
END TO END PIPE REPAIRS					
CIPP Lining		Flexible tube externally coated with a polyurethane membrane and internally with resin, is inverted on site by air/water pressure. The tube turns inside out and travels down the pipe and is later cured by hot water.	• No excavation • Economic compared to manhole-to-manhole replacement • New pipe within old pipe	• Tightness of liner to pipe is questionable; an annular space exists. • Does not stop I/I • Expensive	• Repair of holes and areas of extensive cracking
Fold and Form Liner or Deform/reform		A folded thermoplastic pipe is pulled into place through a manhole and then rounded, using heat or steam and pressure to conform to the internal diameter of the existing pipe.	• No excavation • New pipe within old pipe	• Reduction of pipe diameter • Long-term buckling strength may be an issue • Does not stop I/I • Expensive • Limited to small diameter pipes	• Repair of holes and areas of extensive cracking

[25] https://www.avantigrout.com/images/stories/articlePics/cigmat-vipu%20white%20paper.pdf
[26] https://inbound.envirosight.com/inflow-and-infiltration

Options	Picture[26]	Description	Advantages	Disadvantages	Areas of Application
Slip Lining or Pipe insertion		Insertion by pulling or pushing a new pipe into the old one. The remaining annular space may be filled with granular material.	• New pipe within pipe	• Reduction of pipe diameter • Full length of pipe has to be lined • Lateral connection is difficult to reconnect • Does not stop I/I • A large annular space exists in slip lining unless the annular space is grouted • Expensive	• From manhole to manhole • Medium level of damage
Pipe Bursting		Technique which uses radial forces to break out and push away the pieces of the existing pipe and permit a new pipe to be simultaneously installed	• New pipe inserted • Limited surface disruption	• Excavation required • Laterals reconnected by digging • Expensive	• Replacement of badly damaged sewers • Runs with few laterals • Can result in a new, pipe with larger diameter
Other end to end repair technologies: spray-lining and pipe reaming.					

Beside typical sewer rehabilitation methods presented above, measures should also focus on eliminating stormwater discharges as follows:

- Disconnect street/roof/yard drains connected to the sewer network;
- Disconnect overflows from storm drains;
- Disconnect illegal stormwater connections.

Leaky or vented manhole covers also contribute to overall infiltration. Fortunately, there are some actions one can take after a manhole inspection reveals inflow and infiltration. Here are few[27]:

- Replacement of manhole cover of right type. Covers should not be submerged during rain events.
- Replacement of damaged manholes.
- Lining of the manhole.
- Chemical grouting to seal up leaky joints.

Buried hollow structures, such as plastic and concrete manholes, tend to float out of the ground under high groundwater conditions.[28] In areas of the high-water table, manholes have to be designed against flotation. Any buried hollow structure must be designed, installed, and anchored to resist potential flotation forces.

Figure 5: Manhole buoyancy consequences[29] and manhole with double bottom[30] prevents deformation

In Shkodra city groundwater level is undoubtedly quite high, especially in the lower part at the lake level.

[27] http://www.sehinc.com/news/how-identify-and-reduce-inflow-and-infiltration-collection-system

[28] http://www.davandam.com/files/125865801.pdf

[29] https://www.eng-tips.com/viewthread.cfm?qid=434165

[30] https://www.zagozen.si/si/kanalizacija/kanalizacijski-revizijski-jaski/pe-kanalizacijski-revizijski-jasek/5g-jaski-z-dvojnim-dnom

The system has to be designed to minimize the infiltration of clean water into the sewer, which hydraulically overloads the sewer system.

Some manufacturers and designers use an extended base to provide additional resistance to buoyant forces. These structures are constructed with a lip extending beyond the outer edges of the manhole and are termed extended base manhole installations. An extended base manhole (Figure 6) uses the additional weight of soil above the lip and its self-weight and frictional forces to resist flotation.[31] Besides, the inundation level has to be taken into account and used to prevent the flotation of pipes.

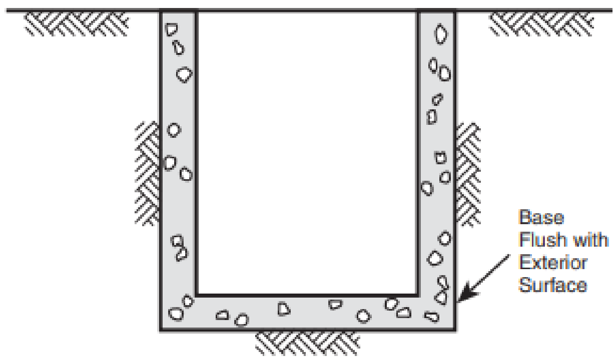


Figure 6: Cross section of an extended base manhole

The commonly used types of pipe, pipe joints, and joint material can perform satisfactorily in sanitary sewers. The effectiveness of sewer joints for infiltration control is so vital that no sewer system is better than its joints. The field performance represents the sum of the manufactured joint characteristics and the contractor`s installation practice.[32]

