FLOWSERVE

SEPTEMBER 2021

*Application Solution Guide*

# WATER

*Experience In Motion*

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# GLOBAL MUNICIPAL WATER LANDSCAPE

## Water Market Overview

The need for clean, environmentally sustainable water is global and growing. An expanding population, urbanization, industrialization, sustainability, climate change, infectious diseases, and an increasing list of new contaminants are factors greatly impacting the industry. Irrigation remains the largest use of freshwater in most parts of the world. It represents 70% of water withdrawals worldwide (varying by country). By 2050, agriculture will need to produce 60% more food globally and 100% more in developing countries. Thermoelectric power water demand follows irrigation in the US.

There are 6,629 major water utilities worldwide, with 52,000 community water utilities in the U.S. alone. Of these, 138 are large, Tier 1 municipal utilities. About 85% of domestic water is delivered to homes by a public-supply facility, such as a county water department. About 15% of the nation‘s population supplies their own water, mainly from wells.

Indifferent to size, water facilities have experienced decades of infrastructure neglect due to funding shortfalls. The industry is in urgent need of modernization to meet its ever-growing challenges. By one estimate, U.S. water systems alone need $1 trillion over the next 20 years. This is while federal funding for water infrastructure has fallen 74% in real terms since 1977. The industry is seeking to increase operational efficiency as one way to reduce costs.

## Population

Since the 1950s, the world population has doubled while water demand has tripled. The world's population is growing by about 80 million per year and is predicted to approach 10 billion by 2050. Feeding 9 plus billion people by 2050 will require a 60% increase in agricultural production (which consumes 70% of the resource), and a 15% increase in water withdrawals. Population growth undoubtedly leads to greater pressures on the availability of water resources.

Overpopulation will strain current water resources to their limits, cause an increase in water pollution, and lead to an increase in civil and international conflicts over existing water supplies. In 2015, approximately 40% of the world population lived in water scarce areas. The domestic sector accounts for 10% of total water use. And yet, worldwide, an estimated 748 million people remained without access to an improved source of water in 2015.

## Urbanization

In 2017, more than 50% of people worldwide lived in urban areas. By the year 2025, nearly 70% of the world population is expected to be living in cities. Further, urban areas will absorb all the world's population growth over the next four decades, as well as accommodate significant rural-to-urban migration. Most will live in overcrowded conditions.

with inadequate, or non-existent, water supply. The UN believes that around 2 billion people will suffer from water scarcity by that time. As populations continue to move to cities for economic opportunities, megacities will form. Surface and groundwater implications must be addressed.

## Industrialization

Industry and energy together account for 20% of water demand. More-developed countries have much larger freshwater withdrawals for industry than less-developed countries, where agriculture dominates. Balancing the requirements of sustainability against industrial mass production

creates a challenge for industry. One of the biggest issues is globalization and how to spread the benefits of industrialization worldwide and without unsustainable impacts on water and other natural resources.

## Pollution

Water pollution is a problem in places where factories are built next to natural water sources. These toxins can come in a variety of forms — solid, liquid or gaseous — and they can all end up contaminating the local water supplies. Even landfills and other waste disposal areas can leach toxins into the local water supply, leading to water pollution as in the case of River Nile.

Soil contamination is another problem that goes hand in hand with industrialization. Lead is the most common form of soil contamination, but other heavy metals and toxic chemicals can also leach into the soil and, in turn, contaminate any crops that grow there. This leads to groundwater contamination.

## Sustainability

Sustainability in **environment, energy** and **agriculture** are all critical to the water industry. Water is finite and irreplaceable. It's fundamental to human well-being and societal advancement. It is only renewable if well managed. More than 1.7 billion people live in river basins where depletion through use exceeds natural recharge, a trend that will see two-thirds of the world's population living in water-stressed countries by 2025.

Water processing is also energy intensive. Water and wastewater utilities account for 30-40% of municipality energy consumed. The USEPA (United States Environmental Protection Agency) estimates 3 to 4% of electrical consumption is used to provide drinking water and wastewater services each year. On average, a waterworks and distribution operation use about 12% of its plant budget on energy. In this, approximately 90% of electrical power is used for pumping operations.

## Climate Change

Global warming is having a measurable effect on the water cycle, altering the amount, distribution, timing, and quality of available water. A warmer climate increases evaporation from land and oceans. In turn, a warmer atmosphere can hold approximately 4% more water for every 1°F rise in temperature. Some areas will have increased precipitation and runoff leading to increased flooding. Other areas can expect less precipitation and longer, more severe droughts. **Weather unpredictability makes planning and management of water operations more difficult and costlier.**

**Declining water quality is another consequence of climate change.** As more intense precipitation leads to increased runoff, more pollution is washed into our waterways: sediments, nitrogen from agriculture, disease pathogens, pesticides, and herbicides.

One of the most significant effects of climate change is the rise in global sea levels. **Rising sea levels drive saltwater into freshwater aquifers.** This translates into more water from our aquifers needing to be treated.

## Market Trends

Decades of under investment have left a legacy of decaying infrastructure, an inability to adapt to new environmental standards and concerns of water scarcity. Recent market trends are an outflow of these market dynamics, along with other factors such stricter standards and greater demand. The market trends below reflect these dynamics.

- **Distribution project spending is considered urgent maintenance and essential to service continuity.**
- Spending on water networks is set to be one of the most important areas
- As pump efficiency grows in importance in the water industry, meeting or exceeding DoE (U.S.) or local standards are increasingly important to customers.
- **Water industry project activity remains high during COVID-19**. There have been more delays on large water projects. The activity level comes as much of the water infrastructure aged and at a critical level.

- **Project funding remains challenging** as municipalities are met with resistance to rate increases by constituents.
- **Remote monitoring is a part of many utilities, especially the larger entities.** Complex digital solutions such as IoT predictive analytics, have yet to take hold.
- **Lead and other contaminants** in water is increasingly a public concern and scrutiny.
- **Increased utility consolidation through private partnerships are on the rise** as smaller utilities struggle to find funding to do needed repairs and modernization projects.
- **Urbanization continues to increase globally.** More likely to be a larger utility with access to funds. The Engineering Consultant less likely to be the dominant decision-maker with instead the water board committee.
- **Competitive supplier intensity into the water industry has noticeably increased** as industrial suppliers find alternatives to oil and gas during COVID-19.
- **Large part of water market is moving to design and construct, where design team is selected, and design is done in parallel** with the engineer, contractor, and vendors.

## COVID-19 Impact

Developed and emerging countries have been dramatically impacted by COVID-19. In developed nations, there has been mostly budget tightening and larger projects being delayed. While water utilities in emerging countries are deeply challenged with securing funding to meet their infrastructure needs during this period and beyond. The reason behind the absence of adequate water treatment facilities and regulations in most developing countries is the lack of funding to finance water infrastructure.

# TECHNOLOGY OVERVIEW

The development and implementation of water treatment technologies have been driven by three primary factors: the discovery of new contaminants, enhanced water quality standards and costs. Water technology can range from meters to gauge usage, automation to chemical reactants to speed up process and water quality. Technology advances, particularly in automation, offer plant management ways to lower capital, and operations and maintenance costs, gain higher efficiency, easier operations and better effluent water quality.

Flow measurement, more broadly, is a key control parameter to ensure clean, high-quality water is available. Applications ranging from water storage and transmission to leak detection cannot be done without flow technology. Companies must find ways to deal with new, higher standards for water quality and pollution controls. They are also under pressure to save energy and upgrade aging infrastructure.

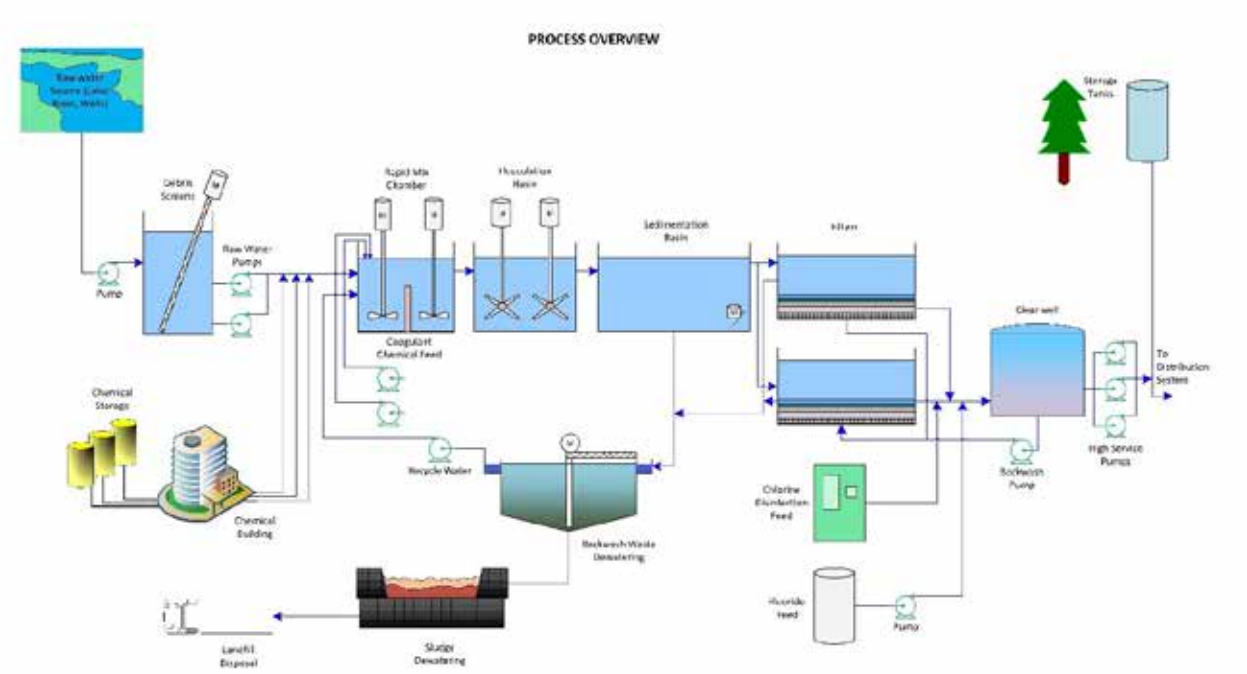
Water plants use chemical reactants, flow control and pressure to maintain high quality drinking water. A myriad of equipment is used in the process, including piping, pumps, seals, valves, actuators (large facilities) and automation (i.e. remote monitoring). All equipment is highly regulated to ensure drinking water is safe. For example, NSF-61 requires equipment must have lead content below 0.25%. Water utilities expect new technology to meet the following criteria:

- Can be scaled to large applications (i.e., > 5 MGD)
- Cost competitive with existing technologies at large scale
- Produce water that meets regulatory requirements
- High degree of reliability

Flow measurement technological innovations that increase water flow precision and reliability that lead to clean, high-quality water are greatly valued. Applications ranging from water storage and transmission to wastewater treatment, leak detection and pump management and metering, cannot be done without sound flow technology.

New technologies impacting water processing also continue to be developed, tested, demonstrated, and introduced into the municipal water market. These include in membrane filtration, UV treatment, advanced oxidation, ion exchange, and biological filtration. As cost of these technologies decrease, their applicability will steadily rise.

# A CLOSER LOOK AT WATER PROCESSES



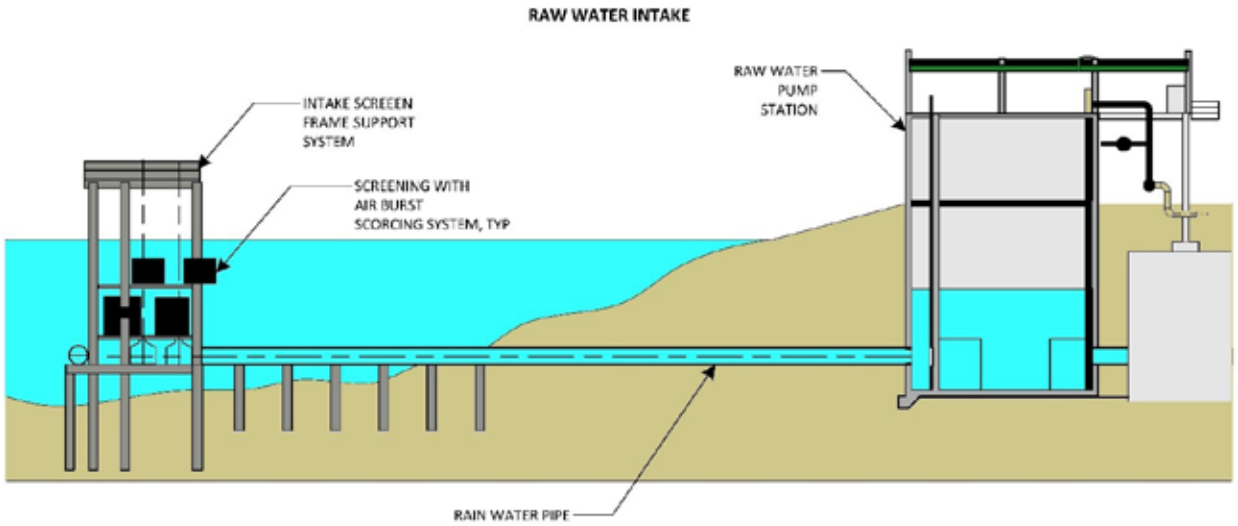

Population and water consumption estimates are the basis for determining the flow demand of a water supply and distribution system. Flow and pressure demand on the system are determined by hydraulic network analysis of supply.

Raw water intake, water processing and treatment and distribution (network) are the main process areas of a municipal water plant. The goal of the water plant is to make drinking water safe through control of water sources, optimizing the effectiveness of water treatment and purification and increasing the integrity of the distribution network that carries water to consumers.

