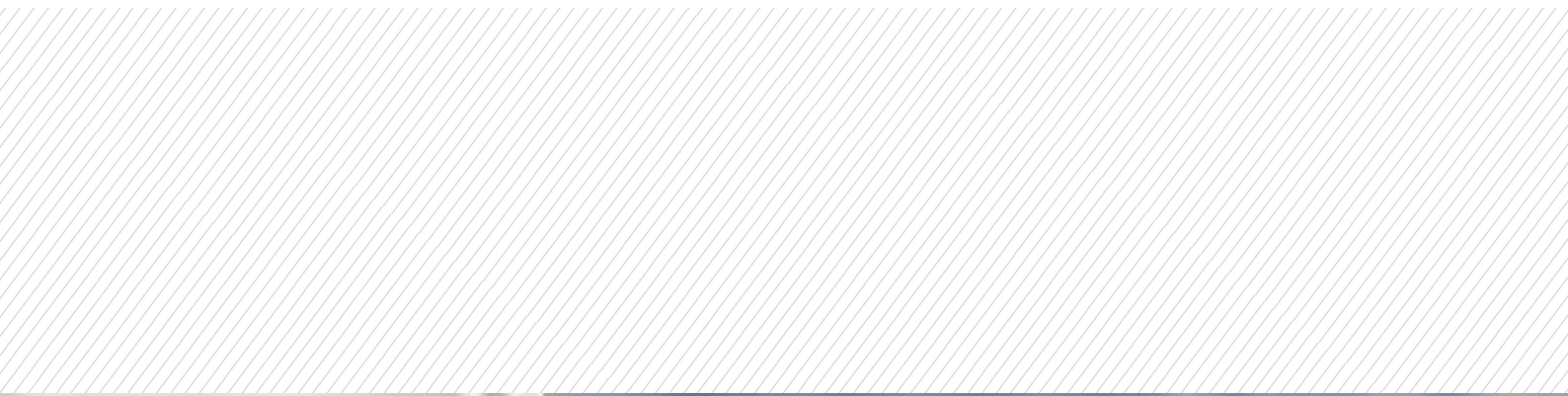




OPTIMISING WATER DISTRIBUTION





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DISTRICT METERED AREAS (DMA)

Many water utilities still operate their distribution system as an open system, where water is fed from one or more water treatment plants or reservoirs into an inter-connected pipe network. The water will mix in the network, which affects system pressure and water quality. In an open system, NRW (Non-Revenue Water) can only be calculated as an average for the distribution system, and it is very difficult to determine the exact locations of NRW occurrences—and prioritize where NRW reduction activities should take place.

As described in the AVK NRW Solutions Brochure, dividing the network into sections - by making District Metered Area (DMA) - is an effective tool to prevent water loss and to do active NRW Management.

AVK range of products fit perfectly into the establishment and operation of DMAs and also into the NRW management. The AVK products consist of a wide range of tools and solutions that help the utility to manage and operate the distribution system in an optimal way from mains to meters. AVK products add value both with great functionality, flexibility and reliability. The risk of not using high-quality products is short time of reliable operation and high cost of ownership.

A district metered area (DMA) is defined as a discrete part of a water distribution network. It is usually created by closing boundary valves or by permanently disconnecting pipes to neighbouring areas. Water flowing in and out of the DMA is strictly controlled and metered in order to calculate the accurate water balance for each DMA. Based on the IWA Water Balance, the NRW can be monitored to secure fast action and be the basis for planning the activities based on the highest return of investments in the future optimization of the water distribution network.

IWA (International Water Association) water balance

The IWA Water Balance shows the different contribution to the NRW, like the Apparent loss = commercial loss, and the Real loss = the physical loss. Based on the water balance it is highlighted if there is any low hanging fruits to harvest in the NRW reduction.

SYSTEM INPUT VOLUME	AUTHORISED CONSUMPTION	BILLED AUTHORISED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
			BILLED UNMETERED CONSUMPTION	
	WATER LOSSES	UNBILLED AUTHORISED CONSUMPTION	UNBILLED METERED COMSUMPTION	NON REVENUE WATER
			UNBILLED UNMETERED COMSUMPTION	
		APPARENT LOSSES (COMMERCIAL LOSSES)	UNAUTHORISED CONSUMPTION	
			CONSUMER METER INACCURACIES	
	REAL LOSSES (PHYSICAL LOSSES)		LEAKAGE ON TRANSMISSION AND DISTRIBUTION MAINS	
			LEAKAGE AND OVERFLOWS AT STORAGE TANKS	
			LEAKAGE ON SERVICE CONNECTIONS UP TO POINT OF CONSUMER METER	

Dividing the network into separate DMAs enables network operators to manage the system more effectively and based on IWA Water balances from each DMA they will have the overview to prioritize their efforts. Based on the water balance the operators will know, what is the main problems for NRW to address and where in the network should they prioritize to start.

To be able to perform efficient NRW reduction based on DMAs, it is of highest importance that all the DMAs are effectively isolated, and that no uncontrolled flow takes place between DMAs, therefore it can only be successful if the valves remains 100% drop-tight throughout the future operation, AVK valves can deliver that safe operation.

The DMA will also make it possible to optimize water distribution in terms of energy consumption, pressure management and water quality issues.

The Active NRW Management also consists of dedicated teams to be sent out to look for water losses, such as leaks, reservoir overflows, and illegal connections. Some of the leaks are very easy to locate, others will never show up at the surface.



IMPORTANCE OF RELIABLE HIGH-QUALITY VALVES

**"HIGH QUALITY, FUNCTIONAL AND
OPERATIONAL VALVES ARE THE
BACKBONE IN ANY WATER DISTRI-
BUTION SYSTEM"**

When the utility company in the city of Al Ain in the United Arab Emirates modernized a part of its water distribution system in 2014, the responsible engineer stated: "High quality, functional and operational valves are the backbone in any water distribution system". This statement was based on the outcome of the city's modernization with a reduction of the water loss from 19 % to 8 % through a SMART water management project and in addition, the proportion of sold water was increased by 19 %.

In order to get a reliable Water Balance and be able to control the water distribution, it is of vital importance to install reliable high-quality valves. And this is exactly what the Al Ain engineer meant by his statement that high quality, functional and operational valves are the backbone in any water distribution system!

Quality pays, especially in relation to products installed underground. Such products must be capable of withstanding corrosion for many years, as well as any stresses caused by water hammer or earth movement. Even the smallest defect will be critical and over time become very expensive.

You can significantly reduce your water loss by using valves and fittings from AVK. The secret behind the success of our products is the high quality in performance and long lasting reliability, and also a trouble-free performance without affecting the quality of the drinking water.