1.3.4 Flood affected sewer systems

During a heavy storm, the flow in the sewer is much greater and can reach maximum capacity. Sewers are designed to cope with the vast majority of storms, but occasionally extreme events can be so massive that it overwhelms the system. When this happens, sewage can overflow from manholes and gullies and flood land, rivers, and gardens. In the worst cases, sewage can even flood homes. That is why the first step is stopping floods from happening, constantly upgrading pipes and keeping everything flowing as it should be. All pipes should be in good condition by replacing and repairing damaged sewers and those that might cause future problems. However, there will always be the odd flood that comes as an unwelcome surprise. When the flood is caused by heavy rainfall, it is vital to keep track of when this happens and gather data on which parts of the wastewater network more support is required and measures to stop the occurrence in the future. It is essential to prioritize the worst-hit areas, so sometimes a repair might have to wait several years. In the meantime, some measures help to protect a home from future floods (like flood-proof doors and gates). Infection problems arising from floods are rare. Usually, any harmful bugs in floodwater become very diluted and present a low risk.
Flooding of Shkodra city has the following impact on the sewer system:

[31] https://www.concretepipe.org/wp-content/uploads/2014/09/DD_41.pdf
[32] https://www.concretepipe.org/wp-content/uploads/2015/05/extra_flow.pdf

- Stormwater flooding event
    - Local overload leading to surface water and sewer surcharge and flooding (high impact)
- Flooding of a river or a lake
    - Solids deposited in inundated surface water sewers - sewers overflowing, floodwaters contaminated (medium impact)

General preventive and maintenance measures for urban sanitation systems to be prepared for extreme weather events[33]:

- Reliable forecast on meteorological and hydrological conditions as well as information on current weather conditions;
- Use of simulated hydrological models of water runoff based on precise measurements and calibration increase knowledge of the vulnerability of the system related to changes in the surrounding hydrological conditions;
- Use of mathematical models to illustrate the hydraulic characteristics of the sanitation system helps to identify its most critical points;
- For large systems the central operational unit can be in charge to steer and supervise the response of the network;
- Maintain the system and its important nodes periodically (clean and wash pipelines and tanks to prevent aggregation of sediments, perform regular maintenance of machines, pumping stations and their electric parts);
- Develop and regularly update maintenance, crisis and emergency plans based on the cooperation of all actors (facilities owners, operators, municipal authorities, road management, river basin authorities, flood authorities, flood forecasting authorities, stakeholders, etc.);
- Train the staff for the emergency (drought, flood, storm, wind, etc.);
- Involve and inform the public;
- Test the emergency system regularly.

Specific measures for protection against flood and mitigation of their impact are recommended[34]:

- Flood proof manhole cover;
- Watertight joints or manhole without joints or with joint restraint;
- Separate rainwater from the sewer system where possible;
- Install a spare flood pump available for emergencies;
- Have an electricity source prepared as a power failure may occur during flood or storm;
- Establish an alarm system that enables a quick response in case of extreme events.

[33] http://www.euro.who.int/__data/assets/pdf_file/0016/160018/WHOGuidanceFVLR.pdf
[34] http://www.euro.who.int/__data/assets/pdf_file/0016/160018/WHOGuidanceFVLR.pdf

1.3.5 Overview of technical problems is Shkodra city

Overviews of technical problems in Shkodra city are addressed in Table 4.

Table 4: Proposed steps/solutions for technical problems in Shkodra city

Identified problem	**Suggested step/solution**
Pipe replacement	- New pipe installation - or t*renchless rehabilitation methods* When replacing defective pipes by open excavation method, attention should be drawn to the following: maintenance of the existing flow; the traffic conditions; the presence of underground utilities; nuisance and inconvenience to the public; excavation dewatering; and working area and shoring requirement. Many of the defective sewers in the urbanized area have become undersized because of city expansion and redevelopment, and if feasible the chance should be taken during the remedial works to replace them with larger pipes.
Inflow and infiltration into the sewage network	- flow monitoring - inspection - development of cost-effective sewer network rehabilitation program - rehabilitation actions (design and implementation)
Flooding of sewage network	- regular maintenance and operation activities - prevent inflow and infiltration (rehabilitation actions) - installation of flood proof sewer infrastructure (design and implementation); - separate rainwater from the sewer system; - install a spare flood pumps and additional electricity sources; - all mechanical and electrical equipment should be water resistant or sited above the flood level; - working alarm system.