There are seven critical challenges facing the water industry. They are:

1. Complying with regulations and staying abreast of new and changing regulations
2. Sustaining water infrastructure – maintaining and upgrading facilities, equipment and processes
3. Sustaining energy
4. Water management privatization or reengineering
5. Benchmarking
6. Maintaining a viable and well-trained workforce
7. Upgrading security

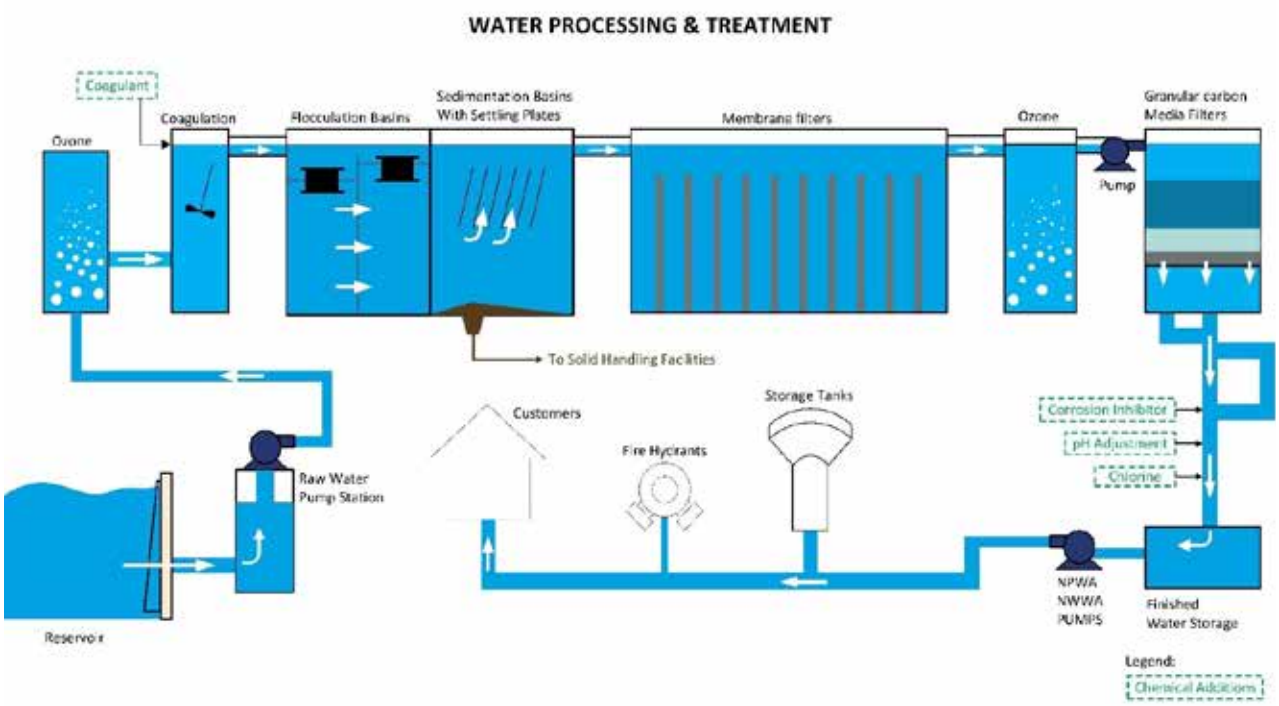
# Raw Water Intake




Raw water intake is the function of collecting/ pumping fresh water source to a water treatment facility. Depending on the source of fresh water, utilities can utilize different equipment to transfer. Surface water and groundwater are the two water sources utilities use for drinking water. Surface water includes rivers/streams, lakes, aquifers and reservoirs. Groundwater is water that has seeped into the earth's layer and can usually be extracted through wells. It can require pulling water from hundreds of feet below grade

Raw water has natural occurring impurities such as microorganisms, inorganic/organic and suspended solids. And these impurity levels vary based on weather, seasonal run off and pollution.

# Water Processing & Treatment

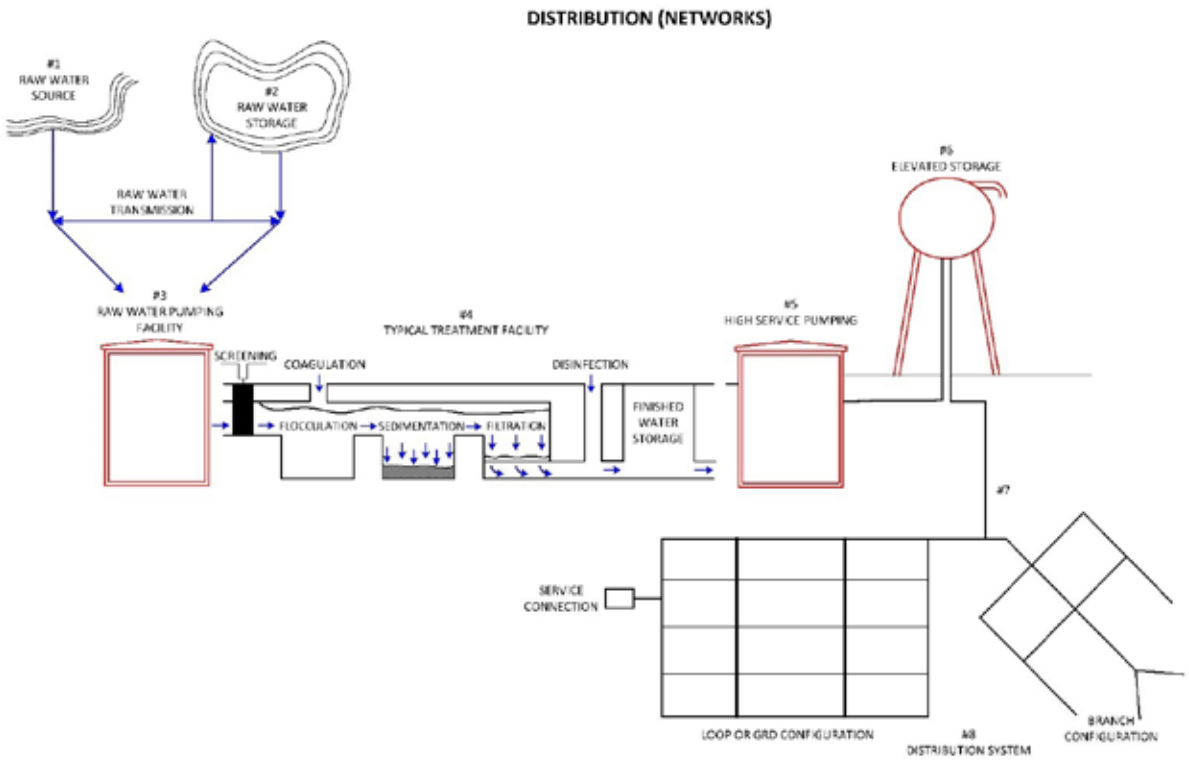



Water Processing and Treatment operations provide removal of solids, other contaminants, and the disinfection of remaining bacteria for safe use and human consumption. It is also used to reduce pollution of water resources and hazards to the community's health.

Raw water impurities removed in this process will be dissolved gases, suspended and dissolved solids, and bacteria. The traditional water treatment plant will consist of a combination of: aeration, clarification, filtration, disinfection, and effluent discharge sections.

| WATER TREATMENT AREAS | PROCESS DESCRIPTION |
|---|---|
| **Aeration** | • *Used to separate hydrogen sulfate and iron*<br>• *Water pressure will be required based on elevation* |
| **Clarification** – Coagulation, Flocculation, Sedimentation | • *Coagulation is used to destabilize suspended charged particles*<br>• *Most impurities (colloids) are negatively charged and will repel each other in the solution. A coagulant is a positively charged additive (polymer) that attracts, neutralizes, & collects the particles to form floc formation*<br>- *Dependent on pH > temperature*<br>- *Colder temperature is longer retention time for better efficiency*<br>- *Aluminum sulfate (ALUM) used at 5.5-7.5 pH is target*<br>- *Polyalanine chloride, iron salts (ferric chloride, ferric sulfate) alternatives*<br>• *Flocculation step provides a mixing technique to assist in agglomeration of particles. Propriety additives:*<br>- *Cationic polymers used to bid coagulate particles together*<br>- *Coagulate agent is added to water to bond to the solid particles and force them to drop out of solution with gravity*<br>- *Water usually travels over a weir to the next process. Coagulated solids will settle to the bottom of the vessel*<br>- *Maix (magnetic ion exchange)*<br>- *Softening system or agent likely to utilized in this section to lower alkalinity (CaCO3). Removing organic material before disinfection will help control disinfectant byproducts levels*<br>- *Sodium hydroxide* |
| **Filtration** | • *Water is pumped through a filter bed of particles to remove any remaining sediment. Bed is usually a combination of sand/gravel and active carbon beds*<br>• *Active carbon beds benefit taste and odor concerns*<br>• *Filtration section is likely to have suction pump and backwash pump sets* |
| **Disinfection** | • *Chloride is a chemical disinfection and used to destroy any remaining bacteria*<br>• *Once water is treated, a regulated amount of chlorine can remain through distribution piping to prevent additional contamination from distribution piping. Chlorine can have adverse effects on wetted equipment, customers (taste), and any discharge water will have to be treated for off-site blowdown*<br>• *O3 disinfection will require specialized ozone equipment. This equipment will introduce ionic charges to water to create a reaction of H2O with oxygen to create 03 ozone. Ozone is strong oxidizer that attacks organic bacteria in water:*<br>- *Advantage is effectiveness of controlling taste and odor of product*<br>- *Disadvantage is no residual treatment agent left for additional control in downstream systems*<br>- *Sodium Bisulfate can be the final addition to remove any residual ozone*<br>• *UV light is utilized to rearrange bacteria DNA and sterilizing the organisms. Sterilized bacteria are not harmful to consumers. Disadvantage to this system is zero residual* |
| **Auxiliary Additions** | • *Fluoride to prevent human tooth decay*<br>• *Orthophosphate (corrosion inhibitor) to prevent lead pipes from leaching* |
| **Effluent Release/Discharge** | • *Handle off-spec, impurity streams from clarification and filtration stages*<br>• *Section consists of settling vessel, aeration pond, and likely some chemical treatment for separation and/or pH balance*<br>• *Pumps will be required for transportation from settling to pond, pond to destination, and likely for chemical treatment addition* |

# Distribution Network




The objective of a distribution network is to supply a community with the appropriate quantity and quality of water through a system of pipes and trenches. The network construction and layout must be carefully prepared to guarantee enough pressure and ensure the flow of hygienically safe water. Once constructed, maintenance - including repair, leakage control, re-contamination prevention, and operation of pumping stations where gravity pressure is not enough, are continued activities in the network. Distribution projects are often considered vital to service continuity and given priority.

**High performing distribution systems include:**

- Water quality that doesn't deteriorate while in distribution pipes
- System is capable of supplying water to all intended places with enough pressure head
- Can supply the requisite amount of water during firefighting
- The layout is such that no consumer is without water supply, during the repair of any section of the system
- All the distribution pipes should preferably be laid one meter from or above sewer lines
- It should be watertight to keep losses (e.g. due to leakage) to a minimum

**There are four principal methods to design a distribution system.** While there are variations, they are:

- Dead end or tree system
- Gridiron system
- Circular or ring system
- Radial system

## Dead-end or tree distribution system

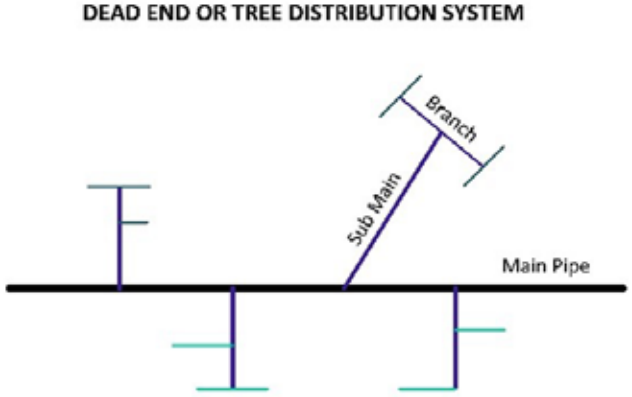
In the dead-end system (also called tree system), one main pipeline runs through the center of populated area and sub-mains branch off from both sides. The sub-mains divide into branch lines from which service connections are provided.

**Advantages dead-end System:**

- *Design calculation is simple and easy*
- *A smaller number of cut-off valves required, and O&M cost low*
- *Pipe laying is simple*

**Disadvantages dead-end system:**

- *System is less successful in maintaining pressure in remote*
- *Main pipeline provides entire city (high risk)*
- *Head loss is relatively high, requiring larger pipe diameter, and/or larger capacities for pumping units. May affect the water quality*
- *Water hammer could cause burst of lines. Large number of scour valves required at dead ends*
- *Discharge available for firefighting in the streets is limited due to high head loss*



## Gridiron distribution system

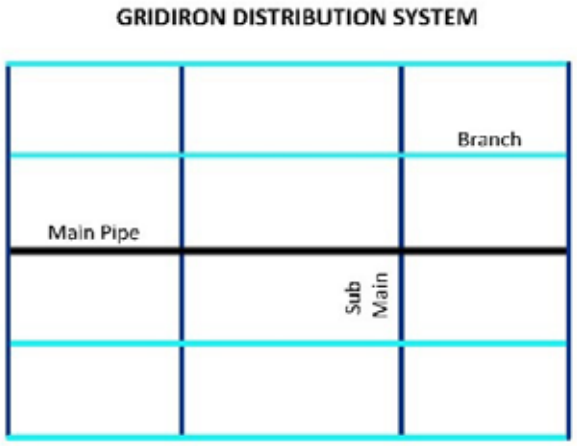
In this system the main supply line runs through the center of the area and sub mains branch off in perpendicular directions. The branch lines interconnect the sub-mains. This system is ideal for cities laid out on a rectangular plan resembling a gridiron. The distinguishing feature of this system is that all the pipes are interconnected and there are no dead ends. Water can reach a given point of withdrawal from several directions, which permits more flexible operation, particularly when repairs are required.

