Managing rainwater at source

Focus on tram line T6 extension project, from Hôpitaux Est station to Campus de la Doua station (Lyon France)

Editors: **Benjamin FRUGIER / Bertrand SAVARIT / Simon ROUE**

Foreword

Managing rainwater in urban environments has become crucial in an era of increased flood risks. Rapid urbanisation and soil sealing have made cities particularly vulnerable to heavy rainfall and the substantial runoff it causes. Addressing these problems requires the development of sustainable and innovative solutions that allow surface water to soak into the ground close to where it falls. Therefore, it is essential to design structures specific to each site, while also protecting groundwater and reducing pollution risks.

Key data

- 5,6 km – Extension of line T6 from Hôpitaux Est Pinel to the La Doua university campus in Villeurbanne
- Total surface area of rights of way redeveloped: 14.5 ha
- Project owner: SYTRAL Mobilités
- Project engineers: EGIS / INGEROP / GAUTIER CONQUET AUP
- Partners: Water Cycle Division, Grand Lyon authority, DDT69 (Water police), SAGE de l'Est Lyonnais and Agence de l'Eau Rhône Méditerranée Corse.

The T6 tram line extension project adopted an eco-design approach aiming to support the preservation of water resources and the management of flood risk. The applied principle involves storing runoff and allowing it to infiltrate into the ground close to where it falls. To achieve this goal in a highly restrictive urban environment such as the T6 extension, innovative and tailored solutions had to be conceived.

This operation had high ambitions and unprecedented scope. In addition to allowing runoff from more than 50% of the land redeveloped by the project to soak into the ground, the infiltration systems also receive rainwater from neighbouring roofs and roads adjacent to the tramline. The infrastructure was sized to manage flows and volumes for 30-year events.

Benjamin FRUGIER
Expert in sanitation and stormwater management

Bertrand SAVARIT
Study Director

Simon ROUE
Project Manager

Figure 1: Line T6 nord route

Challenges and constraints

Rights of way, buried utilities and building proximity

The line runs along streets of considerably varying widths, from 10-15 m for the narrowest to 35-40 m for the widest. In the narrowest streets, several factors created obstacles to the implementation of appropriate structures. These included the presence of utility networks in the subsoil and the proximity of building facades. The infiltration systems had to be built a sufficient distance from these to avoid interfering with foundations or flooding basements. In general, the infiltration trenches are built as far away as possible from facades but are as wide as possible to maximise infiltration.

Soil permeability and polluted soil

Soil permeability was the parameter with the most uncertainty, especially in the shallowest layers of the subsoil composed of 0.5 to 3.0 metres of backfill. These materials are heterogeneous and sometimes polluted. To control these risks as comprehensively as possible, a multitude of on-site tests and lab analyses were conducted along the length of the track route. The findings made it possible to precisely ascertain the permeability and depth of the various horizons, and the extent and depth of the polluted soil.

Groundwater protection

To protect underlying groundwater from contamination, the infiltration systems were designed so that their base was always at least one metre above the maximum anticipated groundwater level, ensuring a depth of unsaturated soils. On the southern part of the route, which is located within the boundaries of the East Lyon water control and management programme (SAGE), specific attention was paid to the sensitivity of the groundwater. As the groundwater here is deep (5 to 30 m) and the soil not overly permeable (less than 10-3 m/s), standard industry practice were followed without additional measures.

Pollution risks

Pollution of surface water received special attention to limit ground pollution risks and reduce the risk of clogging the infiltration systems. On most areas, where pollution risks are limited, silt traps was systematically deployed upstream of the infiltration systems (see Figure 3 here below). On roads and junctions with high vehicle traffic, where accidental pollution risks are the highest, technical constraints