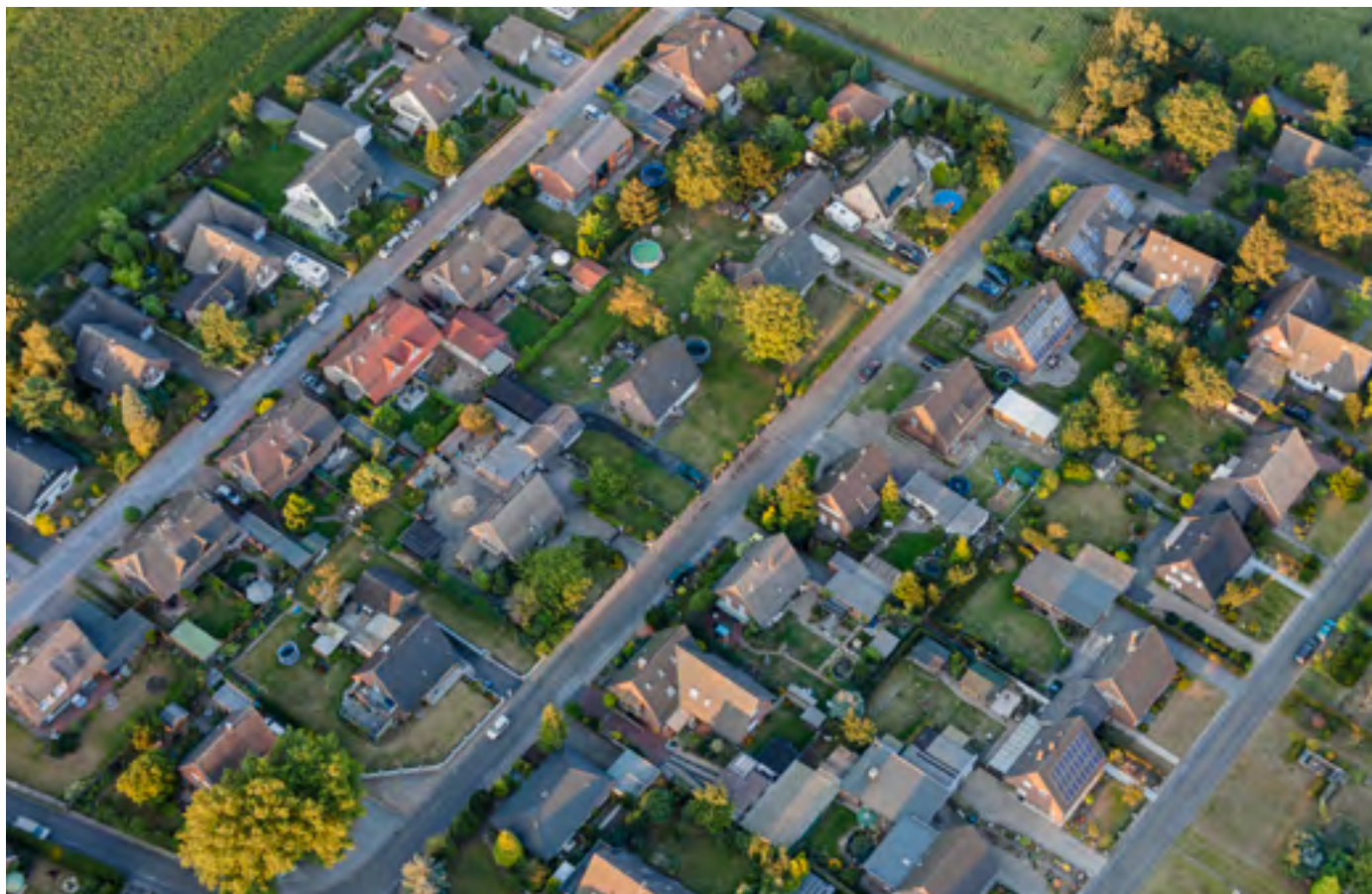
VALVE REPLACEMENT REDUCES WATER LOSS IN ROMANIA

A large water supply utility in Romania, covering a water network of about 400 km and a population of approximately 200,000 people, decided to replace its old pipes with new PE pipes and install AVK gate valves. The modernization reduced the utility's loss of water by more than 10% and resulted in big savings on operational costs.

The problem with the previously used metal seated gate valves was that they were mounted in concrete wells and often caused problems in relation to shut-off tightness. In contrast, the newly installed AVK resilient seated gate valves have been mounted directly underground and feature rubber which absorbs impurities and are thus able to shut tightly for a lifetime. The Romanian water supply utility also installed AVK air valves which furthermore had a positive impact on the utility's network as it led to both a reduction in hydraulic problems and a decrease in energy consumption needed for pumping. Read more about air in pipes on page 17.



WHAT ARE THE CRITERIA FOR ESTABLISHING A DMA



The design of a series of DMAs is very subjective, and it is unlikely that two utility engineers working on the same network would come up with the same design. The engineer typically uses a set of criteria to create a preliminary DMA design using a network model and tested in the field.

These criteria include:



Size of DMA (e.g. number of connections—generally between 500 and 2,500)



Number of valves that must be closed to isolate the DMA



Number of flow meters to measure inflows and outflows (the fewer meters required, the lower the establishment costs, and more accurate reading.)