**Advantages of the Gridiron distribution system:**

- *Free circulation of water without any stagnation or sediment deposit, minimizes the chances of pollution*
- *Water interconnections available at every point with minimum loss of head*
- *Enough water available at fire hydrants*
- *Small network area affected with repairs*

**Disadvantages of Gridiron distribution system:**

- *Large number of cut-off valves required*
- *Requires longer pipe lengths with larger diameters*
- *Pipe analysis of discharge, pressure and velocities difficult*
- *Cost of pipe laying is higher*



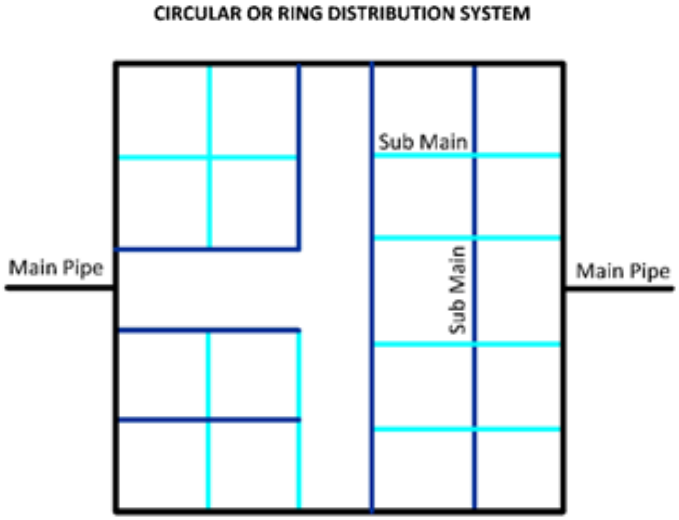
## Circular or ring distribution system

In a circular or ring system, the supply main forms a ring around the distribution area. The branches are connected cross-wise to the mains and each other. This system is most reliable for a town with well-planned streets and roads.

**Advantages and Disadvantages:**

*Are the same as those for the* ***gridiron system***

*However, in case of fire, a larger quantity of water is available, and the length of distribution main is much higher*

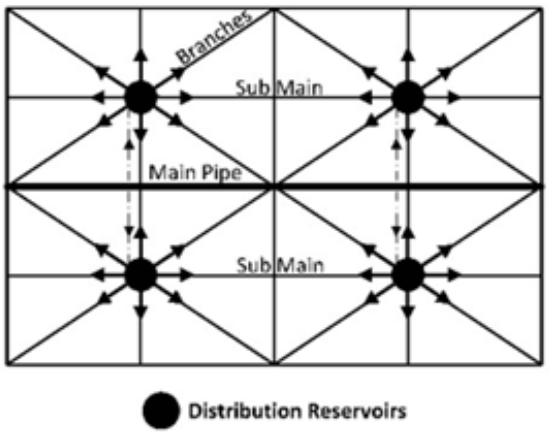



## Radial distribution system

In this system, the whole area is divided into distribution districts. Each district has a centrally located distribution reservoir (elevated) from where distribution pipes run radially towards the periphery of the distribution district.

**Advantages:**

- *Enables swift service, without much loss of head*
- *Design calculations are much simpler*



**Water source:** At the beginning of every water distribution network, there is a raw water source (i.e. lake, river or groundwater). To provide enough water for the network the water can be stored in a reservoir by utilizing pumps to transport water from the source to the raw water storage facility. The water is filtered prior to being injected into the network to prevent corrosion.

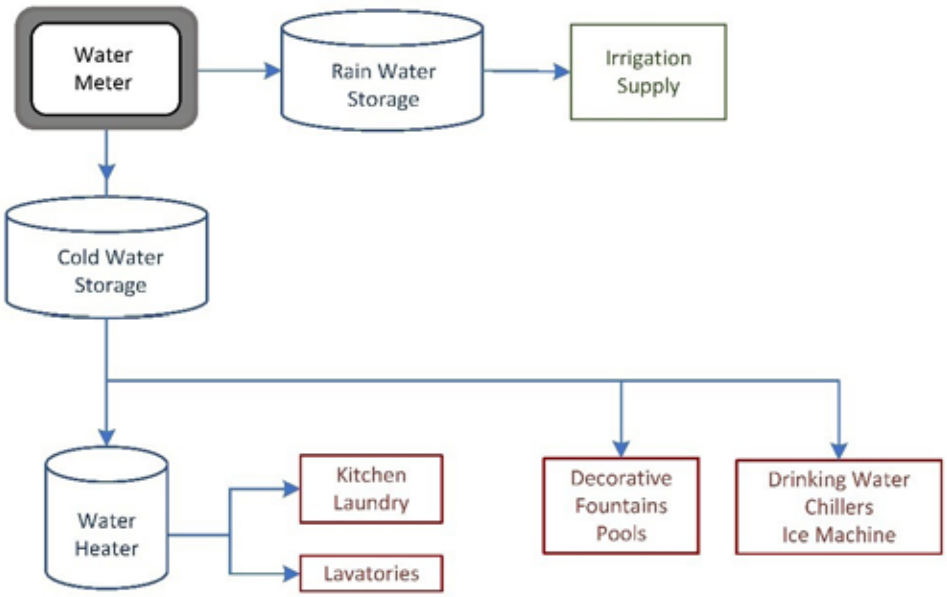
**High service pumping:** Is typically part of pumping stations. These pumps may be needed to:

- Pump water up to service areas that have higher elevations than other areas of the community
- Fill gravity tanks that float on the water supply distribution system
- Distribute water when no water storage is provided, having the pumps force water directly into the network

**Elevated storage:** A key aspect of water distribution is water storage. System storage facilities have a far-reaching effect on a system's ability to provide adequate consumer consumption during periods of high demand while meeting fire protection requirements. The two most common storage methods are ground-level storage and elevated storage.

**Piping/ distribution system:** At the end of the system, water is distributed via pipes to the consumer, who has to pay for the used amount. See typical consumer water use below.

## Consumer Water Use



# FLOW CONTROL PRODUCTS IN WATER

## Pumping Stations

Pumping stations are vital to a water plant. They provide enough pressure to overcome the force of the gravity on the water. Pumping systems account for a significant portion of a facility's energy use and maintenance costs. In most pumping systems, the energy added to the working fluid by the pump is much greater than required by the process. The excess energy added to the system not only increase energy costs; it generates heat, noise and vibration that increase the system's maintenance costs.

Main pumping stations that supply water to the distribution system will be located near the water treatment plant or a potable water storage facility and will pump directly into the piping system. They are used for:

1. Pump station that pumps to high elevation storage to maintain water pressure
2. Pump station that boosts water pressure based on area targets

Depending on location, pumps used directly into transmission lines and distribution systems are often high lift pumps. Booster pumps may be also used and can be located anywhere in the system to increase the pressure in the pipeline. Many times, these pumps are located remotely from the main pump station, where added pressure is required. Booster pumps may also be needed to handle peak flows in a distribution system. A hydraulic analysis should be performed when booster pumps are added to an existing plant.

### Hydraulics

The hydraulics of the network (adequate pressure and flow) is the main element of network dimensioning and design. Pressure occurs through gravity or pumps and is lost by the action of friction at the pipe walls. The pressure loss also depends on the water demand, pipe length, gradient and diameter. When designing a piped system, the aim is to ensure that there is enough pressure at the point of supply to provide an adequate flow to the consumer. For maintaining microbial quality, it is important to minimize transit times and avoid low flows and pressures. These requirements must be balanced against the practicalities of supplying water according to the location of consumers and needed piping.

Hydraulic network analysis is based on the following demand rates:

- Annual Average Daily Consumption (ADC)
- Annual Maximum Daily Consumption (MDC)
- Peak hour consumption on Annual Maximum Day (MDC/Peak Hour)
- MDC plus Simulated Fire flow

### Pump efficiency

Pump efficiency is defined as the ratio of water horsepower output from the pump to the shaft horsepower input for the pump. This usually is an electric motor. The efficiency of a pump is estimated by determining pump flow rate and total head. Total head is determined by measuring the distance from the source water surface to the output of the pump, as well as the pressure the pump is producing at the pump outlet. The better the efficiency, the greater utility cost-savings.

## Seals

Flowserve has been trusted for more than 80 years to design, manufacture and distribute mechanical seals, sealing systems and parts to customers worldwide. Our collection of mechanical seals is supported by strong aftermarket services and provides users with safety and environmental benefits.

As government regulations on water quality increase, the cost of water treatment and the value of clean water increase. Flowserve seals and sealing systems can offer a significant savings in operating costs including:

1. Reduced environmental contamination
2. Lower power requirements
3. Reduced downtime by increased mean time between planned maintenance (MTBPM)
4. Reduced maintenance costs with the implementation of mechanical seals due to their:
    - ease of installation
    - long, trouble-free life
    - designed repairability
    - low cost repair program
    - elimination of packing adjustment costs

| APPLICATION | CATEGORY | MODEL |
|---|---|---|
| **Water & General Duty** | *Standard Cartridge* | *ISC2 Series* |
| | *Pusher* | *QB Series* |
| | *Pusher* | *RO* |
| | *Pusher* | *Europac 600-610* |
| | *Special Duty* | *PSS 4* |
| | *Special Duty* | *Pac-Seal* |
| | *Packing* | *Varies* |
| **Sludge** | *Slurry* | *SLM* |
| | *Slurry* | *Allpac* |

# Valves

While the principal market for valves in developing countries is in new builds, the main source of growth for valves in more mature markets is replacing and refurbishing existing infrastructure. Valve companies are increasingly looking for growth in associated smart technology, such as automated controls, pressure management, asset condition monitoring and leak detection. The valve market can be segmented into isolation valves and control valves. Isolation valves are "on-off" while control valves regulate pressure. Valves have three primary functions in water. They include:

- Shutting off flow of water
- Controlling the flow of water – using pressure and flowrates, and
- Releasing air from the water system

More countries are trying to localize their economy, presenting difficulties for valve companies that rely on export markets. The biggest driver of demand for valves is population growth. Demand for valve types are usually driven by locality.

The intensity of price competition largely depends on the type of valve. Most manufacturers in Europe and North America focus on highly engineered products which compete on quality and reputation rather than price. This is in contrast to China, where there are over 1,700 valve companies with revenue of over $2 million.

## Shut-Off Valves

All pumps and check valves are equipped with a shut-off valve to allow isolation of the system and maintenance of the lift station components.

Examples of quarter-turn valves are ball valves, plug valves, and butterfly valves. These and others are detailed in the chart below.

| VALVE TYPE | CHARACTERISTICS | DESCRIPTION | APPLICATIONS |
|---|---|---|---|
| **Check Valves** | • *Installed in pipelines to prevent backflow*<br>• *Essential for keeping water in the pipes* | *One way valve in which flow can run freely in one way. If the flow turns, the vale will close to protect the piping* | *Protects pumps in liquid applications, or compressors in gas systems, where backflow causes shutdown. Also applied in systems with varying pressures that must be separated.* |
| **Butterfly Valves** | • *90° degree rotary motion using a disc for closure*<br>• *Very low head loss*<br>• *Low torque requirements*<br>• *Can stop flow in both directions*<br>• *Very limited to no leakage*<br>• *Must be designed, manufactured and tested in accordance to AWWA Standard C504* | *Regulates flow through use of disc element that is centrally fixed by a rod. As disc only requires a 90° rotation to open or close the valve, flow can be controlled rapidly* | *Large pipe diameters. High pressure and high temperature water services. Water treatment systems. Water distribution and transmission* |

| | | | |
|---|---|---|---|
| **Ball Valves** | • *Leak proof service*<br>• *Low head loss*<br>• *Multiway design flexibility – reducing number of valves needed*<br>• *Used in pump check service* | *Isolates flow through the 90° rotation of a ball-like element. When open, ball is in line with valve inlet and outlet. When closed is perpendicular to flow openings* | *Water distribution* |
| **Regulating Valves** | • *High head loss*<br>• *Multiple control scenarios*<br>• *To be maintained in place* | *Designed to reduce flow/ pressure* | *Water Distribution* |
| **Air/Vacuum Release Valves** | • *Releases air during filling and testing of pipe*<br>• *Allows air into pipe during draining*<br>• *Vents air continuously – after filling*<br>• *Releases air that naturally accumulates in pipes*<br>• *Ensures pipeline carrying capacity*<br>• *Proper location of valve releases all air* | *Designed to protect the system from water hammer or surging events during critical conditions (start-up, shutdown or loss of power)* | *Water distribution*<br>*Irrigation* |

### Pump Control Check Valves

When main pumping stations operate at high head or pump fluid through a very long force main (i.e., five miles), pump control check valves and special surge equipment may be needed instead of a traditional check valve. Quarter-turn plug, or ball valves equipped with electric, pneumatic or hydraulic-powered actuators and electrically connected to the pump circuit are often used as pump control check valves. The use of pump control check valves can significantly save power consumption due to their low head loss.

## Actuators

Actuators are integrated into water treatment plants, pumping stations, water pipelines, dams and drain gates. Integrated into control systems and converting signals into mechanical motion, actuators are linked to control centers or monitoring consoles. Alternatively, electric actuators rely on their own intelligent electronics to perform their primary function of controlling valves. In water sector applications, these valves link to treatment plants or filtering systems.

Actuation solutions can be used for open/close valve applications to divert flow to respond to the works' treatment requirements. Alternatively, actuators perform flow control duties to operate the valve in modulating mode. The actuator controls the flow to adjust the amount of medium passing through the valve into or out of the treatment plant.

Actuator specification is driven by the requirements of the valve application and environment but essentially two types are used. Part turn actuators drive butterfly valves and are used to control ball and plug valves. Multi-turn actuators are used primarily for wedge or knife gate valves and for pen-stocks.