Heavy rainfall events may also lead to flooding, especially in urban areas, and this can have serious impacts on the performance and efficiency of water supply and wastewater treatment systems, which may lead to health risks. Waterborne diseases arise predominantly from contamination of water supplies after heavy rainfall and flooding.[35]

The briefing cites some examples of investments already being taken across Europe to improve wastewater treatment resilience, with the use of retention ponds and rainfall reservoirs to manage water flows from flash floods.[36]

[35] https://www.eea.europa.eu/publications/safe-water-and-healthy-water/download
[36] https://www.eea.europa.eu/highlights/new-challenges-facing-europe2019s-wastewater/@@rdf

2 Improvements of stormwater management system

Action plan for improving the stormwater drainage is usually formed on the conjunction of spatial planning processes and water management processes.

1) Analysis of current status;
2) Analysis of objective status;
3) Analysis of measures (optional measures or scenarios) to achieve the objective status;
4) Planning and design of the measures;
5) Implementation of the measures;
6) Maintenance of the measures and monitoring of their efficiency – improvements.

In the project, current status was analyzed and objective status drafted with the indication that mainly open-channel drainage systems are applicable for the Shkodra urban areas since high level lower boundary conditions defined by the Lake Shkodra is governing the entire system. Simultaneously, one must recognize the situation related to the historical development of the open channel drainage developed along the Rruga Dracin, for example.

The development of a new urban drainage system should be defined along with the overall gradual changes in the Shkodra urban tissue and be aligned with urban developers for a harmonized development of Shkodra. This is necessary following the realization that the city's central development is defined along the Boulevardi Zogi I, and the roads connecting to Sheshi Parruce square. The design process itself follows the next steps:

- Stage 1: Set strategic surface water management objective
- Stage 2: Conceptual design (initial design and layout)
- Stage 3: Outline design (sizing and optimization)
- Stage 4: Detailed design (testing and finalizing the scheme).

The land use (spatial planning) planning system in any country controls development and land use in the public interest at different scales. It is a plan-led system, requiring planning through development plans, which gives local authority a pre-eminence in determining applications for planning Acts and Regulations.

Local criteria relevant to stormwater drainage may be defined with local planning authority's adopted planning instruments (including flooding and urban planning documents) and via standards set by drainage approving and /or adoption bodies (which may also refer to national standards where these exist). Both need to be checked before design starts, to ensure that design is fully compliant with relevant requirements.

Water management is an important planning consideration for any development aspect, considering flooding, climate resilience, community value, biodiversity, and landscape changes. Adequate stormwater management can contribute to a wide range of scales (from catchments to buildings). The level of associated planning should be proportionate.

The alignment and integration of the planning and drainage design process stages are set out in Figure 7.