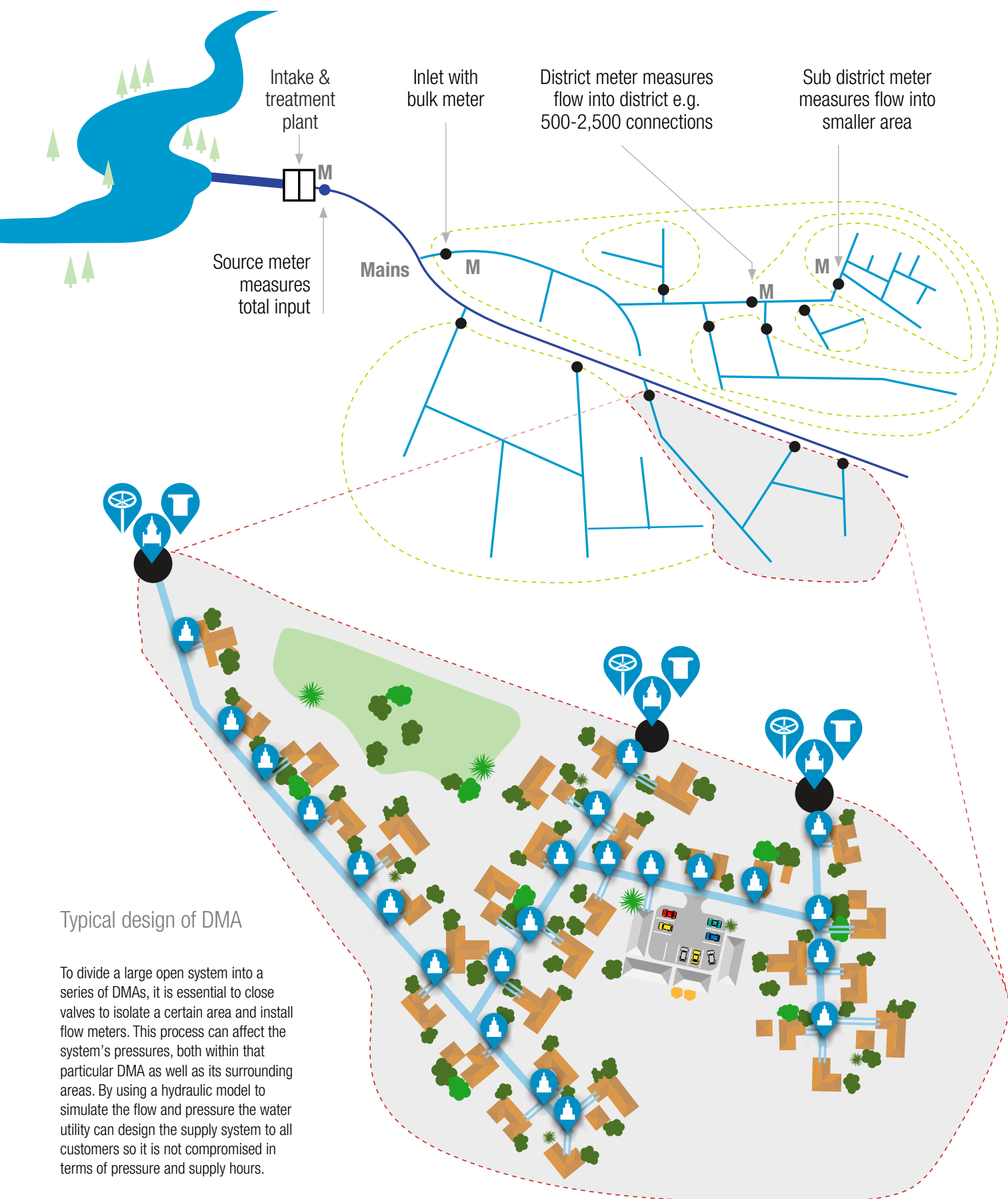


Ground-level variations and thus pressures within the DMA (the flatter the area the more stable the pressures and the easier to establish pressure controls)



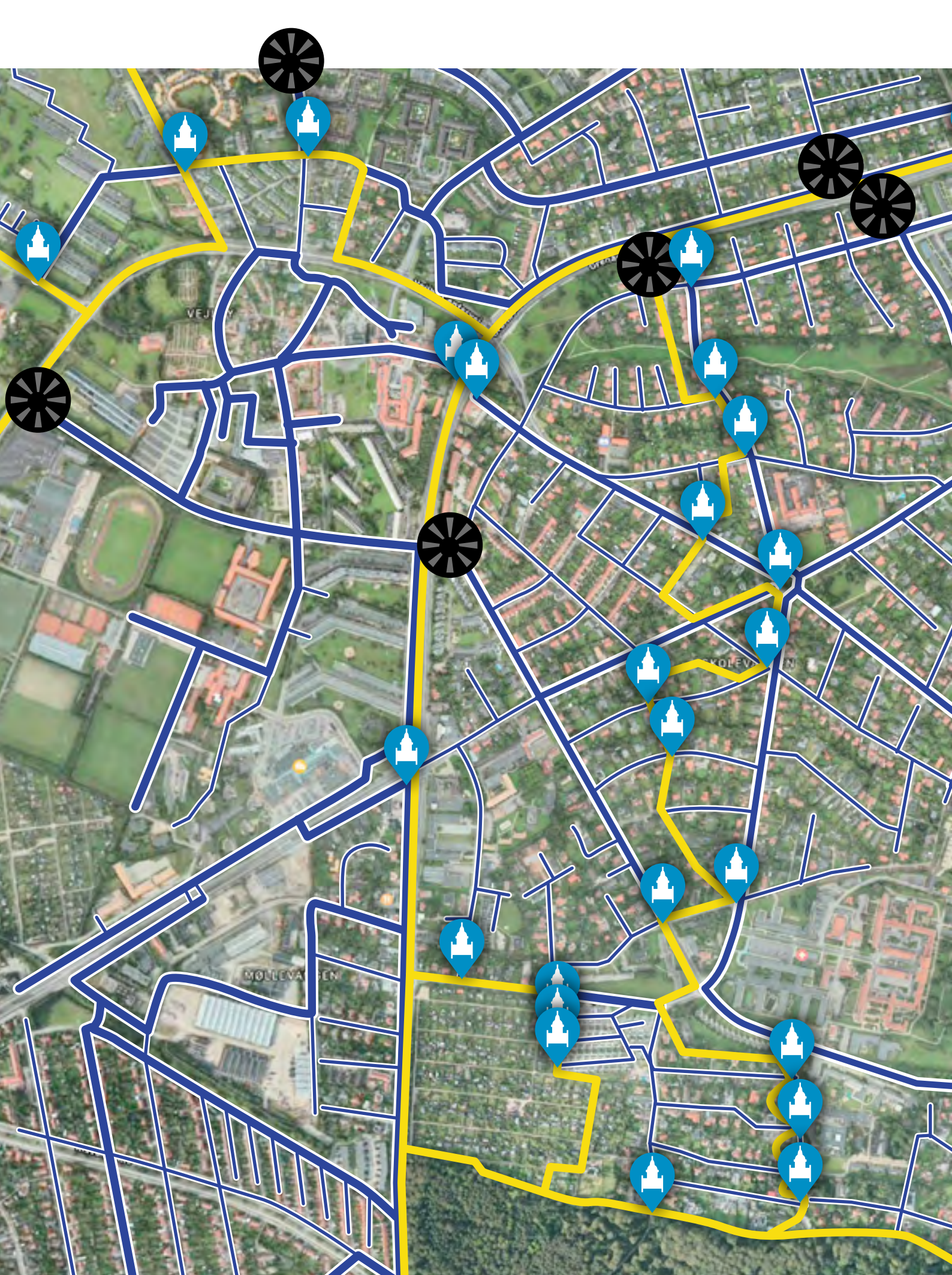
Location of visible structure that can serve as logical boundaries for the DMA, such as rivers, drainage channels, railroads, highways, etc.