# IoT in Water

Surface water control and monitoring provides the largest market opportunity for water automation. Groundwater monitoring, although a significantly smaller market, allows for the understanding of the environment and the level of pollution and depletion occurring. IoT is proficient in monitoring leakage detection in real-time. Also, it increases the quality of water, managing water usage by using sensors and other devices and more. Typical IoT flow measurement applications include:

- Water flow monitoring
- Dosing of water treatment chemicals
- Water consumption monitoring
- Leakage detection and reduction
- Network load monitoring
- Optimization of water usage
- Monitoring influent water quantity
- Monitoring discharge water quantity
- Monitoring of water flow between reservoirs

Water operations require plant-wide process control, integrated measurement, and monitoring capabilities and data reporting. They also need effective solutions to minimize energy usage and reduce risks to assets and the community. Neglected or poorly performing water treatment systems can significantly reduce plant efficiency and reliability, increase chemical and energy costs, and trigger regulatory noncompliance. IoT monitors factors such as real-time water pressure, levels, temperature and flow.

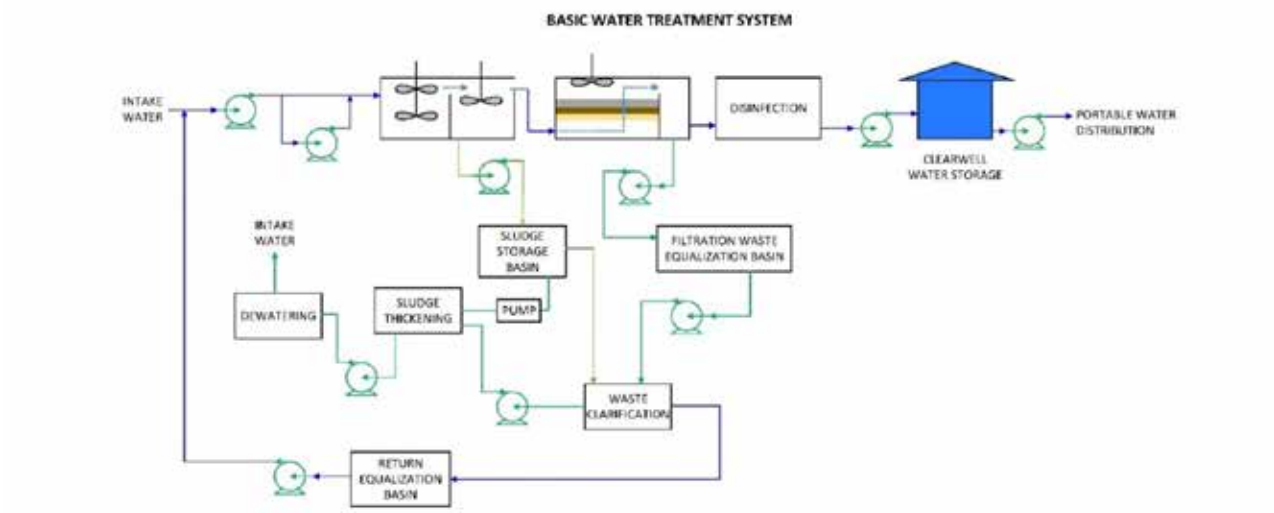
It is estimated that $3.0 billion is annually loss on water leakage. And worldwide, it's estimated the cost of water lost to leaks along with standard theft and billing errors, is approaching $14 billion. Smart water management and monitoring systems using sensors, provide real-time water pressure, water levels, water temperature, leakages and flowrates. Advanced IoT systems incorporate predictive analysis that can help maximize equipment life and save costs.

# FLOWSERVE AND WATER INDUSTRY INTERFACE

## Flowserve Product Summary

- **Flowserve Pumps** provide the greatest opportunity and can cover most areas of the municipal water plant. The most attractive areas are the raw water intake and distribution.
- There are opportunities for **Flowserve Valves** in the water market. Most in demand product are small butterfly valves.
- **Flowserve Seals** offer various options to service the water market. Key products include the PSS 4 (Split Seal) and ISC2 (Standard Cartridge Seal). Other offerings include QB, RO, Europac, Pac-Seal, Slurry Seals and Packing options.
- **Flowserve** offers the Worcester brand of Multi-Turn electric **actuators** and the recently launched Limitorque SMB electric actuator for critical and sever service applications. The Limitorque SMB is a DtV product. The electric actuators can be used in collaboration with external valve suppliers.
- **Flowserve Aftermarket Service** is a good opportunity for pumps because of the large installed based and Flowserve comprehensive service offering, including repair of aging equipment and replacement.
- **Flowserve Pump IoT** has not been first of mind when interfacing with water customers. However, customers value the ability to monitor their operations, particularly remotely, to increase water quality, reduce costs, extend assets and ensure compliance. Predictive analytics allows them to more proactively focus on these areas.

# Flowserve Products by Water Process Area




## Flowserve Pumps

Even with the ever growing and shifting world populations, traditional water sources are unchanged in geography. The modern municipal water systems have adapted to the great distances between source and consumer with pumps. The criticality of pumps in fresh water is paramount in all processes. Pumps are main motive force throughout the process.

Most pumps used in the water industry are either centrifugal or positive displacement. Centrifugal pumps dominate this space with 90% of the market. Flowserve is in line with this. Its centrifugal pump offering addresses all the three process areas of the water plant – raw intake, water treatment and processing and distribution. Pumps groups are vertical, between bearings and overhung. Flowserve has the greatest success in large plants where there is demand for pumps greater than 20”. Applicable pumps and corresponding parameters are detailed for: LR (LRN), VTP, LNN, MX/MN, Mark 3, SIHI and D800 (legacy product). See pump summary charts and specific product details on the next page.

## Flowserve Pumps by Process Area

| PROCESS AREA | PUMPS TYPES |
|---|---|
| **Water Intake:** | 1. Ground water<br>a. Submersible Pumps: Byron Jackson H2O<br>b. Vertical Suspended Pump: VTP/VPC<br>2. Lake/Reservoir<br>a. Vertical Suspended Pump: VTP/QL/VCT<br>b. Between Bearing Pump: LR, LNN<br>c. Solids Handling: MN & MF-Lines, SPL, MVX |
| **Water Treatment:** | 1. Between Bearing Pump: LR, LNN<br>2. Overhung Pump: Mark 3 family, Mark 3 ISO, Z-Line<br>• India Region: CPX<br>• OEM: SMP<br>3. Solids Handling: MSX, MN-line, MF-Line, SPL, DBS |
| **Water Distribution:** | 1. Vertical Suspended Pump: VTP, QL<br>2. Between Bearing Pump: LR, LNN<br>3. Overhung Bearing Pump: Mark 3 family, Z-line<br>• India Region: CPX |

The below chart provides a snapshot of Flowserve's market position for pumps used in the water industry.

## Flowserve Pump Market Positioning

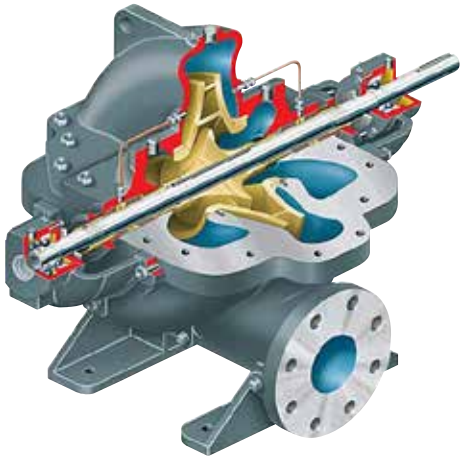
| PRODUCT CATEGORY | FLOWSERVE PRODUCTS |
|---|---|
| Vertical | VTP, QL, VCT |
| 1-Stage Overhung | Mark 3 family |
| 1-Stage Overhung | Z-line |
| Multi-stage | MS, WDX |
| Between Bearing | LR, LNN |
| Submersible | MSX |
| Deep Well Pumps | Byron Jackson H20+ |
| Solid-Handling | MN & MF, MVX |
| High Flow Overhung | Mark3 Group 4, ME |
| Small, OEM Packaged | Z line |

**Additional regional Flowserve heritage products not included.*

## Flowserve Pump Products in Detail

### Product Highlight: LR

LR family of pumps provides a broad range of hydraulic coverage and low total cost of ownership. With thousands of units installed over the years, these pumps provide reliable and efficient performance in applications ranging from water supply to circulation duties to single seal industrial applications.



#### Applications

- High Service Pumps
- Water distribution

#### NSF 61/372 Certified

- Chesapeake, VA, USA

#### Strengths

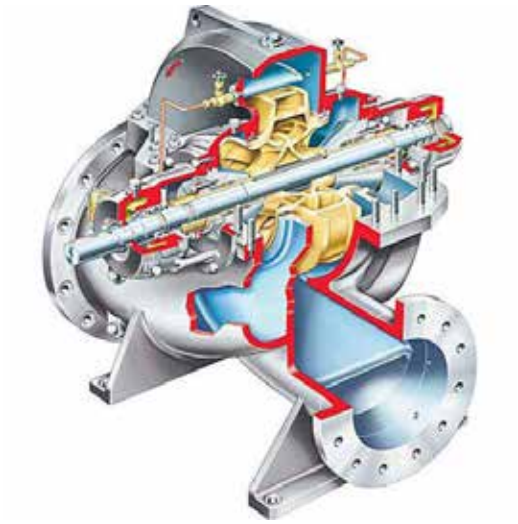
- Lower vibration design
- Higher bearing life (150,000 L-10 design @ 100%BEP)Ease of maintenance at seal chamber (split seals and packing)
- Designed for packing with sleeve and specialized ISC2-EX (single, “pusher”) mechanical seal
- Oil bath and grease lubrication
- 300# Casing Design

#### Aftermarket

- Strong support for existing installation base

**Product Highlight: LNN**

LNN product is a split casing, between bearing pump design. LNN is robust double suction, axially split pump designed for a broad hydraulic range, high efficiency, superior reliability and design flexibility. Product was originally designed for industrial and water markets but the broad pre-engineered options allow this product to branch into higher complexity applications.



## Specifications

- Flows to 25 000 m3/h (110,000 gpm)
- Heads to 500 m (1,640 ft)
- Pressures to 70 bar (1,015 psi)
- Temperature -45 to 204°C (-50 to 400°F)

## NSF 61/372 Certified

- Taneytown, Maryland, USA

## Strengths

- Extensive hydraulic envelope (88 NSF approved, >200 hydraulics)
- Robust 360° bearing housing support for Lower vibration
- Higher bearing life (>100,000 L-10 design @ 100%BEP) with standard single row, antifriction bearing
- Extensive Materials of Construction Options (NSF and non-NSF)
- Additional hydraulics can be developed or obtained from heritage pump families
- Engineering Support available to meet higher efficiency requirements

## Aftermarket

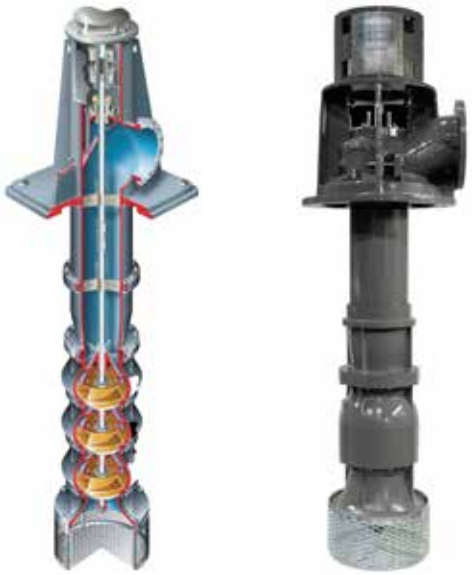
- Strong support of for existing installations

## New Installations

- Successful in larger sizes
- Customers preferring higher value on quality and efficiency due to life cycle mindset

**Product Highlight: VTP**

Flowserve VTP pumps are one of the world's most comprehensive lines of mixed-flow, vertical turbine pumps. Multiple design configurations and broad hydraulic coverage ensure you get a cost-effective solution that precisely meets your application requirements.



## Specifications

- Flows to 13,600 m3/h (70,000 gpm)
- Heads to 700 m (2,300 ft)
- Pressures to 100 bar (1,450 psi)
- Temperatures from -45 to 300°C (-50 to 570°F)

## Applications

- Intake Water (for non-solids application)
- Low-to-High flow High Service Pumps
- Water Distribution/High Service Pumps

## NSF 61/372 Certified

- Taneytown, Maryland, USA
- Hastings, Nebraska, USA

## Strengths

- Unequaled hydraulic coverage and design flexibility to ensure cost-effective solutions to meet application requirements
- Flexibility of configurations, materials, and options
- Unsurpassed hydraulic coverage for any requested performance
- In-depth pump analysis available for optimal performance and reliability
- NSF 61/372 Certified
- New DtV size designs to compete with lower cost & lead time

## Aftermarket

- Strong support for existing installations

## New Installations

- Flowserve has strong position for this product

### Product Highlight: QL

A double-suction, twin-volute vertical turbine pump in single (QL) or multistage (QLQ) designs. ISO 13709/API 610 (VS2) compliant units available.

#### Specifications

- Flows to 25 000 m3/h (110 000 gpm)
- Heads to 500 m (1640 ft)
- Pressures to 70 bar (1015 psi)
- Temperature -45 to 204 degrees C (-50 to 400 degrees F)

#### Applications

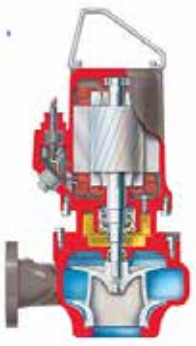
- Raw Water Intake
- Water Distribution/High Service Pumps

#### Strengths

- Superior performance from an innovative, double-suction impeller that produces more flow and higher head at lower NPSHR
- High uptime with sealed-for-life bottom bearing plus heavy-duty discharge head and integral line shaft bracket, which ensure shaft concentricity and alignment
- High operating efficiency promoted by renewable impeller wear rings that restore original clearances
- Reliable performance in applications containing silt or abrasive solids owing to optional enclosed line shaft construction

### Product Highlight: MSX

The MSX submersible pumps is engineered to perform efficiently in the most challenging environments, from pumping raw sewage to moving industrial wastewater; including both solids in solution and solids in suspension.