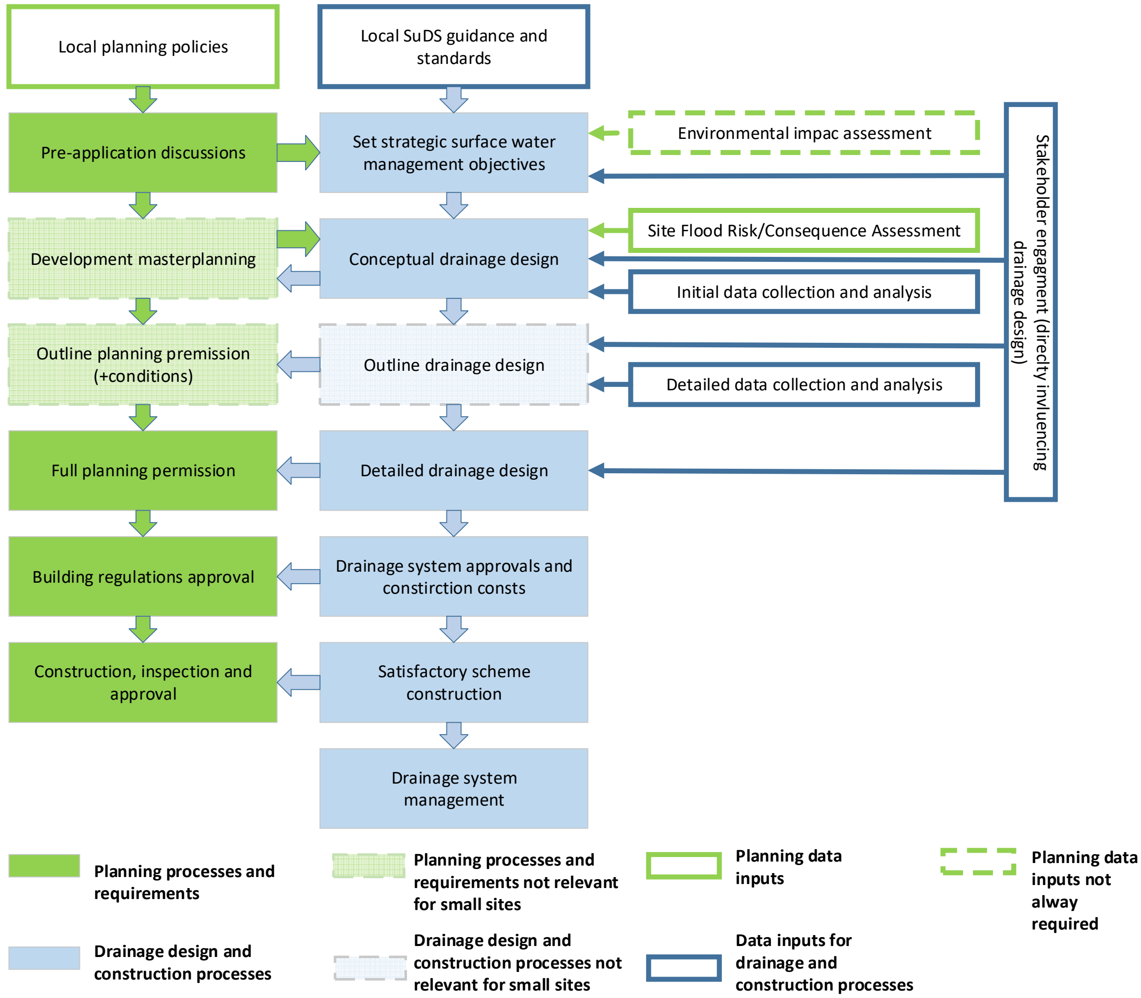


Figure 7: Drainage system design process: links with land use planning[37]

The first step of the process is represented in Figure 7 in the pre-application process – discussion between planners and developers (or their consultants). It is usually a requirement of the planning process (legislation) and part of the drainage approval process – particularly for large cities. These discussions can help ensure that the expectations and objectives for the surface water management system, including approval and adoption requirements, are set out at an early stage in the design of development layouts and characteristics. This will help to ensure that space is used as efficiently and cost-effective as possible. It will also maximize the benefits achieved through effective integration of water management in the city within the overall development. In parallel, it is advisable to have the early engagement of the affected stakeholders. In Shkodra, one of the great necessities is available land for the open canal drainage solutions.

[37] The SuDS Manual, CIRIA (2015), Woods Ballard, B, Wilson, Udale – Clarke, H, Illman, S, T, Ashley, R, Kellagher, R, ISBN: 978-0-86017-760-9

The conceptual development of a sustainable stormwater management system is the next step. It has to go hand in hand with the master planning process, where the master plan is an overreaching planning document, and its spatial layout is used to structure future land use and development. Its scope can range from a ten-year implementation strategy at a larger spatial scale to a shorter period for smaller spatial units (i.e., group of houses).

This provides a crucial opportunity to connect stormwater solutions' sustainable development to be linked with other development objectives. This enables identifying adequate solutions and their adaptability, flexibility, and multi-functionality at the early stages of development. Some zones of the Shkodra city could be subject to overall urban re-development, especially those that should include adequate measures for the improvement of the stormwater drainage system, including collection and disposal concepts and retention and reuse concepts. The master planning process should be used, as it is a collaborative process that provides a strategic framework for considering a whole range of requirements and objectives for development and how they might be delivered. It should be a holistic framework for all relevant stakeholders to contribute and work together, creating high-quality places for future generations. In the following chapters, specific components of the overall design approach defined in Figure 7 will be discussed.

2.1 Local planning policies

Local planning documents are published on the Shkodra municipality website[38] and are the following:

- General location plan (Plani i përgjithshëm vendor 20.4.2017) (before: Plani i pergjithshem vendor bashkia Shkodra - General Local Plan of Shkodra Municipality 2010).

The planning document is addressing come components of the wastewater collection and treatment, as well as a component of the strategic plan – the strategic objective 4 (OS4PS9) is defined - Improvement of underground water and sewage infrastructure (Permisresimi i infrastruktures nentokesore te ujesjellesut dhe KUZ).

Stormwater is not explicitly addressed in the document; nevertheless, it is an essential component of it. In chapter 3.3 (page 42), the development of the corridors is anticipated as a measure. Following photographic research of the Shkodra city, the city's connection with the river Kir is proposed. After various confirmations, this river's route was determined in detail, and the route with its tributaries was once followed.

As we can see below (Figure 8), the two tributaries of the Kir River, which started above the industrial zone, have given the city of Shkodra the urban form it holds today - above all the shape of the city center and the urban and road context along the west coast of the city on the Lake. Research of a natural past development will guide the plan of public spaces and squares that these streets describe.

[38] http://www.bashkiashkoder.gov.al/

Figure 8: Historical connectivity of Kiri river and Shkodra (from the General location plan adopted in 2017).

Three areas of intervention are anticipated by the plan to enhance connectivity:

- in the infrastructure network,
- in buildings that these couriers encourage and
- in the squares along the corridors.