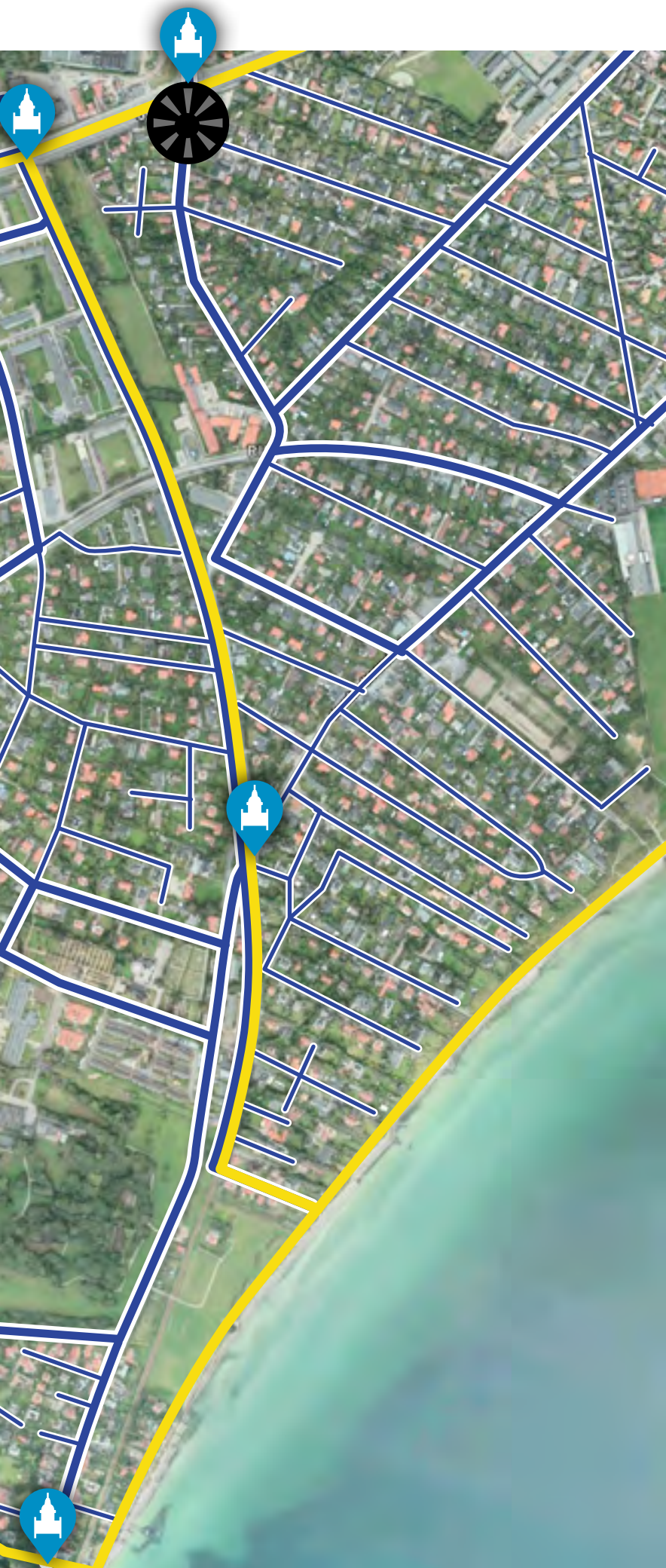
The water utility should initially establish larger zones of 5,000 or more connections. It can subsequently subdivide them into DMAs and sub-DMAs of 1,000 or fewer connections for those DMAs with high NRW and long lengths of pipework.



Typical design of DMA

To divide a large open system into a series of DMAs, it is essential to close valves to isolate a certain area and install flow meters. This process can affect the system's pressures, both within that particular DMA as well as its surrounding areas. By using a hydraulic model to simulate the flow and pressure the water utility can design the supply system to all customers so it is not compromised in terms of pressure and supply hours.





THE DMA STRUCTURE



**VALVE CHAMBER
(DMA INLET)**



**DISTRICT METERED
AREA**



**PIPE MAINS
(LARGE DIAMETER)**



**PIPE MAINS
(SMALLER DIAMETER)**



**DMA BORDER VALVES
(CLOSED)**

HOW DO YOU ESTABLISH A DMA

NETWORK MODELLING WITH COMPUTER SIMULATION OF THE FLOW AND PRESSURE IN A DISTRIBUTION SYSTEM REQUIRES SPECIALIZED COMPUTER SOFTWARE

The model is developed based on GIS registration of all elements in the system and calibrated by comparing the simulated flows and pressures with real flow and pressure data recorded onsite. Adjustments are made to the model to ensure that the simulated and the real data correlate, thus creating a calibrated hydraulic network model. The calibrated model is used for DMA design and enables analyses of system pressures and flows without affecting supply to customers.

When establishing a DMA, the water utility should limit the number of inflows to unify the flow pattern. To achieve this, it is necessary to close a number of boundary valves, which must remain shut permanently to ensure that any flow data accurately represents the total inflow for the DMA. It is typically that there will be one or two active boundary valves to secure sufficient inflow at any time.

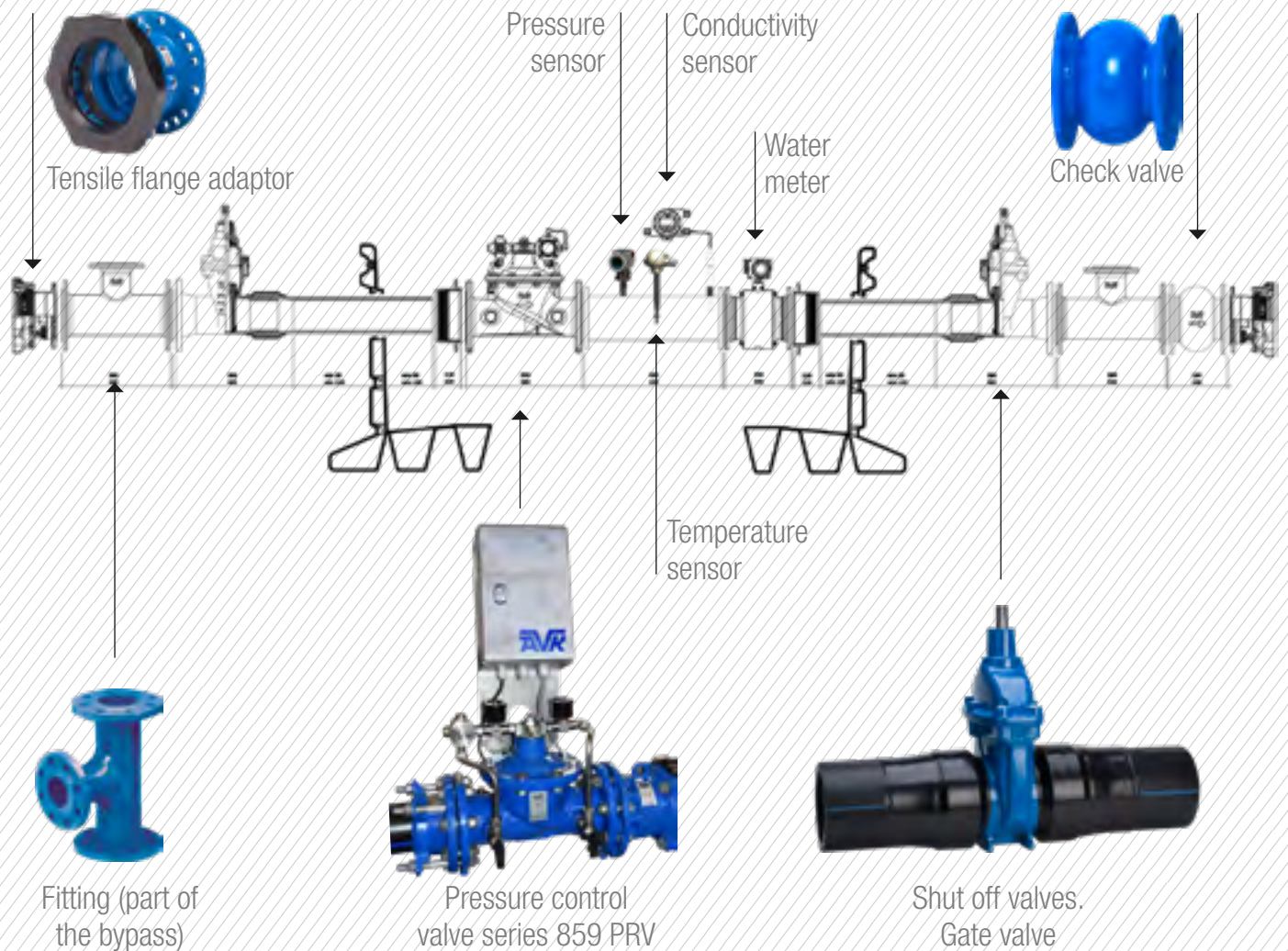
The hydraulic model is also an essential tool to design any form for Pressure Management Areas (PMA) for improved operation and saving of energy for pumping. Based on the calculation from the model the pressure reducing valves are installed and operated.