#### Specifications

- Flows to 4545 m3/h (20,000 gpm)
- Heads to 90 m (300 ft)
- Motors to 224 kW (300 hp)

#### NSF 61/372 Certified

- Taneytown, Maryland

#### Strengths

- Non-Clog Design
- Solid, engineered product
- Good installation base

**Product Highlights: Mark 3 ANSI / LoFlo**

Mark 3 Family is overhung, single stage pump designed to meet ASME/ANSI B73.1 dimensional. These dimensional sizes restrict hydraulics up to ~4,000 gpm. These products are designed with versatility of options and materials for process and chemical market.

## Specifications

- Flows to 1,700 m3/h (7,500 U.S. gpm)
- Heads to 300 m (990 ft)
- Pressures to 27 bar (400 psi)
- Temperatures from -73-370°C (-100-700°F)

## NSF 61/372 Certified

- Chesapeake, VA, USA

## Applications

- Water Treatment/Distribution (<4,000 gpm)

## Strengths

- Only NSF Certified overhung option
- Renewable performance over the life of the pump with the reverse vane impeller
- Versatile modifications and options for high complexity projects

## Additional Configurations: (not NSF Certified)

- Vertical-line: minimum footprint requests
- Self-Primer: substitute configuration for vertical suspended sump pump, up to 20ft lift capable
- Recessed Impeller: recessed impeller design capable of ~1.5in solid pass through (non-abrasive, no cutting action)
- Vertical Sump Pump: ESP3 (interchangeable Mark 3 casing, impeller designs)

### Product Highlight: ZLN, ZLK, ZLI

SIHI-heritage ZLN, ZLK, and ZLI pumps are designed to DIN 24255 / EN 733 and ISO 9908; multiple configurations. Capital cost, power consumption, maintenance, reliability and waste, have all been considered during the extensive development phase.

#### Strengths

- Z line is the top Flowserve seller in Europe
- ATO program to deliver standard pumps within 2 – 4 weeks
  - 57 Pump Sizes and Material with all finished components in stock (2 weeks lead time)
  - 72 Pump Sizes and Material with all raw material in stock (4 weeks lead time)
- Rest of pump combinations according to the longest lead time of the missing component

#### Multiple Configurations

- ZLN: horizontal, overhung, long-coupled
- ZLK: horizontal, overhung, close-coupled
- ZLI: vertical inline, overhung

### Product Highlight: MN & MF

The MN and MF pump families are rugged, solids-handling designs specifically built for reliability and low life cycle costs of demanding suspended and stringy solids applications.

Vertical Configuration for higher elevation motor mount or direct mount

Horizontal, End Suction Configuration

#### Specifications

- MF Flows from 45 to 2275 m3/h (200-10,000 gpm)
- MN Flows to 15,900 m3/h (70,000 gpm)
- Heads to 90 m (300 ft)

#### Applications

- Raw Water
- Multiple Wastewater Applications

#### Strengths

- Non-clog, enclosed, mixed flow impellers
- MF bearing life minimum 40,000 hr B10
- MN bearing life minimum 100,000 hr B10
- Multiple proven configurations

### Product Highlight: MVX

MVX is a rugged wet pit pump designed for use in solids handling applications and other wet pit services. Built and tested in accordance with Hydraulic Institute standards. Non-clog design capable of passing stringy solids and minimum 76mm (3 in) OD solids; up to 152mm (6in) diameter.

#### Specifications

- Flows to 17,000 m3/h (75,000 gpm)
- Head to 40m (130ft)
- Drivers to 950 kW (1250hp)

#### Applications

- Raw Water Intake (solids)
- Multiple Wastewater Applications

#### Strengths

- Large waterways designs to minimum clogging
- Multi-volute design for balance of radial reactive forces
- Specially designed non-clog impeller
- Enclosed Lineshaft Bearing

### Product Highlight: Mark 3 Group 4 / ME

Following pump products extend the hydraulic range of our initial overhung offerings:

- Mark 3 ANSI up to 1600m3/hr (7,400 gpm)
- Z-line (ZLN, ZLK, ZLI): up to 1,800 m3/hr (7,900 gpm)

Mark 3 4K product increases the hydraulic range and physical size of ASME/ANSI B73.1 pump requests. This product is not ASME B73.1 compliant since it exceeds the fixed dimensions of that specification. Mark 3 4K is designed to the same design considerations and robust features/sealing options as the proven Durco Mark 3 designs.

- Flows to 3861 m3/h (17,000 gpm)
- Heads to 125 m (410 ft)
- Discharge pressures to 19 bar (275 psi)
- Temperatures from -73°C to 204°C (-100°F to 400°F); ductile iron: -29°C to 204°C (-20°F to 400°F)

ME pump increases the hydraulic range of our EN733 based overhung pumps (MEN or Z-Line pumps). ME design is targeted to general water applications. ME product was designed in accordance N°547/2012 regulation; exceed the efficiency index (0.4 MEI).

- Flows to 6000m3/h (26,000gpm)
- Heads to 180m (530 ft)
- Pressures to 27 bar (400psi)
- Temperature to 120°C (250°F)

**Product Highlight: SPL**

SPL pump is a horizontal, overhung design for higher flow applications (above Z-Line offerings). Impeller configuration is available in open (standard) and closed.

**Specifications**

- Flows to 3,500 m3/hr
- Heads to 33m
- Temperatures to 110C
- Casing Pressures to 6 bar (P10 flange)

**Applications**

- Raw Water

**Product Highlight: DBS**

DBS pump is designed for dirty liquid applications found in wastewater, pulp/paper, and food/sugar applications.

**Specifications**

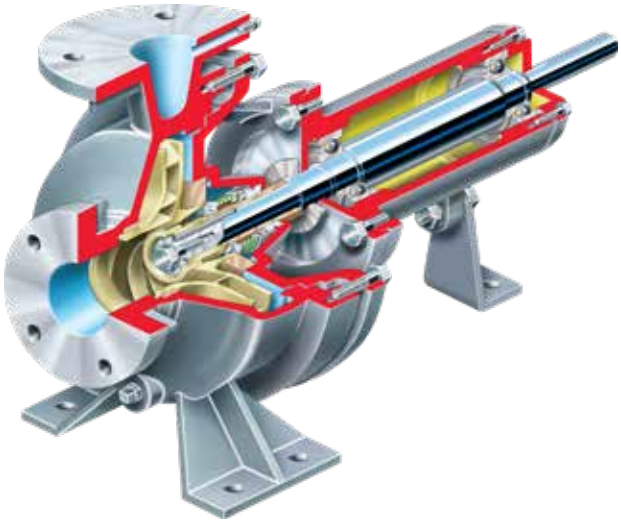
- Flows to 1,200 m3/hr
- Heads to 100m
- Temperatures to 110C
- Casing Pressures to 10 bar (P10 flange)

**Applications**

- Raw Water with solids
- Wastewater

### Product Highlight: D800

The D800 Series of pumps has evolved as Flowserve engineers have reacted to the growing need for economical pumps for general industrial service.



#### Specifications

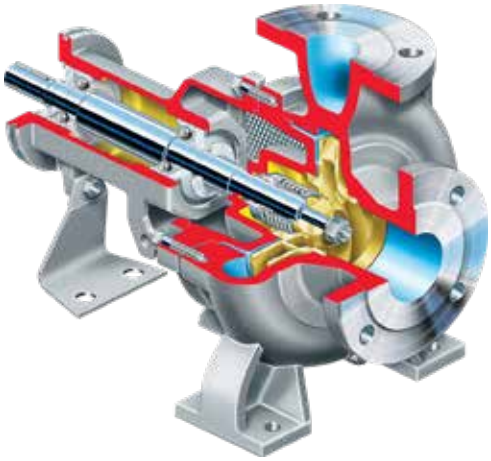
- Flows to 455 m3/h (2,000 gpm)
- Heads to 150 m (500 ft)
- Pressures to 15 bar (220 psi)
- Temperatures to 120°C (250°F

#### Configurations

- D800: horiz., overhung, long-coupled
- D824: horiz., overhung, close-coupled

### Product Highlight: MEN

The MEN Series of single-stage, end suction water pumps provides broad hydraulic coverage with low total cost of ownership. MEN Series pumps feature optimized hydraulics and rugged construction to deliver long, reliable and efficient performance.



#### Specifications

- Flows to 800 m3/h (3500 gpm)
- Heads to 140 m (450 ft)
- Pressures to 16 bar (230 psi)
- Temperatures from -10°C (15°F) to 140°C (280°F)

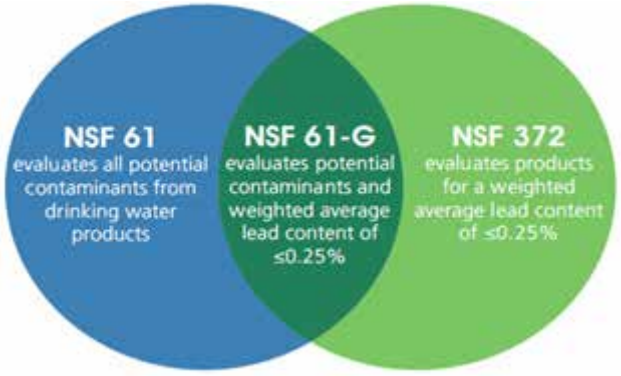
#### Configurations

- MEN: overhung, long-coupled
- MENBLOC: overhung, close-coupled
- MEN-SP: cantilever sump pump

# INDUSTRY REGULATIONS

The Safe Drinking Water Act (SDWA) in 1974 and amended and reauthorized it in 1986 and 1996, was to ensure the quality of American's drinking water by:

1. Assessing and protecting drinking water sources
2. Optimizing treatment processes
3. Ensuring the integrity of distribution systems
4. Effecting correct cross-connection control procedures
5. Continuous monitoring and testing of water before it reaches the tap




## NSF 61/372: Lead and Copper Rule (LCR)

Eliminating lead used throughout the water system to protect drinking water is a goal of the U.S. and most governments. It's become increasingly so since Flint, MI and Newark, NJ uncovered high lead content in their water supply. The Lead and Copper Rule of the Safe Drinking Water Act (SDWA) establishes the definition for "lead free" as a weighted average of 0.25% lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2% lead for solder and flux. The Act also provides a methodology for calculating the weighted average of wetted surfaces.

The EPA issued the final regulation on July 29, 2020, which requires manufacturers or importers to certify their products by meeting a consistent verification process within three years of the final ruling. The EPA is required to review each standard every six years and revise accordingly.

## NSF61:

NSF 61 is the material and design criteria for water components, including protective barrier materials, joining and sealing materials, mechanical devices, pipes and related products, plumbing devices, process media, and non-metallic water materials. Sellers, manufacturers or distributors of potable water treatment or transfer products in North America,  are required by law to comply with NSF/ANSI 61. This standard has been garnering increased attention from utilities as safety concerns grow. The NSF mark assures consumers, retailers and regulators that certified products have been rigorously tested to comply with all standards.

### NSF 61 Regulation for Regional Water Treatment Plants and Drinking Distribution Systems

Potable water system components can be divided into two groups of regulation: regional water treatment plants and drinking distribution systems. Drinking distribution systems from the water meter down or located inside a building are normally regulated by state or local plumbing codes. All major plumbing codes require the use of NSF 61 standards, and the specific requirements for those product types can be found in state or local plumbing codes. The figure below shows that 48 out of 50 states have adopted the standards of NSF 61 for water treatment and distribution.


*Source: NSF/ANSI 61." NSF RSS. The Public Health and Safety Organization, n.d. Web. 07 June 2017.*

There are also international countries now using NSF 61 certification standard guidance. See table below to check the extent of this certification compared to other local regulations.

| | | |
|---|---|---|
| NSF 61 | USA | 49 States and most plumbing codes |
| | Canada | 13 Provinces/Territories and CSA plumbing standards |
| | South Africa | SANS 1160 |
| | Philippines | PNS/BHDT NSF/ANSI 61:2014 |
| | Israel | Acceptance/Specification |
| | UAE | Acceptance/Specification |
| | Saudi Arabia | Acceptance/Specification |
| | Brazil | Acceptance/Specification |
| | Colombia | Acceptance/Specification |
| | China | MOH utilizes NSF 61, Section 9 |
| | Norway | NIPH Acceptance |
| | Finland | SINTEF Acceptance |
| | Malaysia | SIRIM Acceptance |
| WRAS 1.01 | UK | |
| ACS | France | |
| KTW | Germany | |

## NSF 61 Certified vs. Compliant

The words “certified” and “compliant” as it relates to NSF 61. Certification is only attained through stringent 3rd product testing, material analysis, plant inspections, and the monitoring product’s development. Additionally, certification is not a one-time event, but an ongoing process which includes intermittent on-site evaluations and continued testing. Once a product has been approved, it may display a certification mark.

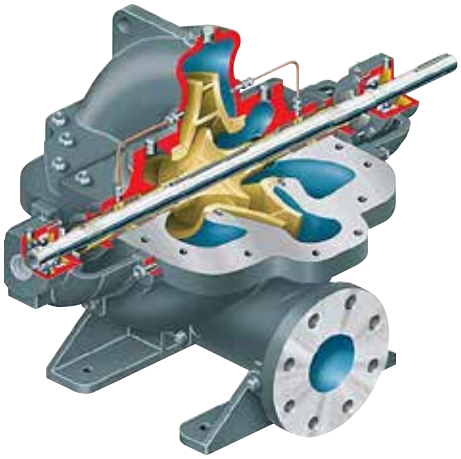
## Flowserve's NSF products

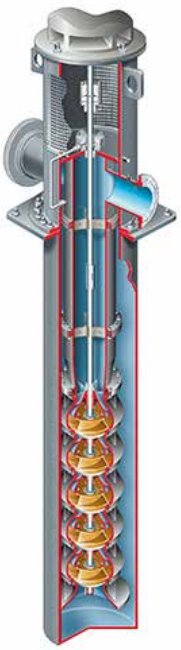
- Vertical Turbines (VS1): VTP/VPC product
- Submersible Pumps/Motors: Byron Jackson SUBM products
- Horizontal Splic Case: LR, LRN and LNN
- Overhung, (OH1): Mark 3, Z-Line

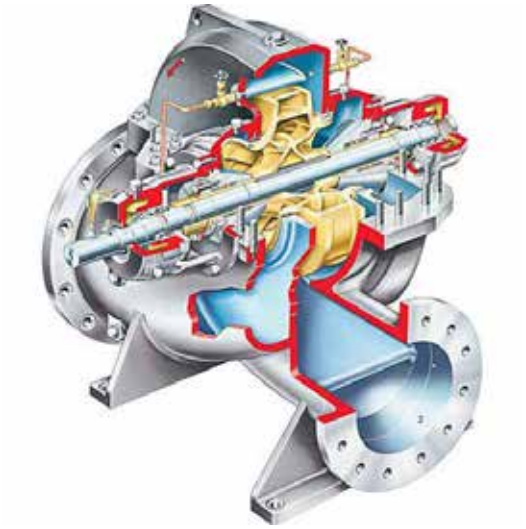
All NSF product certifications are strictly defined by multiple criteria. NSF certification applies only to the wetted materials of construction of a given product. Any modifications required will require both engineering review, factory approval and 6-12 approval cycle.