Figure 9: Redevelopment of corridors (from the General location plan adopted in 2017).

While the anticipated interventions' urbanistic aspects are emphasized: “Aiming to bring back a stronger memory linking the Kiri River with Shkodra Lake, three Corridors will be proposed; the main focus of the intervention will promote cultural, tourist and economic values.” It is essential to underline the stormwater management aspect of it. With the re-established corridors, the surface runoff could be significantly improved, as proposed by developing key runoff corridors. The corridors with the surface water will also have a strategic advantage in reference to the climate change adaptation process, where water and related green surfaces are a necessary prerequisite for the urban heat island reduction.

- Urban planning of the territory (Planifikimi urban i territorit) -

The document provides an important insight into status and priorities with the applied SWOT analysis. Under the priority (3) also an infrastructural system of stormwater drainage is recognized as a priority – (pg. 48) – "Damage to road infrastructure due to poor stormwater management." According to the document, the waterfronts of Shkodra Municipality will be retrained according to the concept:

- Lake of the Lake (Shkodra Recreation Park)
- Lakeshore (From Buna bridge to Zogaj as a lake tourism development area) Velipoja (Waterfront of a seaside town including social activities and spaces)
- Rehabilitation of the Kir River Waterfront
- Rehabilitation of Drin River Waterfront
- Rehabilitation of Buna River Watershed (National / Ecological Park)

The Urban planning document is referring to the OS5PS4 Strategic Program. "Protection of aquifers from pollution" The measures anticipate controlled and sealed groundwater use, control of pollution sources in watersheds, surface water, and related valleys, implementation of legislation on the use and protection of water resources, wastewater treatment, and reuse.

OS5PS5 Strategic Program: Flood Risk Management Centre is addressing only river flooding, not urban flooding – stormwater management. Increased focus on urban floods and stormwater drainage is proposed.

2.2 Local stormwater guidance and standards

Existing legislation in the field of environment and related water services:

- Law no. 111/2012 "On integrated management of water resources" – see article 74
- Law no. 10448, dated 14.7.2011 "On environmental permits"
- DCM no. 1063, dated 23.12.2015 "On the emission to environment from equipment for outdoor use "
- DCM no. 340, dated 04.05.2016 "On the removal from the forest fund of the surface and the volume reduction in the forest parcels of the forest economies" Breg Drini "
- DCM No. 594, dated 10.09.2014 " On the approval of the Strategy on Environmental Air Quality " Law No. 68/2014 on some additions and changes to law no. 9587, dated 20.7.2006, "On the protection of biodiversity", as amended Law no. 10431, dated 9.6.2011 "On Environmental Protection" Law no. 9587, dated 20.07.2006 "On the protection of biodiversity" Law no. 10440, dated 7.7. 2011 "On Environmental Impact Assessment" Instruction no. 8, dated 27.11.2007

Specific legislation addressing stormwater discharge is not adopted in Shkodra municipality. On the other hand, technical guidance documents were drafted as a part of the cooperation project with the Office of Waters[39]. In the book 1 and 6 following standards are proposed for implementation:

- EN 752: Drain and sewer systems outside buildings.
- EN 752-2: Drain and sewer systems outside buildings. Performance requirements
- EN 752-3: Drain and sewer systems outside buildings. Planning
- EN 752-4: Drain and sewer systems outside buildings. Hydraulic design and environmental considerations
- EN 1295: Structural design of buried pipelines under various conditions of loading
- EN 1610: Construction and Testing of Drains and Sewers
- EN 1916: Concrete pipes and fittings, unreinforced, steel fibre and reinforced
- EN 1917: Concrete manholes and inspection chambers, unreinforced, steel fibre and reinforced
- EN 13508-2 + A1: Investigation and assessment of drain and sewer systems outside buildings - Part 2: Visual inspection coding system
- EN 2613: Plastics warning devices for underground cables and pipelines with visual characteristics. And Book 6: EN 752: Drain and sewer systems outside buildings.

2.3 Setting strategic stormwater management objectives

The first stage of the stormwater design process is setting the strategic surface for water management objectives for the development. Consultation with relevant stakeholders and reference to adopted local planning and regulators guidance, policy, and the sire Environmental Impact Assessment and flood risk /consequence assessment should establish relevant local or site-specific strategic objective including:

- flood risk management objectives
- water quality management objectives
- community, social and amenity planning objectives
- habitat and biodiversity strategy requirements and needs
- viable long - term maintenance bodies for the proposed stormwater drainage system and adoption requirements
- climate change adaptation/climate resilience requirements and needs
- water supply objectives and constraints (relative to potential stormwater retention and use).