Each DMA has one or two inlets with an inlet chamber. The inlet is designed to be the supply connection to a DMA from the main pipe system. It is important that the inlet has a dimension so the supply can take place with sufficient pressure to the consumers at any time and consumption.

The inlet chamber includes valves and equipments to control the supply and to monitor the flow and pressure for NRW management.

TYPICAL CONTENT OF AN INLET CHAMBER



RELIABLE SHUT-OFF GATE VALVES HAVE DECISIVE IMPORTANCE FOR A DMA

AVK Gate Valves are renowned for superior quality and 100 % drop tight. The majority of our gate valves are installed underground and must therefore be maintenance free and remain fully functional for many years. All our gate valves are part of vital infrastructures delivering clean drinking water, efficient handling of wastewater, as well as crucial fire protection systems. Compromise on quality is not an option at AVK. Therefore, a high-quality reliable AVK gate valve is the perfect choice to shut off the flow between the different DMAs completely.

For each DMA, utility managers should develop a detailed operations instruction to assist future teams in managing the water distribution. The operations instruction includes access to GIS registration of the pipe network; flow meters, pressure control valves, and boundary valves; together with the information from the billing database for each DMA.

The data and instruction should be continually updated, and include information on the following:

- IWA Water balance
- Flow and pressure
- Leakage step tests data
- Leak locations and types
- Illegal connection locations
- Legitimate night flow (LNF) test data
- Pressure T Factor test data

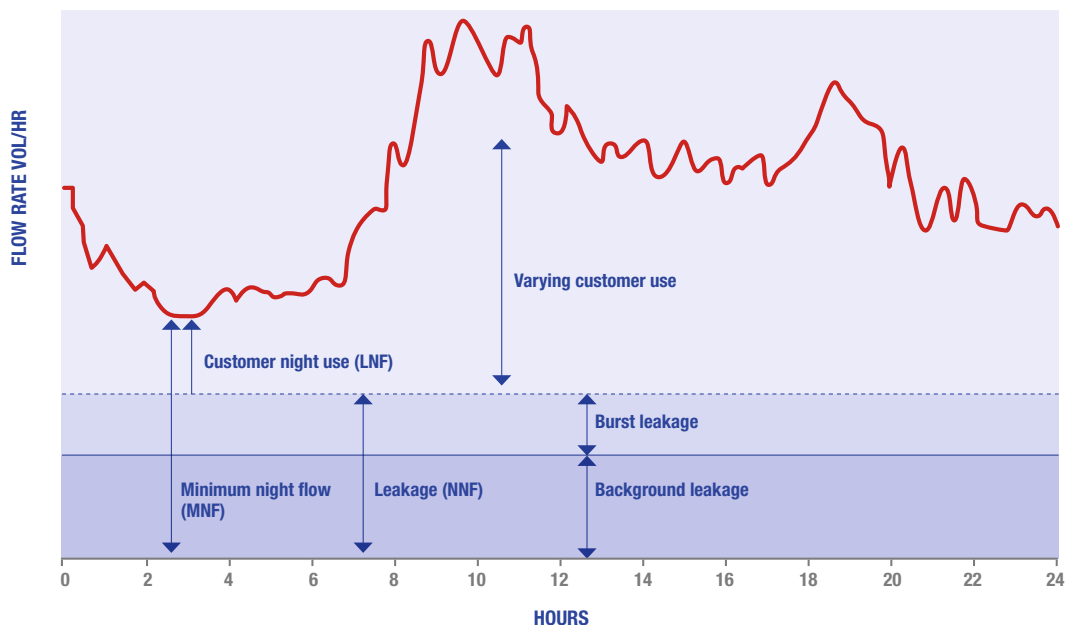
USING DMA TO **REDUCE** **NRW LEVELS**



Physical losses within a DMA are pipe leaks on both the main pipes and on service connections. Leakage occurs through holes or cracks in the pipes or at leaking valves, which will leak water constantly over a 24-hour period.

Worst case scenario are leaks that have been leaking water over a long period of time leading to under flushing of the underground or soil with fatal consequences. So called "Sink holes" is a depression or hole in the ground caused by some form of collapse of the surface layer where buildings or part of a drive way disappear. Sink holes can create tremendous damage to materiel and people. If suddenly the drive way is collapsing into a big hole during rush hour the water utility can end up in serious trouble.

Because leakage from the main pipes and valves is continuous, while customer demand is minimal at night, water operators should monitor leakage during the night period. The graph shows the flow pattern into a typical DMA with mainly domestic customers.



$$\text{NNF} = \text{MNF} - \text{LNF}$$

To estimate the level of leakage in the DMA the operator needs to calculate the system's **Net Night Flow (NNF)**, which is determined by subtracting the **Legitimate Night Flow (LNF)** from the **Minimum Night Flow (MNF)**.

The MNF is measured as the lowest flow into the DMA over a 24-hour period, which generally occurs at night when most consumers are inactive. Although customer demand is minimal at night, water operators still have to account for the small amount of legitimate night flow (LNF).

To determine the level of Net Night Flow (NNF) or the portion of night flow directly attribute to leakage, subtract the LNF from the recorded MNF.

Leakage is proportional to the pressure in the system. Similar to water flows into the DMA, the DMA average pressure will change over a 24-hour period directly proportional to flow, and thus when the DMA has its lowest inflows, the pressure will be at its highest.

Therefore, the NNF or leakage calculated for the minimum night flow period will not be a true representation of leakage across a 24-hour period. Utility managers must also determine a pressure factor, or T Factor, that creates a true average 24-hour leakage value when applied to the NNF. The T Factor is calculated by using a data logger to record pressure over a 24-hour period, and then using those measurements to calculate the average 24-hour pressure. This average 24-hour pressure is compared to the system pressure during the minimum night period and a factor applied.

$$\text{Commercial loss} = \text{NRW} - \text{NNF}$$

Determining commercial losses

The level of total water losses (NRW) within a DMA can be calculated by subtracting the recorded consumption from the inflow.

The commercial losses are a simple subtraction of physical leakage (NNF) from the NRW.

Once utility managers identify the DMAs with significantly high commercial losses, they should investigate for faulty meters, tampered meters, and illegal connections. They may also conduct a series of customer surveys of each property within the DMA to verify the property's inclusion in the billing database, interview the occupants, and assess the water meter accuracy.



ACTIVE LEAKAGE CONTROL



A targeted leak detection program with active leakage monitoring of each DMA can in most places reduce the overall leakage in this distribution system by at least 40-50 %.

A successful leakage management strategy must be based on DMAs with pressure management, active leakage control, pipeline and asset management, and speedy and high-quality repairs. As fundament for this strategy it is a must always to use reliable and long-lasting equipment to make sure that all installations will continue to function seamlessly at any time.