Defined Criteria of NSF Certificates:

- Product Equipment Sizes
- Wetted Materials of Construction defined by Factory Sourcing
- Equipment Manufacturing Facility







**DOE EPCA "Energy Conservation Program for Certain Industrial Equipment"**

New Standard compliance for industrial water paper started enforcement at the beginning of 2020. The new efficiency requirements fall within a specific pump type and application criteria.

**Pump Configurations**

- End Suction Frame Mounted
- End Suction Close Coupled
- Overhung, In-Line
- Radial split, diffuser multistage, vertical/in-line casing
- Submersible Turbine

**Application Range**

- Driven by Induction Motor: direct drive, 1-200hp, 2-4 pole motors (1,440-4,320 rpm range)
- => 25gpm BEP Operation at theoretical max impeller trim (not rated/sold impeller trim)
- <459 ft Differential Head per sold stage count at theoretical max impeller trim
- <= 6" bowl diameter Submersible Turbines
- <=5,000 U.S. SSU specific speed for horizontally mounted, end-suction pumps
  - Excluded pump configurations are excluded self-priming, magnet driven

For pump products that fall within the above configuration and application range, each manufacturer must test efficiency across a specified flow range. Manufacturers will test efficiency for all applicable configurations and results will be compared against industry benchmarked efficiencies, obtaining the "Pump Energy Index."

A passing pump efficiency requires **a calculated Pump Energy Index (PEI) of less than/equal to 1.0.**

In addition to DOE program, there are related initiatives like the Energy Rating Metric released by Hydraulic Institute or NRCAN efficiency regulations.

There is a similar regulation in place in Europe (2009/125/EC). This directive establishes eco-design requirements for the placing on the market of rotodynamic water pumps for pumping clean water. Similar to DOE program, establishes different pump configurations and a Minimum Efficiency Index (MEI) which covers equipment operating range, pump size, specific speed or rotational speed.

In addition to this, there's an extended product approach to include in the evaluation the efficiency of electric motors, setting also a minimum Energy Efficiency Index (EEI).

Equipment not compliant with this directive can't be commercialized in European Union and other European countries that have adopted this regulation.

For further reference, please refer to the Commercial Operations Team.

# FLOWSERVE SEALS

Flowserve seals and sealing systems can offer a significant savings in operating costs to meet increasing regulations on water quality and by addressing critical customer needs including:

- Low leakage rates
- Reliability
- Resistance to contamination and abrasives
- Low cost but durable designs for stuffing box retrofits
- Maximum interchangeability of components to reduce inventories
- Reduce or eliminate environmental contamination

Additionally, NSF is giving greater weight to the use of pump seals over packing to address leakage, contamination and environmental impact.

## PSS 4

The PSS 4 split seal makes installation quick and easy without requiring equipment teardown. The pre-assembled, semi-cartridge rotating, and stationary halves eliminate equipment measurements and handling of small intricate components, including seal faces and gaskets. This innovative design with enhanced pressure capability makes the PSS 4 seal ideal for nearly all industries, including water and wastewater treatment, pulp and paper, power generation and light chemical.

The preferred split seal products are PSS 4 and PSS L for large sizes (greater than 6 inches). Both can be used across various municipal water applications.

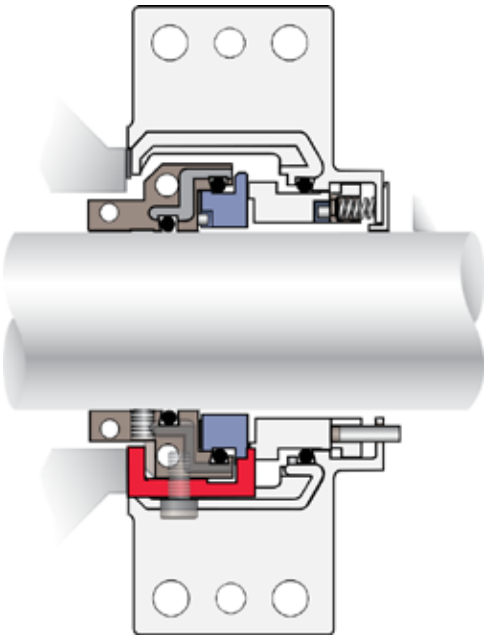
Flowserve offers various sealing products for the water industry highlighted below. Benefits of the PSS 4 and ISC2 are provided below.

| APPLICATION | CATEGORY | MODEL |
|---|---|---|
| Water & General Duty | Standard Cartridge | ISC2 Series |
| | Pusher | QB Series |
| | Pusher | RO |
| | Pusher | Europac 600-610 |
| | Special Duty | PSS 4 |
| | Special Duty | Pac-Seal |
| | Packing | Varies |
| *Sludge* | *Slurry* | *SLM* |
| | *Slurry* | *Allpac* |

**Key design features**

- Clamshell cartridge for ease of installation
- Patent Pending 3D Key technology along split surface
- Patent Pending 3 direction collar/rotor setting tabs assure component positioning
- All internal gaskets held in place without adhesives for improved sealing
- Integral gland assembly positioning
- Set screw collar drive for positive drive
- Positive seal face pin drive
- Reliable gland face gasket retention
- Tolerates shaft runout up to 0.060" FIM
- Captured fasteners

| WHERE | WHY |
|---|---|
| Packing replacement | No equipment teardown |
| Double ended pumps | No bearing removal |
| Agitators and mixers | Mounts outside box |
| Large equipment | Saves installation time |
| Old equipment | Replaces packing |
| Any industry | Reduced downtime |



## Materials of construction

**Stator Face:** Carbon, silicon carbide
**Rotor Face:** Silicon carbide, aluminum oxide
**Metal Parts:** 316 stainless steel
**Springs:** Alloy C-276
**Secondary Seals:** FKM, EPDM

## Standard operating limits

**Pressure:** Full vacuum to 30 bar (450 psi)
**Temperature:** -18°C to 121°C (0°F to 250°F)
**Speed:** 19.3 m/s (3800 fpm)
**Sizes:** 38 to 152 mm
(1.500 to 6.000 in)
For larger sizes, use the PSSL.

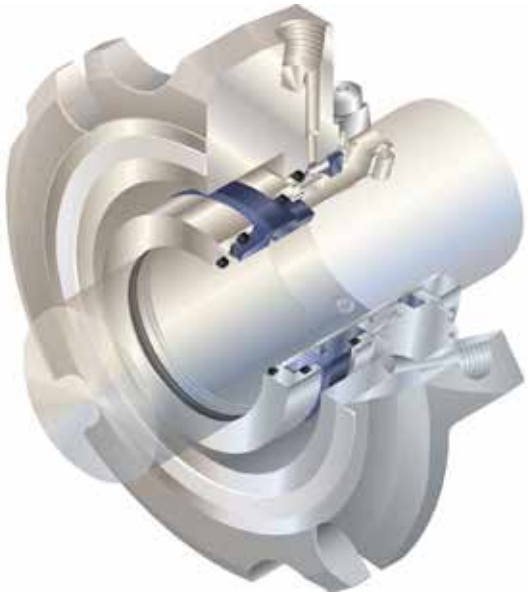
## ISC2

ISC2 seals are the most capable and versatile general-purpose family of cartridge seals available, meeting all international standards (ASME, DIN, ISO, JIS, and others) and designed to fit hundreds of pump models from global manufacturers. ISC2 seals can provide uninterrupted, long-term operation even with multiple service conditions, off-design operation and frequent stops and starts.

Facilities in water and wastewater and industries that standardize to ISC2 seals for general purpose applications will immediately benefit from ease of installation, less inventory, greater flexibility, rapid availability, less downtime and longer seal life. Cartridge seals are factory assembled, pre-tested complete units. Each seal is backed by 24-hour support, on-site service, engineering analysis, seal repair capabilities, customized stocking programs and on-time delivery.

### Key Design Features

- Global-design cartridge mechanical seals for chemical and general-purpose applications
- Satisfies ANSI, DIN, ISO, JIS and other key industry specifications
- Fits literally hundreds of pump models in single and dual, pusher and metal bellows configurations
- Thermal management technology is a key enabler of long-term seal life and less downtime
- Simple yet robust single pusher cartridge seals are ideal for cost-effective sealing; hard face options improve solids handling
- Lifting holes on large sizes
- Clearly marked ports
- Set screws resist galling
- Standardized parts reduce inventory requirements and simplify stocking programs
- Complete support at a local QRC



## *Materials of Construction*

| | |
|---|---|
| **Metal Parts** | 316 Stainless Steel, Alloy C-276, Alloy 20, Titanium |
| **Seal Faces** | Premium Resin Carbon vs. Sintered Silicon Carbide<br>Sintered Silicon Carbide vs. Sintered Silicon Carbide<br>Premium Resin Carbon vs. Tungsten Carbide<br>Tungsten Carbide vs. Sintered Silicon Carbide |
| **Metal Bellows** | Alloy C-276 |
| **Elastomers** | Fluoroelastomer, Perfluoroelastomer, EPDM, TFE-Propylene |
| **Springs** | Alloy C-276 |
| **Set Screws** | 17-4 H900 Stainless Steel |

## *Operating Parameters*

| | |
|---|---|
| **Pressure** | |
| Pusher seal | 0 to 20.6 bar (300 psig) |
| Metal bellows seal | 0 to 13.8 bar (200 psig) |
| **Temperature** | -40 to 204°C (-40 to 400°F) |
| **Maximum Speed** | 3600 rpm or 23 m/s (75 fps) |
| **Seal Chamber Specifications** | ASME B-73, EN 12 756, JIS, ISO 3069, API 682 |
| **Shaft Size** | |
| Pusher seal | 25 to 200 mm (1.000" to 8.000") |
| Metal bellows seal | 25 to 95 mm (1.000" to 3.750") |

**Flowserve Seal Value Proposition**

Flowserve seals and sealing systems can offer a significant saving in operating costs by addressing critical customer needs including:

- Lower total cost of ownership from advanced seal design features that enable superior reliability
- Reduced maintenance costs with the implementation of mechanical seals due to their:
  - ease of installation
  - long, trouble-free life
  - designed repairability
  - low cost repair program
  - elimination of packing adjustment costs
- Increased plant and personnel safety delivered by cartridge security
- Broad application flexibility assured by comprehensive range of pre-engineered configurations and materials; custom solutions also available
- Compliance with all major international standards
- Reduced environmental contamination
- Lower power requirements
- Reduced downtime by increased mean time between planned maintenance (MTBPM)
- Range of options for cost conscious customers including Packing and component seals

# FLOWSERVE VALVES

Flowserve has not been a traditional player in valve projects in water. Flowserve valves are directed toward more sever or hazardous environments and thereby are overengineered for water applications. This is is a challenge in a fragmented market where pricing is one of the key buying decisions.

Flowserve does offer a range of valves derived from other industries which fit with water industry requirements. Nevertheless, refer to Commercial Operations Team for further specific information about Flowserve valves and how they align to water applications.

# FLOWSERVE ACTUATORS

Electric actuators are used solely in the municipal water market. Flowserve's Intrusive Multi-Turn products, Limitorque L120 and SMB meet the specifications to perform well in the water market and used with other manufacturer's valves. However, they are overengineered since built for hazardous environment.

## Flowserve Actuator Market Snapshot

- Ideal customer profile is the valve OEM focused on water industry
- Available for multi-turn and quarter-turn operations with non-intrusive designs
- Full complement of network controls and options, or basic intrusive actuation for simplified control applications
- Strong MRO opportunity
- Electric actuator sales in water industry can be completed in 1-2 sales calls

**Flowserve Limitorque SBM**

# FLOWSERVE IOT


Flowserve offers a comprehensive IoT offering for pumps and valves. IoT is in line with primary customer goals to increase process efficiency, maximize asset life, enhance safety and meet compliance standards.

Flowserve IoT differentiates itself from many suppliers in water, by offering condition monitoring *and* predictive analysis. Below is a summary of each package type. Latest IoT release, Red Raven is the flagship offering in this space.

## Condition Monitoring

Asset monitoring systems and software let you detect the slightest changes in equipment operating conditions — changes that could be an early indicator of failure. With immediate access to equipment performance information, you can proactively prevent failures and disruptions.

- 24/7 access to data and trending reports
- Used on most rotating equipment
- Cloud-based portal access
- Near real-time monitoring

## Enhanced Condition Data Point Monitoring

Enhanced Condition Data Point Monitoring (eCDPM) combines 24/7 equipment monitoring (via sensors) with traditional route-based condition data point monitoring, providing the condition of your rotating equipment.

- Logged data and trend analysis for better informed decisions around plant-wide reliability improvements
- Full-spectrum vibration analysis reports for improved maintenance and reliability recommendations
- Allowing increased mean time between failure (MTBF) and process efficiency, while reducing total cost of ownership

### Predictive Analysis

- Real time system measurement and analysis, including critical equipment monitoring
- Critical failure mode
- Remaining time to maintenance
- Configurable trending report
- Efficiency and performance optimization curves
- Customizable alerts and alarms

# FLOWSERVE AFTERMARKET SERVICES


As municipalities look to make water treatment equipment run longer with higher performance and while using fewer operational staff, having a comprehensive aftermarket partner is essential. The need for aftermarket products and services in water are further compounded by plant age, lack of consistent infrastructure investment and reduction in skilled workers through natural attrition. Flowserve provides levels of service agreements which are designed to resolve problems quickly, optimize equipment and systems, and predict problems before they happen. Below is a snapshot of the Flowserve Aftermarket offering for water customers.