2.4 Conceptual design for Shkodra city

The second stage of the stormwater design process is conceptual design. This stage's key outcome is to identify and assess the stormwater system's potential components and linkages in developing management teams for the addressed site. Conceptual design in the Shkodra urban area is already drafted by the General location plan (2017) with defined corridors connecting Kiri river and Lake Shkodra. However, these corridors should be verified regarding their stormwater capacity utilization. Besides the corridors, a conceptual design of buildings' connectivity and other impervious areas to

[39] Technical standards for the water and sanitation sectors in Albania (2012) ministry of public works and transport of Albania, ministry of economy, finance and industry of France, International Office for Water

open canal stormwater drainage should be conceptualized. The shift from the existing limited capacity underground stormwater system and road conveyance to open canals should be drafted. While there are no specific flow routes in the Shkodra city defined by the terrain (beside roads), other factors will define the routes, especially space availability – existing land use.

With the main routes defined, the exceedance routes and storage locations should be considered as well. The exceedance routes can include roads in the side, and exceedance storage areas can also include the areas with low flood damage potential (parks, parking lots, playgrounds, recreational areas, etc.). Their use for this purpose should not impede their normal function to the extent of putting people or vehicles at risk and can be maintained in the long term. Appropriate legal permissions for land use as an exceedance route should be sought at an early stage.

2.5 Outline design

The third stage of the stormwater action plan is the outline design, which should be developed alongside the agreed layout and design of the development, and landscape, and building characteristics. Outline design should consider:

- detailed runoff rates to which the runoff from the site will need to be controlled,
- likely runoff rates from the developed sub-catchments (including any climate change and urban creep provisions),
- infiltration capacities where infiltration components are proposed,
- demand for non-potable water where rainwater harvesting components are proposed,
- the remaining difference in runoff volume between the development runoff volume and the greenfield (or other agreed) runoff volume for a specified large event.

The constructability and maintainability of the proposed stormwater management solutions should be given full consideration and initial construction and maintenance strategies developed for stakeholders' consideration. Any requirements of the drainage approving body and other engaged stakeholders regarding design detailing should be evaluated.

The scheme's costs should be given full consideration and agreed with scheme funders. The drainage adoption body should approve long-term operation and maintenance costs before the final design. Where the scheme's benefits drive scheme investment, benefit quantification should also be undertaken.

The principles for site and sub-catchment scale component sizing for outline design are presented in Figure 10.

