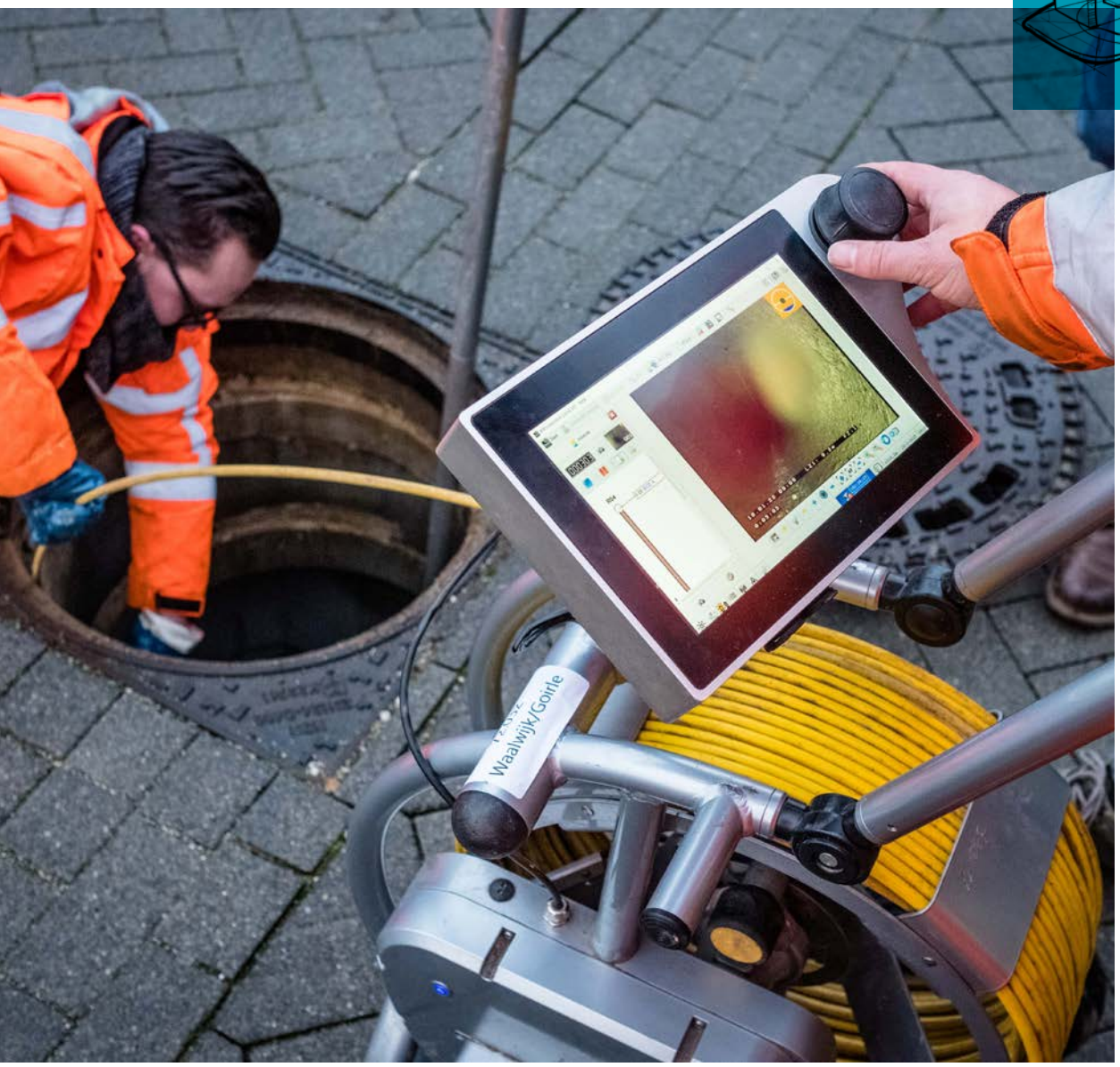
Rockflow attenuation and infiltration systems

Durable and easy to maintain



Naturally, it is preferable for a rainwater infiltration system to remain serviceable for a long period of time. Rockflow is a reliable, maintenance-friendly system with a lifespan in excess of 50years.

Reliability for 50years

Rockflow attenuation and infiltration systems are made of stone wool, a robust and weatherproof material. The inherent properties of stone wool are not substantially influenced by the effect of time or the exposure to typical field conditions like the presence of oxygen, heat, frost, sunlight, water, oils and fats. The durability of stone wool ensures that it will continue to attenuate and bear imposed loads even after 50years.