## Flowserve Aftermarket Product and Services Offering

- Parts and components replacement
- Repairs (QRC service centers and manufacturing facilities)
- Retrofits
- Life Cycle Management Programs
- Educational and Consultative Services
- Strategic Procurement
- Streamlined Inventory
- Rapid Prototyping
- Technical Support
- One-year warranty on parts - differentiator with most 3rd parties offer 30-day part warranty

**Note list is not exhaustive*

## Quick Response Centers (QRCs)

All services can be completed at QRCs, which are located around the globe.

The map below details locations for Pump and Seal QRCs.

**Flowserve Pump and AMSS QRC Locations**

# FLOWSERVE'S VALUE PROPOSITION TO CUSTOMERS

The value Flowserve brings to customers is unmatched when paired with the ideal customer profile. Flowserve's comprehensive suite of products and services addresses customer economic, reliability, safety, skill shortages and asset management concerns, maximizing customer peace of mind. The Flowserve brand has a strong history in water. The most successful process areas being raw water intake and distribution. Through its global sales managers, manufacturing reps and distributors, Flowserve has earned a reputation for standing by its products, partnering with Customers and finding the most innovative solutions in an ever-changing and increasingly demanding industry.

Flowserve's ultimate value proposition is its ability to fully address the water industry's heightened efficiency requirements with a wide-range of N61 certified pumps that are becoming more competitive (i.e. DtV VTP rollouts).
NSF-61 certification of seals is in view. Flowserve seals and sealing systems solve key customer concerns of reliability, safety, downtime and total ownership costs. Flowserve is one of a few equipment suppliers offering customer IoT solutions that increase plant safety, compliance and process efficiency (adjusting flowrates and leakage and theft detection/reduction), having 24/7 monitoring and two-way communications. The Predictive Analytics package ensures process optimization, historical validation and clarity on plant allocations that can potentially pay for itself. IoT also empowers the plant to operate at peak performance with less skilled workers through years of attrition.

Flowserve Aftermarket Services provide a unique opportunity to differentiate itself in a crowded marketplace. It enjoys a large, global installed base. Its QRCs are well-equipped and have wide-ranging service capabilities from material upgrades to

pump efficiency gains. The one-year parts warranty offered to customers is in direct contrast with 3rd party service providers which offer 30-day parts guarantees.

Flowserve has experienced its most success with projects in raw water intake and water distribution.

With Flowserve's broad product line in the water market, Flowserve will have the largest selection and highest efficiency pump that is available for the customer needs. In summary, Flowserve water market solutions are comprehensive and continue to add value for its customers.

## Supplier Relationship

**Engineering Consultant** – Most projects are Design/Build/Operate (DBO), in which the engineering consultant is the key decision-maker as to whether a project comes to fruition. The end-user is equally important. Undoubtedly, the engineer consultant will seek to ensure the interest of the end-user is met.

## Addressing Customers Need for Funding

**Infrastructure and plant modernization** – access to funding heavily impacts decisions around water project implementation. Capital improvement projects are funded by bonds which remain relatively strong. However, additional funding is dependent on tax revenue, which has been hard hit. Therefore, some cities will run out of budget in the current economic climate. Expect maintenance budgets to be 75% of the original amount for many utilities. Even in normal times, only about one-third of water systems earn enough revenue to cover replacement costs. Other factors determining project completions include:

- Available EPC's to provide profitable quotes
- Investment costs
- Availability of skilled labor
- Environmental instability
- Governmental support of public utilities

## Funding

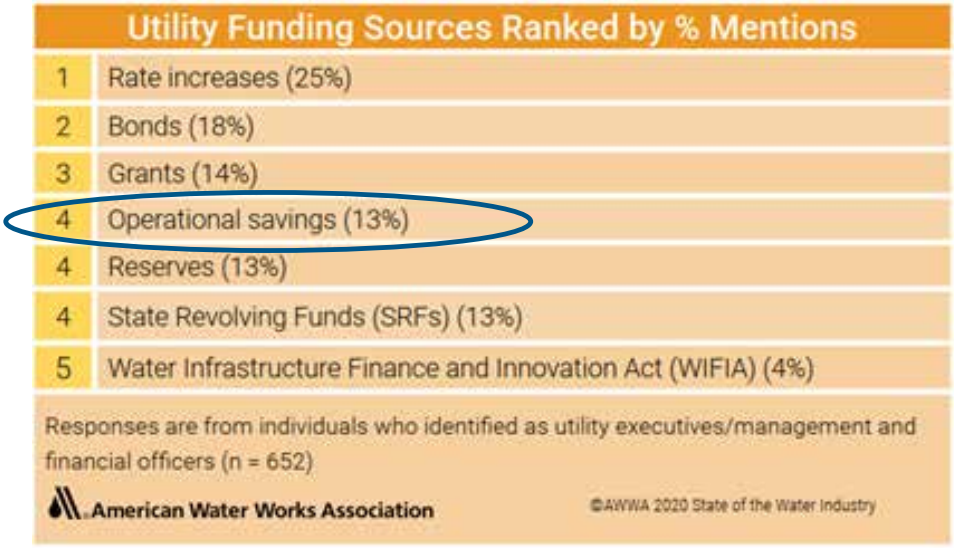
Each country or region may have different mechanism to access to funds for water related projects. Specific details shall be obtained with the applicable entities at a local level. The following list is an example of the different options in the U.S.

Four legislative actions are designed to assist utilities in funding modernization and expansion projects.

- **WIFIA** – Water Infrastructure Finance and Innovation Act. U.S. Congress passed in 2014.

- **AWIA**— America's Water Infrastructure Act of 2018 reauthorized WIFIA for two years. It also reauthorized the Drinking Water and Clean Water State Revolving Funds.
- **Farm Bill**— Agriculture Improvement Act of 2018. Prioritized source water protection and expanded funding to protect drinking water sources through agricultural conservation programs.
- **State Revolving Funds**—In 2020, the EPA allocated $1.07 billion in new federal grant funding for the Drinking Water State Revolving Fund and $1.6 billion for the Clean Water State Revolving Fund.

Note, in a 2020 AWWA water utility survey, 13% of respondents expect operational savings to help with project funding.



# INNOVATIVE WAYS FLOWSERVE IS HELPING CUSTOMERS

## Success Story: Orange County Water District

**Success Story:** Orange County Replenishment Program – Gary Sacchetti, West Sales Mgr.

**Project Value:** $5.5 million

**Project Detail:** Qty (6) 1000 HP Vertical Turbine Pumps (VTPs), 316 SS Construction and RO Feed Pumps

**Background:** Operational since January 2008, the Groundwater Replenishment System is a state-of-the-art water purification project that can produce up to 100 million gallons (379,000 cubic meters) of high-quality water every day, enough water to meet the needs of nearly 850,000 residents in north and central Orange County, California.

- The Orange County project was a collaboration with a Cortech Engineering Rep. The pumps were a part of a big package project. This was the second phase of the replenishment project.
- Cortech is an exclusive Flowserve Rep for pumps. We collaborated with them on the project from the beginning, ensuring selected pumps met all design requirements.

**Competitor(s):** Alton

**Lessons-Learned:** Get involved in all project phases, especially the first one. The fact we had equipment in the plant already, weighed heavily on their decision to go with us.

## Success Story: City of Folsom

**Success Story:** City of Folsom – Gary Sacchetti, West Sales Manager - Water

**Project Value:** $1.1 million

**Project Detail:** Qty (4) 600 Hp Slant Submersible Pumps, Raw Water Intake

**Background:** The City of Folsom project entailed with pumping lake water. The time from bid to close on the Folsom project was 3 months. This is because the project required slant submersible pumps. Most competitors do not carry it. Flowserve won on price. We had one competitor on this and that was Floway (Weir). Large pump projects typically have about six competitors bidding.

**Competitor(s):** Floway (Weir)

**Lessons-Learned:** Some large projects are in design 2-3 years. It's important to build that relationship with the consultant to know right timing. Suggest salespersons start working with engineering consultants 12-18 months ahead of time to influence the spec. This was the case for the City of Folsom project. Would also suggest looking for opportunities like this. However, they are quite limited.

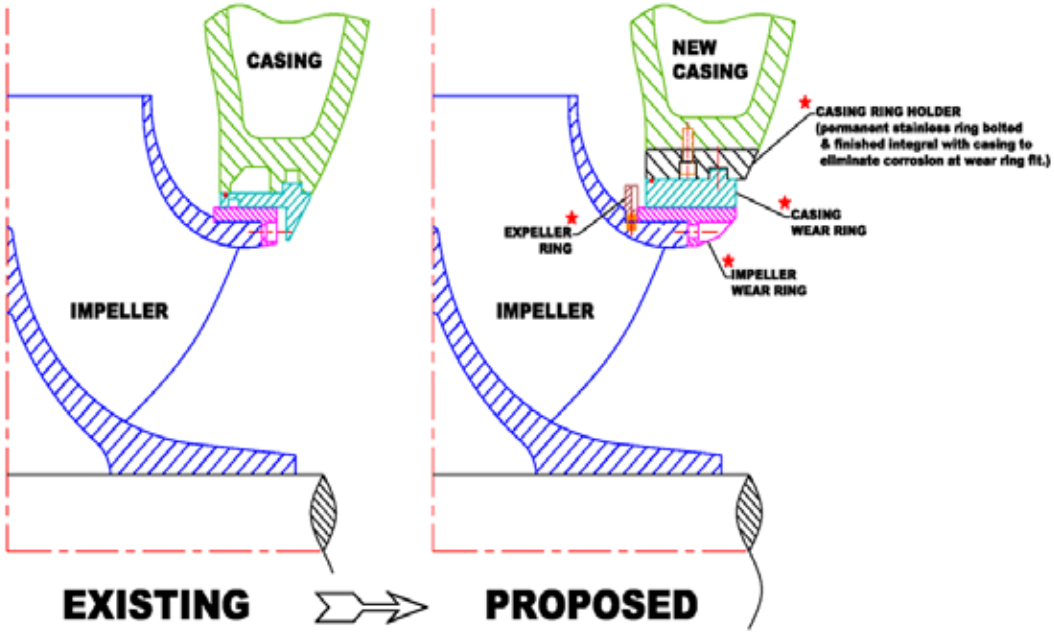
# Success Story: New York City Department of Environmental Protection

**Success Story:** New York City DEP Wards Island Main Sewage Pumps Upgrade – Rob Lowe, Northeast Regional Sales Manager

**Project Detail:** Quantity (6) Worthington Model 48 LA Horizontal Split Case Pumps

**Background:** Existing 48 LA pumps could not meet the DEP guarantee of 550 MGD with 5 pumps in operation. They also presented reliability and maintenance challenges. Flowserve engineering designed a new impeller to increase flow, designed new wear ring configuration to improve reliability and added expeller to decrease wear and extend MTBF.

**Lessons Learned**: We have an old, aging installed base and we have the engineering and hydraulic expertise to address customer problems. Flowserve can offer a solution to the municipality so that they can save time and money by avoiding the hiring of an engineering consultant and potentially going through the bid process.

## Success Story: South Florida Water District (Everglades)

**Success Story:** Florida Everglades – John Ondrejack, Southeast Sales Manager - Water

**Project Value:** $4 million ($50 million total over 6 projects)

**Project Detail:** Aftermarket Services – Repair project

**Competitor(s):** Goulds, Fairbanks, Xylem, Grundfos

**Lessons Learned:** Flowserve has successfully penetrated and have installations at most of the major municipalities such as this. It's time to leverage these and target the Tier 2 utilities. Have insight into them with WaterHub program that gives us leads from conception to bidding. See Sales Organization and Regional Sections.

The quality of Flowserve vertical pumps has allowed SFWMD to operate the installation for more than 20 years without the need of large overhaul operations. This outstanding reliability has been key to become a quality supplier for this Entity.

**SUCCESS STORY : SFWMD 96 APS REPAIR**

*Customer History and Background*

**SOUTH FLORIDA WATER MANAGEMENT DISTRICT**

A. Public Utility to Manage the Everglades
B. Board Members report to Governor DeSantis
C. 25 Pumps 96 APS 500 CFS/127 APS 1000 CFS
D. Sold in 6 PS 1998-2001/ $50 million Flowserve
E. All Direct bid to SFWMD Army Corp Point System
F. In 2016 sold [4] 57 APM/SIHI for $4 million

**OPPORTUNITY : Repair of 96 APS/ 20 Years Service**
**ISSUE: SFWMD WAS GOING OUT TO THIRD PARTIES FOR PUBLIC BID VERSES FPD SOLE SOURCE**

## Success Story: Cesan

CESAN
qualidade em saneamento

**Success Story:** Project to save energy on Grande Vitoria – Marcelo Soares, Brazil Sales Mgr.

**Project Value:** $2.84 million (USD)

**Project Detail:** Equipment maintenance, retrofit and improvements required achieve reliability and energy savings

**Flowserve Equipment:**

- **Alto Recalque:** 6 vertical pumps, model 20 QL-26 with 1.100 HP electrical motor
- **Biaxo Recalque :** 5 vertical pumps, model 44 LKL with 850 HP electrical motor
- **Santa Maria:** 4 vertical pumps, model 20 QL-26 with 1.250 HP electrical motor

**Background:** A study was conducted since it was not possible to complete on-site measurements. The study was based on data provided by CESAN pyrometry department. With this information, system curves were drawn. Current operational conditions and other details helped to determine there was an opportunity to increase average system efficiency by 23%. This represented a reduction in energy spend of $130,000 monthly (USD).