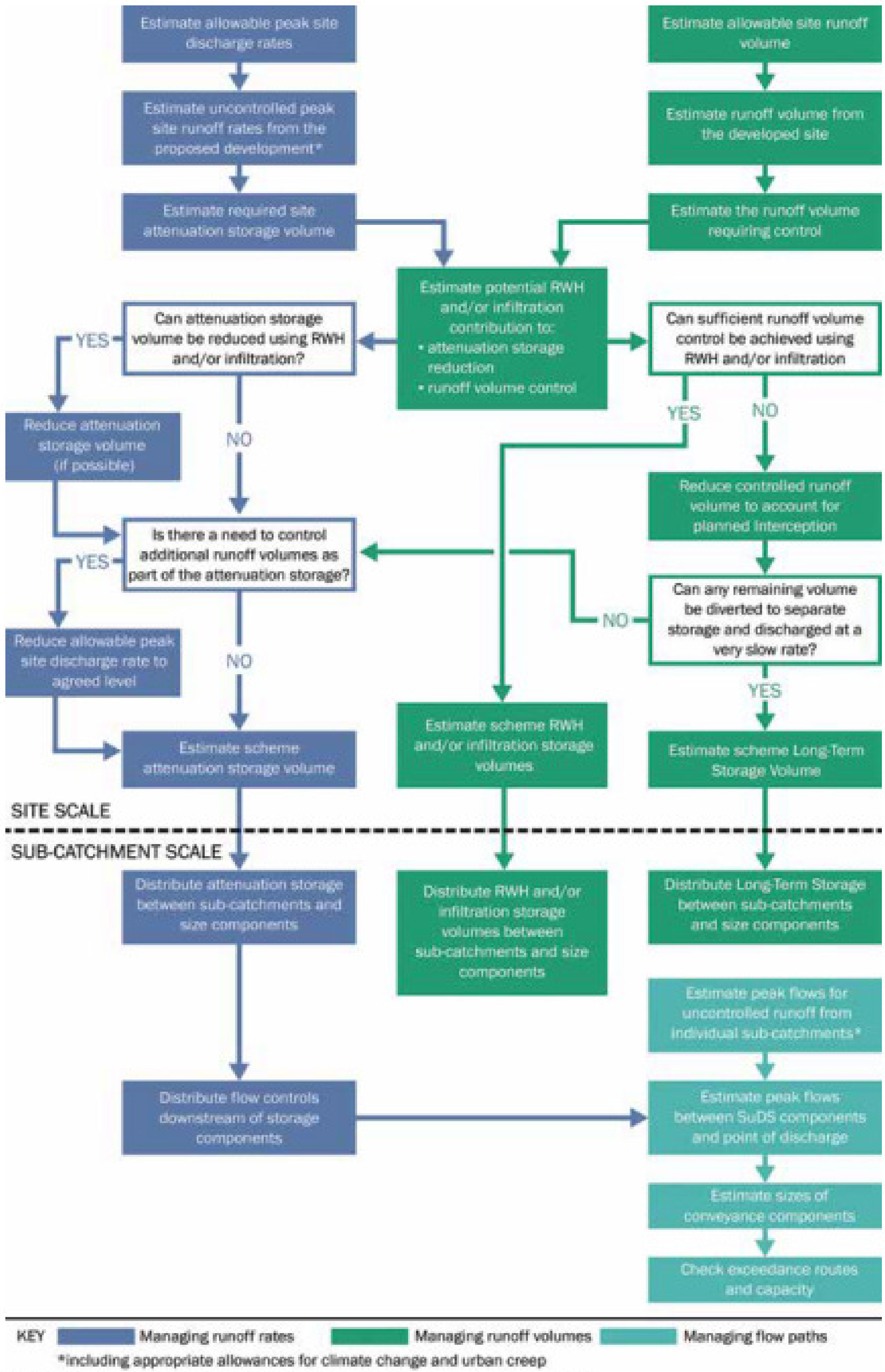


Figure 7.12 Site and sub-catchment scale component sizing for outline design

Figure 10: Site and sub-catchment scale component sizing for outline design.

2.6 Detailed design

Detail design includes hydraulic requirements for open – canal stormwater.

The fourth stage of the stormwater design is the detailed design, which should refine the design in line with the final development design, determine the sizing and detailing for final drawings and documentation to be submitted for planning approval, drainage approval, and contractors costing purposes.

Open canals as any hydraulic conveyance system are defined by the terrain's inclination, the geometry of the canal, and the hydraulic roughness coefficient (Manning – Strickler coefficient).

In the case of Shkodra, a general inclination from the Kiri river to Shkodra lake is 4 ‰ as shown in the following figure.

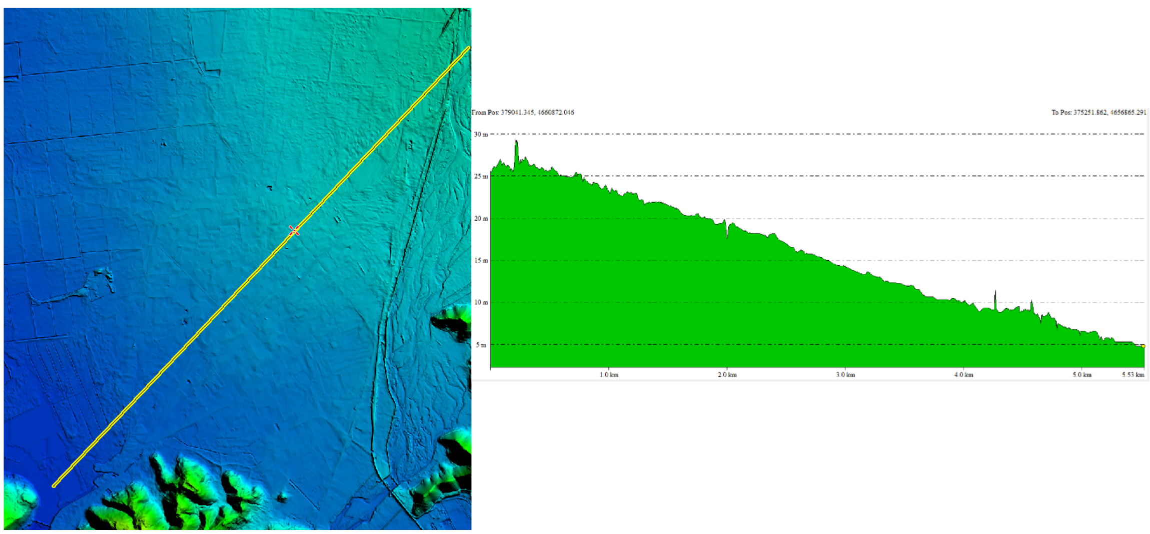


Figure 11: General layout of the conncection Kiri river – Shkodra lake and longitudinal section.

For this section, calculation of water flow was performed with normal depth using Manning – Strickler equation. The hydraulic roughness coefficient used was 0.03, usually applicable to lined canals or canals with maintained geometry and vegetation (grass). The calculation was performed for five discharges from 5 m3/s to 15 m3/s and four types of canal geometries (two trapezoidal forms and two with vertical walls).

The calculation results are shown in Table 5 (water depth - m) (water depth - m) and Table 6 (necessary canal width – m).