Active leakage control is vital to cost-effective and efficient NRW management. The concept of daily monitoring flows into district metered areas (DMAs) is now an internationally well-established technique to determine where leak location activities should be prioritized. Monitoring the leakage based on every day updated Water Balances for each DMAs secure fast registration of leaks and by that way also possibility of fast repair. IT tools, online smart meters, acoustic noise loggers can be used to analyze the data from each DMA and by that report new leaks within few hours. This, together with speedy repair, limits the total volume of water lost to a minimum.

The basic method of detecting and locating a leak is to listen for the noise of the water being released from the pipe under pressure. Noise loggers narrow down the area of leakage within the DMA that contain suspected bursts or number of leaks. Using deployed noise loggers integrated in AVK surface box reduces the runtime of invisible leaks significantly. It enables the leakage team to react quickly and efficiently and target weakest areas and pipeline segments.



A very basic condition to do successful active leakage control is to control the flow into and between the DMAs, and the best way to secure that is to use AVK gate valves. AVK provides absolutely zero-leakage valves that remain tight even after many years of operation. Our stem sealing system is based on a maintenance-free solution, and valves are life tested in accordance with AVK specifications.

The wedge is the heart of a gate valve

The quality of the wedge rubber is crucial for the valve function and durability. AVK wedges are fully vulcanized with AVK's rubber compound offering outstanding characteristics. The double bonding vulcanization process ensures maximum adhesion of the rubber and prevents creeping corrosion. By choosing AVK high-quality shut-off valves, leakages from the valve itself can be avoided. Gate valves with high-quality gasket of rubber ensure that the valves are 100% drop-tight.

Air in the pipe network will always create problems. It is causing increased energy consumption for pumping due to air pockets that reduces the cross sectional area, accelerate corrosion in the pipes, cause inaccurate meter reading and will enforce water hammer when they occur.

Pipe network should always be equipped with air valves on strategic places where air will accumulate, typical on the high points of the network. AVK Air valves is an important installation to reduce water hammer. Water hammer will occur when large volumes of air under pressure are released at high velocities and result in leaks because of hard impact from the pressure on the pipes and valves!

To reduce water hammer is an important activity to reduce leaks and NRW!

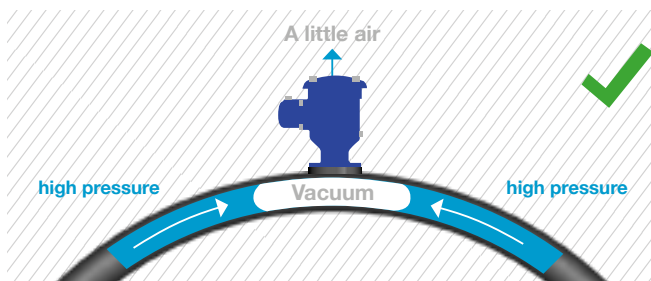
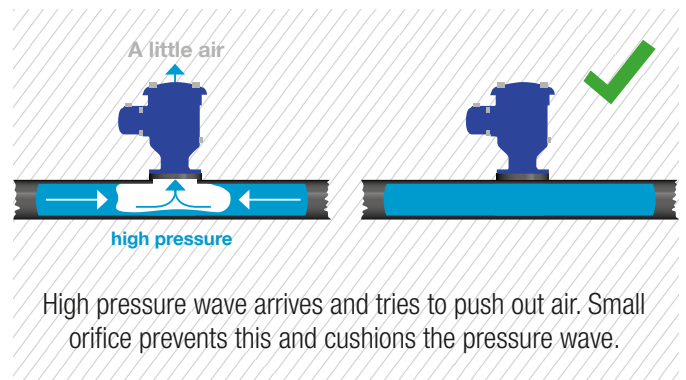
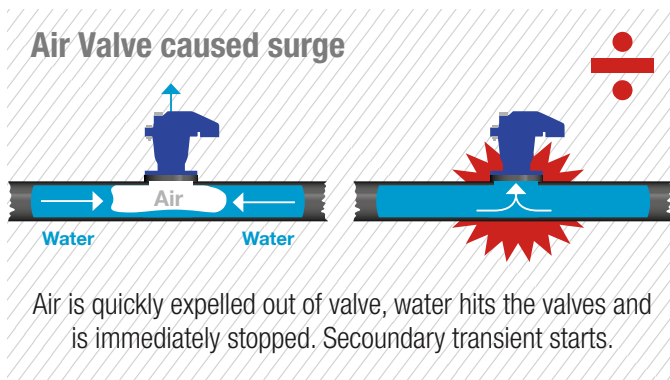
The principal sources for air in the pipe line system is often incomplete filling; air dissolved in the water that is released when pressure drops, or air is sucked into the system through leaks.

There are many types of air valves installed in potable water supply systems: air and vacuum, automatic air release and combination (double) valves. Air and Vacuum valves discharge large quantities of air from non-pressurized pipes and are used mainly when filling a line. Air and vacuum valves also make it possible

to admit large quantities of air when lines are drained and when the pressure drops suddenly.

Air and vacuum valves are also known as: Kinetic valves, Large orifice air valves, Vacuum breakers, Low pressure air valves and Air relief valves.

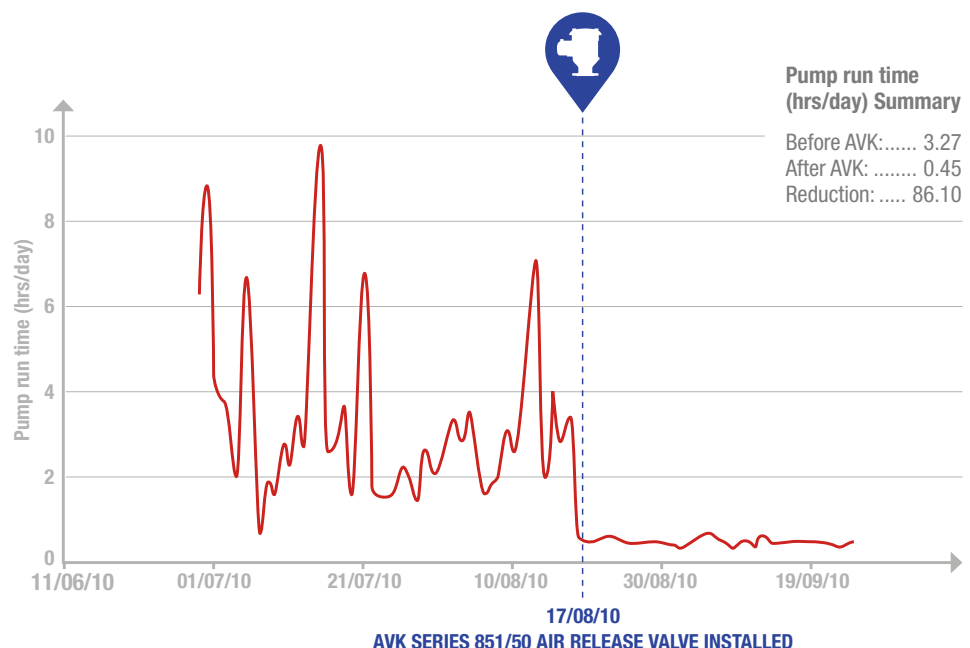
- Automatic air release valves continuously release relatively small quantities of air from a pressurized line. The automatic air release valve is also known as a small orifice air valve and as a pressure air valve.
- Combination air valves fulfil the tasks required of both types of valve – air, vacuum and automatic. They discharge or intake large volumes of air when filling or emptying a system and continuously release small volumes of air when the line is pressurized.
- Combination air valves are also known as double orifice air valves, double acting or dual orifice.