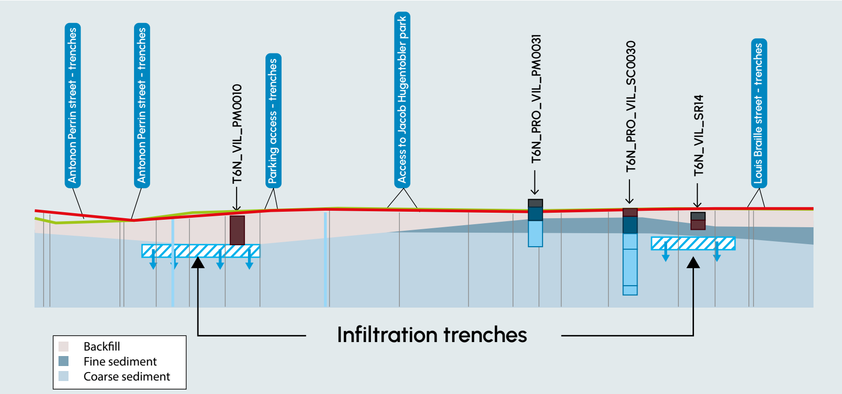


Figure 2: Excerpt from geotechnical longitudinal section incorporating the position of two drainage trenches

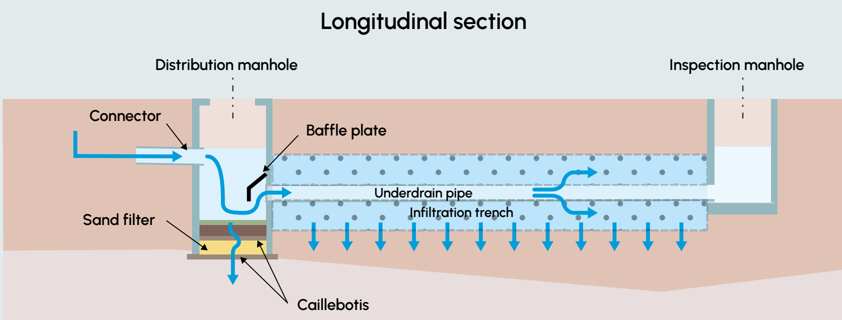


Figure 3: Outline longitudinal section of an infiltration trench and a silt trap

did not allow for the installation of adapted traps. In these cases, infiltration has been avoided and runoff water will remain discharged to the existing combined sewer.

Operational perimeters and maintenance of structures

To avoid the multiplication of structures, the infiltration systems are designed to manage all developed public spaces without distinction, whether they fall within transport (SYTRAL), metropolitan (Grand Lyon's roads), or communal (green spaces) operational perimeter. Metropolitan technical services, responsible for maintaining these structures, must have easy access without interfering with tram operations.

Solutions

Given the restrictive context of the project, only below-ground structures can handle 30-year rainfall events. Additionally, dry swales (shallow vegetated channel) were installed wherever possible to treat runoff and allow frequent rainfall (up to 15 mm) to infiltrate.

Infiltration trenches beneath the track bed

During the construction of a tram line, buried utility networks are diverted away from the right-of-way taken up by the track bed. This allows future repair or maintenance work to be carried out on these utilities without interrupting tram operations, and it avoids having to demolish and rebuild the infrastructure. The ground beneath the track bed, which is no longer occupied by these utilities, thus becomes available for the installation of infiltration systems. The selected systems are infiltration trenches (or soakaways). These infiltration trenches were sized in such as way so as to provide a consistent foundation for the tram track bed, with special attention paid to its implementation, compaction and the bearing capacity obtained once these beds had been installed. As they occupy the full width of the track bed, their widths exceed their heights.