Table 5: Water depth (m)

Discharge (m3/s)	Geometry			
	Trapezoid, bottom width B=2 m, sides 1:2	Trapezoid, bottom width B=2 m, sides 1:1	Vertical - width B=2 m	Vertical - width B=3 m
5	0.91	1.05	1.63	1.08
7	1.07	1.25	2.05	1.38
9	1.21	1.43		1.67
11	1.33	1.59		1.94
15	1.53	1.86		

Table 6: Width of the canal - necessary space (m)

Discharge (m3/s)	Geometry			
	Trapezoid, bottom width B=2 m, sides 1:2	Trapezoid, bottom width B=2 m, sides 1:1	Vertical - width B=2 m	Vertical - width B=3 m
5	5.62	4.09	2.00	3.00
7	6.27	4.51	n.a.	3.00
9	6.82	4.86	n.a.	3.00
11	7.3	5.17	n.a.	3.00
15	8.13	5.72	n.a.	n.a.

The range of discharges was defined by the model and potential additional flow from the Kiri river. The selection of adequate cross-section is in the hands of the designer of the overall solution. It could be used to indicate minimal space required to be three meters (with vertical walls of the canal), and very optimistic with the trapezoidal canal – between 7 and 8 meters. Target water depth is around 1.5 meters, and specific attention should be given to the canal's mouth – where it is discharging to the Lake Shkodra.

Design considerations for the stormwater solution on floodplains are presented in Figure *12*.

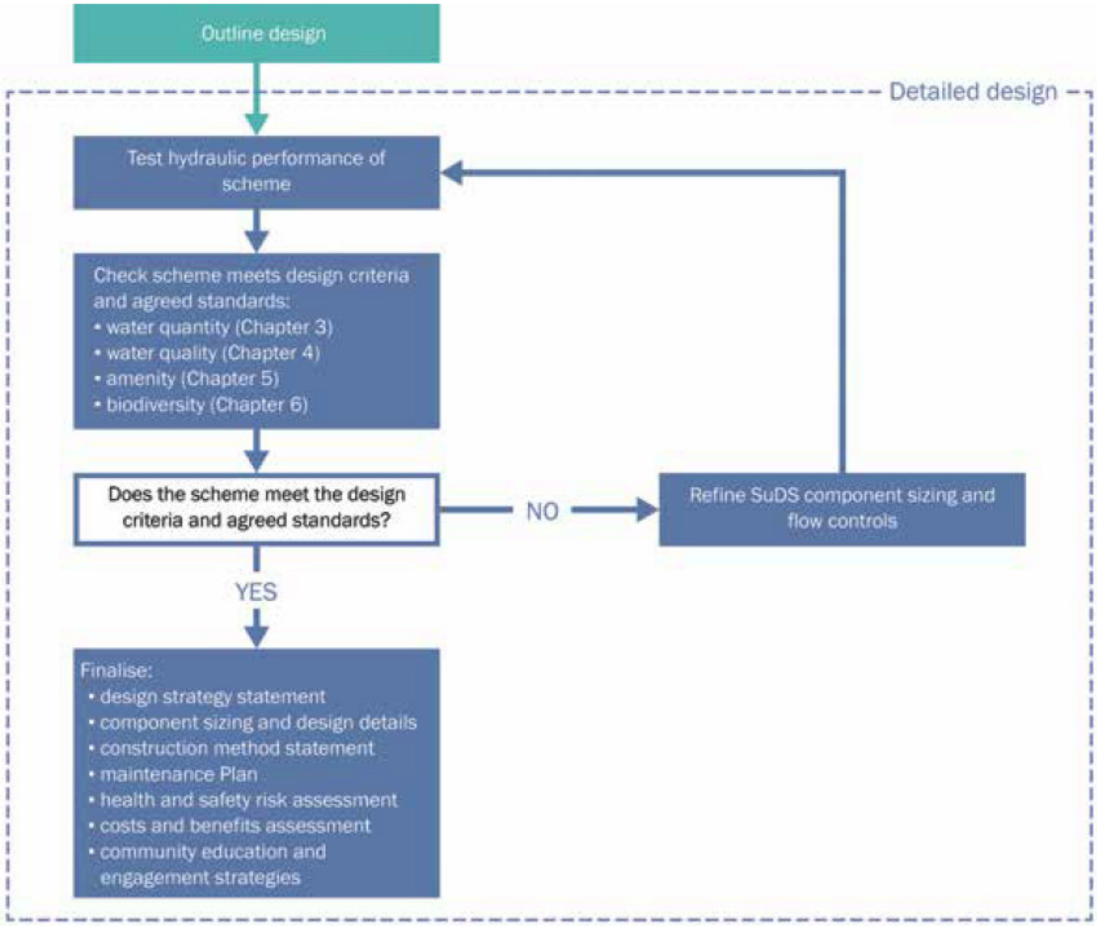


Figure 12: Detailed design process.