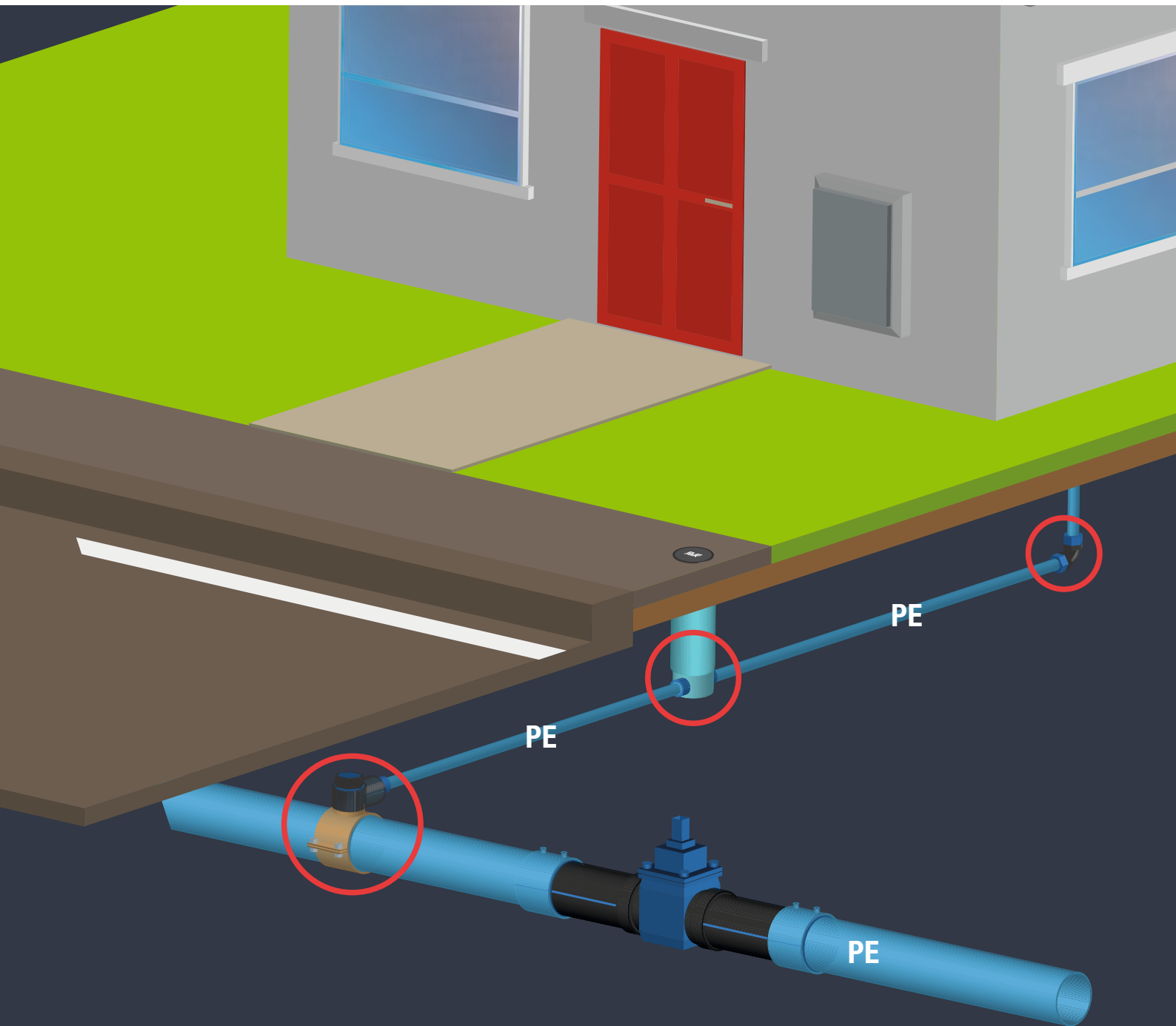
Water Column Separation

High pressure wave arrives later and tries to force vacuum pocket closed. Small orifice prevents this and cushions the pressure wave.

Significant energy savings have been the immediate result of this installation and benefitted in energy saving certificates (ESCs) revenue.



TYPICAL PLACES TO LOOK FOR LEAKAGES



One of the most critical elements in water distribution is the service connection, i.e. tapping saddles, old valves, fittings and service pipes of badly coated metal.



Leakages from transmission and distribution mains are usually large events that can cause serious damage, but the public typically reports them rapidly, followed by the utility repair on an emergency basis. One of the most critical elements in water distribution is the service connection, i.e. tapping saddles, old valves, fittings and service pipes of badly coated metal.

They will contribute with many smaller leaks if they are not of the best standard. They are installed underground for many years, and it is difficult to detect the many smaller leaks so only the best quality valves should be used. For a complete service connection system, AVK offers a comprehensive range of service connection valves, extension spindles, surface boxes and tapping saddles. Furthermore, the Supa Lock™ range also comprises a wide range of fittings for any purpose.

AVK's service connection system is a well-proven solution that secures easy and maintenance-free installation and long life. Each product in the range has outstanding design features, and when combined, the products form a system with the best possible durability and reliability.



Supa Lock™



Series 03 Service Connection Valves



Series 16 Service Connection Valves

“MAINS TO METER” SOLUTION



AVK has developed the AVK PentoFlow range to ensure we can meet your product requirements from the water main to beyond the water meter. That has been done to develop a complete system useful in any part of the distribution system – from Mains to Meter called AVK PentoFlow.

AVK PentoFlow has especially a wide and flexible range of products to be used to keep NRW contribution from the service connections at a low level. Some of the products offered is:

The AVK PentoBox range of Water Meter Boundary Boxes, comprises of a class leading, composite Grade B surface box able to withstand an 8 tonne loading and Automated Meter Reading Technology (AMR) can be added.

The AVK PentoMech mechanical range allows PE pipe connections from d20 to d110mm. As part of the range, there is the AVK PentoMech Universal coupling and elbow with a PE outlet and also a Universal x Universal coupling and elbow. This allows you to connect on to lead, copper, PVCU, imperial polyethylene and metric PE.

The AVK PentoPush push-fit fitting is for PE pipework from d20 to d63mm. Both ranges include a Universal range to allow connections to most common water pipes.

The AVK PentoValve range of stop taps is available in polypropylene and gunmetal. It gives installers the flexibility in connections up to d63mm where the installer requires a reliable method of controlling the water supply and if required shutting off the supply.