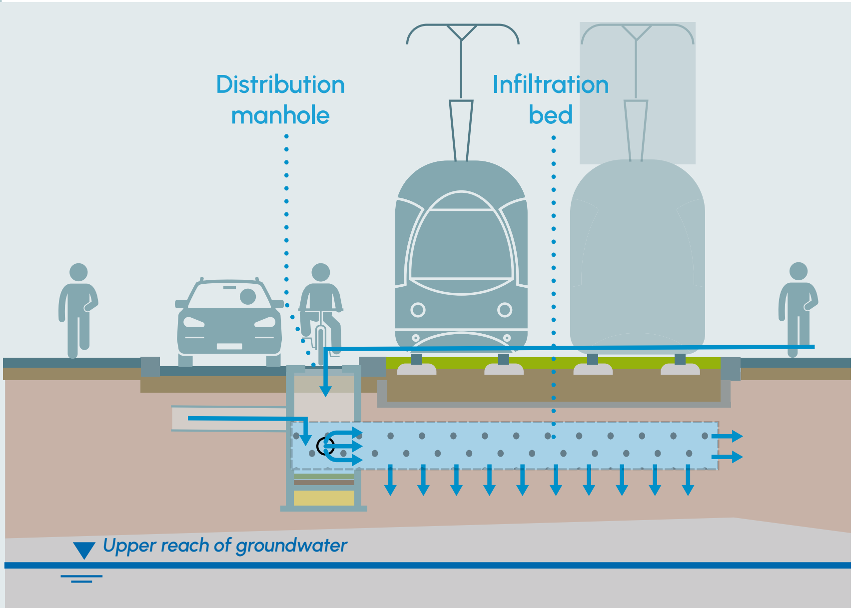


Figure 4: Cross section an infiltration trench beneath a track bed

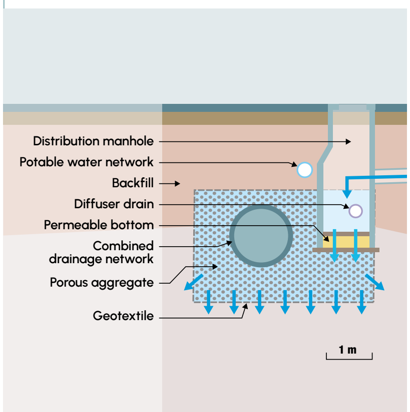


Figure 6: Cross section of shared waterwater/ rainwater trench

Figure 5: Excavation of a trench prior to its backfilling with porous materials and construction of the trackform

Shared trenches

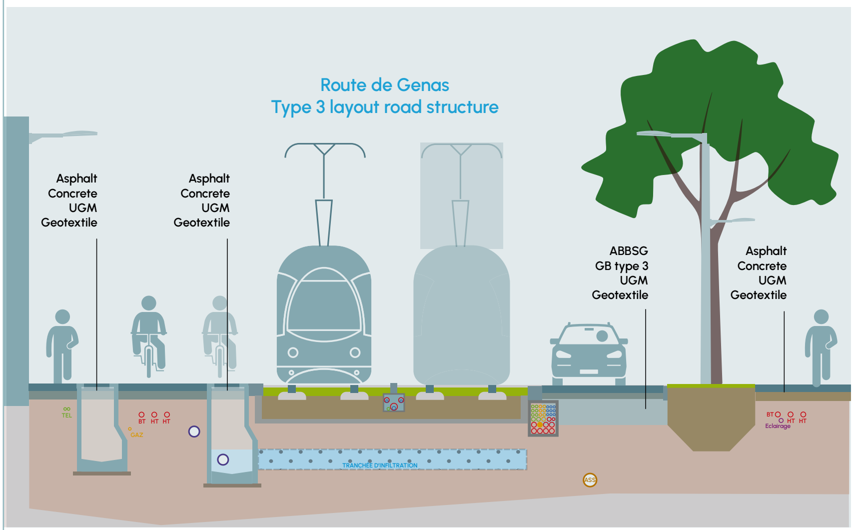
In sectors where combined sewer and/ or potable water network diversions were planned, some of those diversion works were combined with the construction of infiltration trenches. This solution has allowed global optimisations by reducing excavations and shorten the duration of the works.

In these cases, potable water pipes are positioned above the infiltration trench, while combined sewer pipes are laid within the infiltration trench, which constitutive material is both porous and compatible with embedment requirements.

Figure 7: Cross section of a shared trench

Conclusion

The rainwater management solutions designed for the T6 Nord project will eventually allow surface water to soak into the ground close to where it falls, disconnecting nearly 8 hectares of sealed soil from the metropolitan sewer system. The goals were met thanks to the collaborative and iterative work by all stakeholders, in particular the pooling of land ownership duties (city council infrastructure on Sytral right-of-way) and technical pooling (shared trenches). The multi-disciplinary expertise of the Egis group (hydraulics, environment, geology, track and infrastructure, utilities) made it possible to design the infrastructure in fine detail so as to fulfil the ambitions of the project owner and the Greater Lyon Authority.



Editors: **Benjamin FRUGIER / Bertrand SAVARIT / Simon ROUE**