No worries about compression / settlement

Stone wool retains its shape and size, even under heavy loads (20tonnes axle load). This makes it ideal to be installed beneath roads, buildings, tramlines or car parks, minimising the land take dedicated to drainage. Approximately 1% consolidation occurs during installation. Subsequently less than 2% deformation occurs over a period of 50 years, making a Rockflow system stable in shape and size throughout its entire lifespan. This is confirmed by research by the independent research institute Deltares and internal tests. Rockflow therefore complies with civil engineering standards.
Within ROCKWOOL we have vast experience in exploiting the stability of stone wool under heavy loads. In Oslo, Norway our stone wool has been in situ for decades under a tramline (in the form of Rockdelta, to dampen vibration). After several decades we measured the density, form stability and functional properties of the stone wool. These were found to be the same as on the day it was installed.

Installation of a Rockflow system in a new residential area.

Root growth? No problem!

A Rockflow system is perfectly suitable for a green environment. Root growth does not have a negative effect on the operation of the system, unless the roots obstruct one of the water channels.

If a Rockflow system is to be installed in the immediate vicinity of trees, you can choose measures to protect against root ingress or can channel their direction of growth.
On request, we can supply additional detail compiled in collaboration with the Dutch company Plus Floris. In addition, in the design stage we will discuss the presence of existing greenspaces and vegetation to ensure the best result.

Stone wool in use under a tramline.

Easy to inspect and clean

After some time, sediment such as silt, sand or organic material can collect in the channels of the Rockflow system. By carrying out an inspection and any necessary cleaning, the system will remain in an optimum condition. This can easily be carried out without specialist equipment. Inspection is simple using a remote camera or sewer inspection CCTV system. The channels can easily be cleaned with a back-spraying high pressure jet with water pressure up to 100bar. It is also advisable to plan an additional inspection after a pollution incident or flooding.

In 2022 we cooperated with sewer cleaning business Vandervalk+degroot to inspect and clean 15 systems in the Netherlands. Eric Gallé of Vandervalk+degroot, commented as follows:

"It is no problem to inspect and clean the water inlet channels in Rockflow systems. This can be done over and over using standard sewer cleaning equipment. It does not damage the stone wool. A well-designed system allows any dirt that has been washed into the system to be removed easily using water pressure. After cleaning the system is as good as new."

Contact us if you would like to receive the full inspection and cleaning instruction manual.

A robot camera being used for an inspection.

Left: Sediment being removed from the channels. Right: A back-spraying high pressure spray.

Monitoring system performance? No problem!

Do you want to know with certainty that a Rockflow system is working correctly? Install water level meters and moisture sensors for extra peace of mind. Our own monitoring data over the course of several years and Dutch projects in Schimmert, Roermond, Horst aan de Maas, Zevenaar and overseas projects, consistently show that the water is absorbed immediately and the system empties quickly, getting ready for the next rainfall event. Monitoring of our system has been carried out by engineering consultants IB-land, Kragten, Royal HaskoningDHV and others.

Stone wool in use under a tramline.

Extensive testing

The Danish division of engineering consultants WSP tested Rockflow by polluting and cleaning the stone wool hundreds of times. They focussed on:

- The functioning of the system with respect to water absorption
- The integrity of the stone wool after repeated cleaning
- The hydraulic properties after repeated cleaning

For all these criteria Rockflow easily exceeds the projected lifespan of 50years, provided the system is correctly designed and is cleaned every 2-3 years. The research concluded that well after the simulated lifespan a Rockflow system is still perfectly capable of meeting current Dutch requirements for drainage (40mm/m²/h), and even the future stricter drainage norm (76 mm/m²/h).

Stone wool in use under a tramline.

Pollution level of suspended solids [years]	0	10	20	30	40	50	60	70
Absorption speed in line with current drainage norm (40 mm/m²/h)	✓	✓	✓	✓	✓	✓	✓	✓
Absorption speed in line with future drainage norm (76 mm/m²/h)	✓	✓	✓	✓	✓	✓	✓	✓

Addendum: Hydraulic conductivity over time

This report summarizes a series of tests performed on small-scale Rockflow buffers and a laboratory Rockflow filter setup, with the aim of assessing the hydraulic conductivity (maintain permeability) of the material with regards to the clogging effect over time, by naturally occurring sediments in suspension in runoff rainwater. Specifically, the purpose was to simulate and document a lifetime of minimum 50 years of function, to be able to answer three specific questions:

1. When a Rockflow buffer is clogged, will it be possible to clean it with traditional sewer-cleaning equipment and restore its hydraulic function?
2. If it is possible to do so, will it be possible to repeat it over the course of a lifetime of the material (can the material physically withstand cleanings corresponding to a full lifetime of operation)?
3. If the material can be cleaned, how will the hydraulic properties be restored over time (during the course of many cleanings)? Will sediment accumulate inside the material matrix and thereby, over time, decrease the pore volume of the stone-wool material and thus decrease the hydraulic capacity by volume and/or by flow?

Tests Performed

Several different small-scale buffers have been tested in this study, with different objectives such as effects of varying hydraulic and sediment loads, effect of adding a drainpipe to the internal inlet channel of the buffer and most importantly the effect of cleaning the filter to re-establish hydraulic capacity and to assess whether the initial hydraulic capacity of the buffer could be restored.
Finally, a small-scale laboratory setup using a Rockflow stone wool system was durability tested during a complete lifetime of the material, which is defined as typical 50 years of operation. A longer lifetime than 50 years was determined.