The AVK PentoTap range of swivel ferrules and self-tapping saddle ferrules allow an easy trouble free connection, with a 360° rotation from the swivel banjo outlet which is available as a push-fit joint for PE or female threaded outlet. The range has outlets which are from acetal plastic and gunmetal allowing you to make a choice which suits your particular application.

ELECTROFUSION FITTINGS



Fusion, as one of the members of AVK Group, offers global PE network solutions for portable water mains, service pipes and house connections. Fusion is a world leader in the manufacture of electrofusion fittings as well as an extensive range of spigot fittings. All Fusion fittings are manufactured in PE100 black polyethylene. Our products meet and often exceed the highest standards of safety and durability. With ISO9001 accreditation and multi-national approvals, we believe in much more than just passing the finished product on to the consumer, but to give them the quality assurance they need on all the products supplied to the utilities industry.

Electrofusion Fittings

Fusion's electrofusion fittings and polyethylene pipes enable utilities, designers and contractors create fully welded pipe networks. Joints are critical points in any pipe network. The production quality, reliability, and flexibility of Fusion's electrofusion fittings buys you peace of mind and certainty.



Spigot Fittings

Fusion have a whole range of moulded, machined and butt welded spigots including elbows, bends, tees, stub flanges and many more in a range of different sizes and SDR's needed for polyethylene pipe jointing.



BENEFITS OF DMA MANAGEMENT

When a DMA is first established, water utility managers should undertake the initial calculations of NRW, NNF, and commercial losses, and identify the main areas of concern. If the DMA has high leakage or high commercial losses, then relative NRW reduction activities should be implemented in a prioritized approach. This will ensure that the investments in reducing NRW will have the fastest effect and highest return of investment.



Once NRW is reduced to an acceptable level, the operations staff should set up a monitoring regime for the water balance for each DMA. Based on that fast action on repairs can be taken and less water will be lost.

The NRW management should set an intervention limit, or the level at which NRW becomes unacceptable. Once the intervention limit is reached, the teams should be sent in to detect and resolve losses. Generally, once the utility manager deploys teams into the DMA, they can reduce the NRW level within few weeks. It is very important that the repair is done with strong focus on best workmanship and use of high-quality equipment, like AVK Repair Clams. Establishing a series of DMAs not only targets NRW reduction but it also improves asset condition and customer service by:

- Maintaining asset life through pressure management
- Safeguard water quality
- Enabling continuous water supply with controlled pressure

Repair and rehabilitation of pipe systems

Whenever a leakage in a water mains occurs due to a crack, it is essential that the repair is done quickly and efficiently so that the consumers and surroundings experience a minimum of disturbance. As most cracks occur without any prior notification it is of greatest importance that the repair products are available ex-stock either at the waterworks, the contractor or as minimum at the wholesaler. To make this possible the repair products must have multi functionality, flexibility and wide tolerances.

Furthermore, the key demands when conducting repairs are easy and fast installation and reliable functionality.

For all these specific purposes and demands AVK offers a comprehensive range of products specially designed for all sorts of cracks in the most common pipe materials.



AVK offers a wide range of single band, double band or triple band stainless steel repair clamps for any type of pipe size and material. Repair clamps can also be supplied with threaded or flanged tapping connection.



For large diameter pipes, AVK offers both external as well as internal stainless steel repair clamps. All repair clamps are vulcanized with drinking water approved EPDM rubber.

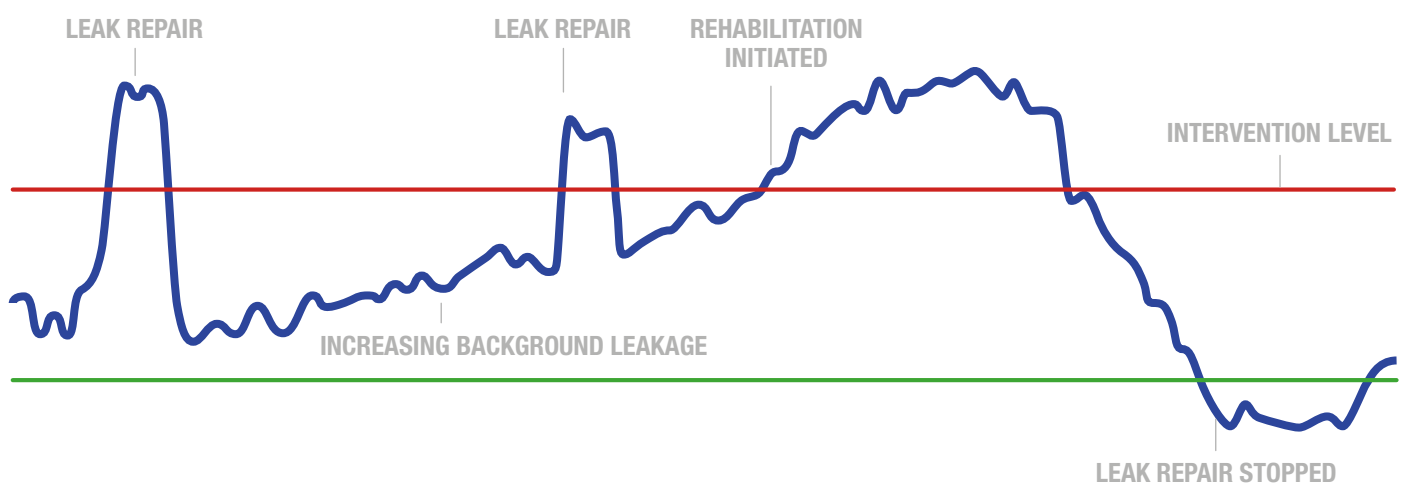


AVK also offer a wide range of couplings and adaptors, tensile and non-tensile, dedicated and multi tolerance for any type of pipe and pipe material.

The NRW manager is responsible for moving from leak repair to rehabilitation based on cost benefit analyzes. He should ensure that the NRW level is monitored until the intervention level is reached again and the cost benefit analyze shows that it is more optimal to rehabilitate.

If the time decreases between detection exercises, it indicates that losses within the DMA are occurring more frequently and that the system's assets are deteriorating. For such a case, water utility managers should consider asset rehabilitation such as pipe and valve rehabilitation, rather than continual leak detection and repair. The rehabilitation should be based on an overall plan and a cost benefit calculations to choose where and when the investments will have the highest return of investment.

MOVING FROM LEAK REPAIR TO REHABILITATION



Upon completion of asset rehabilitation activities, the level of NRW typically decreases due to fewer leaks, especially underground or previously undetected leaks. Monitoring teams should also detect a much slower increase in the NRW level over time with the much-improved asset condition, and the intervention level should be re-set to a lower level.

It can be a challenge to replace pipes of different materials in the DMA. Most replacements will be done with more modern and suitable material than the existing pipe material. SUPA Maxi coupling range and the wide range of Electro Fusion couplings from Fusion can be a great help for safe couplings in a non-leakage full welded systems and pipes.

Most equipment are installed underground and cannot be visually inspected. It is therefore very important that all equipment are quality products to ensure that they will function properly for many years. AVK delivers only high-quality products with long warranty and the best performance when it comes to "Lifetime cost" or "Total cost of ownership".

There is much more than purchasing price behind AVK products