Lifetime-Test Results

To simulate a full lifetime of the stone-wool material the tests were sped up. Generally, it is not possible to speed up the load on buffers/filters compared to natural conditions, this is true for both hydraulic and material (suspended solid) loads. By speeding up the tests either through applying a higher hydraulic load (higher flows into the buffers) or by increasing the load of suspended solids (higher concentrations into the buffers) it effectually undersize the buffers/filters compared to the recommendations, which has the effect of clogging the buffers/filters disproportionately fast (clogging the surface of the distribution channel inside the buffer with a thin layer of silt/clay particles). Therefore, the scope was to deliberately clog the Rockflow material to investigate if the material could be cleaned and thereby have the hydraulic properties restored, and if this could be done over time as well. One small-scale buffer was clogged and subsequently cleaned 50 times with well-known sewer-cleaning equipment (15° nozzle and no more than 100 bars of pressure). Fifty cleanings correspond to a lifetime of 100-150 years according to the cleaning recommendations. The buffer material sustained the numerous cleanings and afterwards the hydraulic properties were proven to be restored.

Hydraulic Conductivities Of Rockflow Material During Lifetime Test

The native hydraulic conductivity of the Rockflow stone-wool material is so high that with a decrease the material still be able to absorb a 2-year event (in Denmark) of 140 l/s/hectare and even a 10-year event (in Denmark) of 230 l/s/hectare, when dimensioned according to the guideline. The lowest recorded hydraulic conductivity after cleaning the filter (measured value of 0,0018 m/s = 155 m/d) was a factor of 13 lower compared to the initial value which would still be able to absorb a 10-year event of 230 l/s/hectare. However, this lowest measured value is attributed to poor cleaning of the filter as the hydraulic conductivity was afterwards increased when cleaning was improved.
On one of the small-scale buffers that was tested with regards to clogging, after a complete clogging with suspended solids, cleaning was performed 50 times and the buffer was subsequently tested for hydraulic capacity again. The results showed that the buffer had the same relative capacity after the cleaning that it had prior to being clogged by suspended solids, meaning that the permeability of the surface of the stone wool inside the Rockflow buffer channel was not the limiting factor of the hydraulic capacity. This test revealed that the hydraulic capacity can be restored by cleaning the channel surface of the buffer and that it could be cleaned more often than required without wearing out.

Laboratory inspection of lifetime-old stone wool

Rockwool has made laboratory assessments on the stone-wool material that was subject to 67 years load of sediment during the laboratory tests. The results show that sediment enter the stone-wool matrix, predominantly close to the surface. At a depth of around 7 cm below the surface, the sediment content is approx. 5% of the pore volume of the stone-wool material, which leaves the material with ~90% pore volume potentially available for water transport.

Conclusions

Overall, the results indicate that it is important to comply with the instructions regarding dimensioning of buffers with regards to catchment size, to correctly determine the size of a Rockflow buffer. However, if a buffer is either clogged or if the channel in the buffer is filled with sediments, it can successfully be cleaned with well-known sewer-cleaning systems.

The results of this project are:

- The Rockflow stone wool material can physically withstand (at least) 50 full cleaning cycles with the recommended cleaning method (15° nozzle, no more than 100 bars of pressure). This corresponds to a lifetime of 100-150 years according to the recommended cleaning frequency.
- In a laboratory setting a sample of stone wool was clogged and cleaned 484 times before it was worn out. The corresponding amount of sediment loaded into the stone-wool filter corresponds to 67 years of operation.
- After 67 years of simulated operation and 484 individual cloggings and cleanings, the hydraulic conductivity of the stone-wool material was lowered, but still able to absorb a Danish 10-year event with an intensity of 230 l/s/hectare when the buffer dimensioning is done according to the recommendations.
- The stone-wool material (after 67 years of loads) was examined for sediment contents inside the stone-wool matrix. This showed that fine-grained sediments enter the matrix up until 7 cm depth. Within this area it was shown that the amount of particles in the matrix pore volume was below 5% of the total matrix pore volume. This means that the particles that entered the matrix during 67 years of function have no actual relevance to the storage volume of the material.
- From inspections of existing Rockflow Buffers in operation, the recommended cleaning interval is every 2-3 years.
- A dimensioning plot tool has been developed to enable quick assessment of dimensioning of individual Rockflow buffers.

More information about the hydraulic behaviour of Rockflow.

Visiting address:
ROCKWOOL Rainwater Systems
Delfstoffenweg 2
6045 JH Roermond
The Netherlands

Postal address:
ROCKWOOL Rainwater Systems
P.O. Box 1160
6040 KD Roermond
The Netherlands

Tel: +31 4 75 35 35 55
Email: rain@rockwool.com
rain.rockwool.com

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