To guarantee the power efficiency increase, Flowserve's proposal included:

- Facility testing before service execution
- Expertise and detailed validation of each equipment situation
- Repair of parts
- Supply of original parts that cannot be repaired
- Electrical motors upgrades
- Facility testing after service execution
- Supervision during assembly and start up

**Competitors:** Ruhrpumpen and EB Bombas (local company)

**Lessons Learned:** Persistence has its rewards. Four years after original customer meetings with their technical and commercial teams, CESAN signed a 22-month contract with Flowserve. Success is already apparent with the following results to date:

**First pump:** Model 20 QL-26:

- Guarantee results = 82%
- Before service = 79,9%
- After service = 88,5%

**Second pump:** Model 20 QL-26:

- Guarantee results = 82%
- Before = 66%
- After = 86,5%

**In addition to efficiency improvement, there was significant recovery on pump performance.*

# FLOWSERVE WATER SALES ORGANIZATION

## Water Industry Channel

Flowserve's water sales organization utilizes Industry-dedicated sales managers, manufacturing reps (primarily in North America) and distributors. The channel mix is heavily influenced by region. For example, while North America uses manufacturing reps for water, other locations are direct or a hybrid of the three (further detailed in Regional section).

**Sales Managers** – Are responsible for the water industry sales for the water, wastewater and desalination sub-sectors by providing input to sales strategy and successfully executing it to secure water business.

**Manufacturing Reps** – Own the relationship with the end-user in North America. Have good relationships with their customers and Flowserve sales managers. Many offer services to further strengthen customer relations. Mostly not in direct competition with QRCs. Services offered are more basic. However, do promote monitoring capabilities.

**Distributors** – Play less of a role in water. They are more active in Europe then other regions. On occasion, distributors have positioned themselves as competitors.

## Affinity Program

Affinity™

Affinity is Flowserve's pump selection program. Affinity is a web-based tool that supports 80-plus products. It delivers immediate, real-time access to the latest, most accurate data on Flowserve pumps. Customers have access to the same pump selection tool that is used by Flowserve application engineers, while maintaining familiarity with the FlowSelex Portal. Used to size a pump for a new application or obtain performance information for an existing unit. AffinitySupport@Flowserve.com for customer questions.

# REGIONAL WATER INDUSTRY

The global water market varies by geographical location. These variances include customer preferences, regulation, water terrain and environmental sustainability requirements. This section captures regional activity of key countries, to better assess the global picture of the water industry.

## North America

North America has a robust water market. The U.S. was the top country for water consumption per capita in 2017, followed by Canada. In North America, efficiency standards are paramount. Market activity continues but it has been affected by COVID-19 too. Many projects have been prioritized or delayed until the funding is restored.

### United States

California, Texas and Florida accounted for 25% of water withdrawals in the U.S, in 2000. Nebraska also has large water withdrawals for irrigation.

Flowserve has penetrated and have installations at most, if not all, major Tier 1 municipalities.

### Canada (NSF) – Ontario

Canada's Water Utility landscape is similar to the U.S. and thereby managed within in Flowserve as North American regional breakdowns.

#### NSF in Canada

Canada countrywide certifications requirements follow closely to those of the US. In Ontario, the **NSF International Strategic Registrations (NSF-ISR)** serves as one of only two approved accreditation bodies for the Ontario Ministry of the Environment Drinking Water Quality Management Standard (DWQMS).

The **Ontario Safe Drinking Water Act, 2002** requires an accredited operating authority to oversee a municipal residential drinking water system. This authority must establish and maintain a quality management system that meets the requirements of Ontario Ministry of the Environment DWQMS.

# Europe

Each country in the European Union (including UK) is distinct in the management of its water operations. This is changing. The goal is to develop commonality where possible, to broaden the opportunities for suppliers and water quality for customers. To this end, many cases government and suppliers are working in collaboration. Below are some of the countries having the biggest impact on the EU water market.

## United Kingdom (UK)

In UK, the equipment used in the production of water to drinking standards is tightly controlled and pumps needs to be manufactured to certain standards and specifications. The Drinking water inspectorate (DWI) is an independent body formed in the UK to ensure water is produced in accordance to the application regulations.

The main regulation for products used in drinking water is **Regulation 31 of The Water Supply (Water Quality) Regulations 2016**. It implements Article 10 of the Council of the European Union Drinking Water Directive (DWD) in England and Wales for all chemicals and construction products used by water undertakers, from the source of the water, up to the point of delivery to the consumer's building. It sets out how approvals can be given to such construction products and materials that do not prejudice water quality and consumer safety.

From the point of the consumers building / house and to the customers tap the products used are then covered under a separate approval, i.e. Water Regulatory Advisory Scheme (WRAS). WRAS is an independent test laboratory and process that tests non-metallic materials suitable for use in drinking water and offers certification, once tested, confirming the product is suitable.

The DWI has published written legal guidance and advice sheets to the water companies and suppliers to ensure the products used for supplying drinking water are suitable for use. In this guidance DWI states that pumps are deemed low surface area and are an insignificant risk and as such, are exempt from compliance with Regulation 31.

Then it becomes the responsibility of the water companies to ensure the materials used in the pumps are suitable for use in Drinking water. This is done by the water companies requesting WRAS approved materials to be used in the manufacture of pumps.

To comply with UK water drinking water regulations/WRAS the pump supplier needs to confirm the pump is manufactured from WRAS approved materials and offer a "material in contact list" listing all materials used in contact with the pumped product. The whole pump is not WRAS approved but each individual component in contact with the product i.e. seal materials, casing gaskets, lubrication o rings, etc.

Other objectives of quality improvements and increased operational efficiency, include initiatives to minimize unplanned outages and energy used by the Industry. The UK water industry uses up to 3% of the total energy consumed in the country. To better meet these goals, utilities are becoming more interconnected for shared resources.

They are also partnering with water industry non-profits that help to facilitate and gauge market changes. Major non-profits include, Water UK, British Water, Future Water Association and the Institute of Water. The UK water industry services customers using a borehole water distribution system. A borehole is a narrow shaft bored in the ground, either vertically or horizontally. Both the UK and Northern Ireland follow a similar market approach.

**The Asset Management Plan (AMP) period was introduced because of privatization of UK Water Utilities.** Utilities follow an AMP methodology to drive continuous improvement and reduce their operating expenses. AMP periods are five years in duration and begin on 1 April in years ending in 0 or 5. During this time, supplier proposals are submitted to UK regulators to help them better determine future bill limits for their customers and the investment companies can make. Typically, an AMP will cover more than a single asset, taking a system approach – especially where several assets are co-dependent and required to work together to deliver an agreed standard of service. This could work to Flowserve's favor, since it also offers flow control solutions in power and energy. The AMP 7 cycle started in August 2020. There is no network of distributors in UK. The company must win the AMP approval state.

### Flowserve in UK

Flowserve has a strong supplier presence in the UK water market Flowserve's current structure in the UK consist of:

- 9 UK sales persons selling Flowserve portfolio (pump/seal/valve and aftermarket) to all industries
- 2 Water Specialized (1 project, 1 MRO); down from 4-5 down to 2 in 2015
- 2.5 QRCs in UK (including Castlemaine)

## Germany

**Germany has very low distribution losses.** Responsibility for water supply and sanitation with municipalities, which are regulated by the states. Professional associations and utility associations play an important role in the sector. Most of the sector standards are set in Brussels. There are trends toward creating commercial public utilities under private law and modernizing the sector, including through more benchmarking. There's been nearly the same market activity pre- as post-COVID-19. See no change.

## Spain

Potable water is owned/managed by government companies for large cities in Spain, except for Barcelona and Valencia. Spain's remaining population is served by private or mixed private-public water companies that operate under concession contracts with municipalities. 98% of urban areas and 93% of rural areas have access to potable water. Customers demand from suppliers, high quality, good price and efficiency to support their population. Flowserve has had a good reputation in the market.

# Asia-Pacific (APAC)

## Australia

Agriculture is the main user of water in Australia, accounting for around 70% of all extractions in 2018. It is mainly used for irrigation, which accounts for a quarter of Australia's agricultural production.

Much of the growing demand has been from almond plantations. Private sector involvement and environmental concerns have increased in importance for the industry.

**Water Market Regulation:**

- The Australian Water Market is self-regulated. Currently market is monitored by requiring licenses and by the customers and community. There is no market monitoring for lead content
- Australia/New Zealand use a "Watermark" certification for equipment for specific applications in lieu of NSF61. The Watermark means product contains acceptable materials. See detail as follows. It is strictly adhered to in Western Australia

**Australian Watermark**

- Administered by Australian Building Codes Board
- 20-26 weeks of Required Review Cycle (not included manufacturer creation and response cycle)
- Mandatory for certain plumbing and drainage applications in or around buildings
- Applications
  - Water Supply (pumps, seals, valves)
  - In contact with drinking water (pumps, seals, valves)
  - Risk Analysis is part of certification and a risk rating is placed on certification requirement
  - Performed by Approved Certifier
  - Defined applications (must state use)
  - Materials of construction
  - Operational risk of product failure to system
  - Mechanical limitations (connection to system, MAWP)
  - Chemical limitations (compatibility)
- Quality Plan/Audit requirements like normal facility certificates

## China

The Ministry of Water Resources for mainland China recently released an investigation report stating that over 80% of shallow groundwater sources in the country are polluted.

As these nations toughen up environmental controls and attempt to clean water sources, monitoring will play an important part.

### India

Groundwater pollution in India has become one of the most important toxicological and geo-environmental issues. Within the India market, over 50% of market share is installed within water-providing applications. Other market dynamics include:

- Irrigation and Building Systems are controlled by Tier 2 and 3 product offerings. For larger installations, like commercial buildings, Tier 1 manufacturers can have a play
- Water/Wastewater, Flood Control, and large Irrigation opportunities are to be the focus based on our existing pump portfolio
- Small pumps (<300hp) are ruled by small, local manufacturers
- Flowserve aftermarket is strong for existing large pump installations

**India Water Industry Breakdown**

| INUSTRIES | MARKET SHARE |
|---|---|
| **Agriculture** | 27% |
| **Building Services** | 19% |
| **Water & Wastewater Management** | 17% |
| **Power Generation** | 12% |
| **Oil & Gas** | 8% |
| **Metal & Mining** | 4% |
| **Other General Industries** | 13% |
| **Total** | |

## Latin America

### Brazil

**Brazil Market**

- Population: 207 million
- Potable water served population: 71 %
- Potable water reserves: 13 % of worldwide availability
- 90% of the water utilities in Brazil are state-owned companies
- 2021 market for water pumps in Brazil is estimated in $205M
- 70% of this market corresponds to utilities
- Agricultural and Industrial water provide

consistent opportunities on a yearly basis

### Flowserve Brazil

- Strong presence in the water & sewage and irrigation markets since the 1950s
- Flowserve has always been the leader in market with more than 60% of the installed base for pumps bigger than 12 in
- More than 4,000 pumps currently in operation on these installations
- Around 70% of the largest cities of the country have Flowserve pumps in their Lift Stations
- Test stand power capacity 8000 HP, expandable if needed
- Able to manufacture almost all seals product portfolio locally
- Expansion capacity of more than 40% (land available)
- Design considers - all updated safety standards, local laws/regulations, Flowserve standards, Lean flow layout and access for people with special needs

**Rio plant supplies pumps for:**

- Water transportation
- Water Supply
- Sewage
- Drainage
- Flood Control
- Reverse Osmosis
- Desalination

### Government Initiatives thru 2033

- Water – Increase the % of served population from 71% to 99%
- Sewage – Increase the % of served population from 29% to 90%
- Privatize the State-Owned Companies
- Investments of around USD 140 Billion until 2033

### Argentina and Peru

The Argentina and Peru water markets are moving towards private-partnerships to meet their investment needs for water modernization and expansion projects.

# APPENDIX

## Terminology

**Alluvium**--deposits of clay, silt, sand, gravel, or other particulate material that has been deposited by a stream or other body of running water in a streambed, on a flood plain, on a delta, or at the base of a mountain.

**Aqueduct**--a pipe, conduit, or channel designed to transport water from a remote source, usually by gravity.

**Aquifer**--a geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs.

**Aquifer (confined)**--soil or rock below the land surface that is saturated with water. There are layers of impermeable material both above and below it and it is under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer.

**Aquifer (unconfined)**--an aquifer whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall.

**Artesian Water**--groundwater that is under pressure when tapped by a well and is able to rise above the level at which it is first encountered.

**Artificial Recharge**--a process where water is put back into groundwater storage from surface-water supplies such as irrigation, or induced infiltration from streams or wells.

**Base Flow**--sustained flow of a stream in the absence of direct runoff. It includes natural and human-induced streamflow. Natural base flow is sustained largely by groundwater discharges.

**Basin**--an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.

**Bulk Water** – A utility which provides raw or treated water to retail utilities, which then distribute and sell the water to households and industries. Bulk water utilities do not deal directly with end customer, but with other utilities.

**Capillary Action**--the means by which liquid moves through the porous spaces in a solid.

**Consumptive use**--part of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

**Conveyance Loss**--water that is lost in transit from a pipe, canal, or ditch by leakage or evaporation.

**Discharge**--volume of water that passes a given location within a given period, expressed in cubic feet per second.

**Domestic Water Use**--water used for household purposes

**Drainage Basin**--land area where precipitation runs off into streams, rivers, lakes, and reservoirs. Also called a “watershed.”

**Drainage/stormwater** – Entity is responsible for the collection and management of rainwater, stormwater and surface runoff in a network separate from the sanitary sewer system. This may overlap with wastewater collection.

**Drawdown**--a lowering of the groundwater surface caused by pumping.

**Drip Irrigation**--a common irrigation method where pipes or tubes filled with water slowly drip onto crops. Drip irrigation is a low-pressure method of irrigation and less water is lost to evaporation or high-pressure spray irrigation.

**Effluent**--water that flows from a sewage treatment plant after it has been treated.

**Estuary**--a place where fresh and salt water mix, such as a bay, salt marsh, or where a river enters an ocean.

**Floodway**--The channel of a river or stream and the parts of the floodplain adjoining the channel that are reasonably required to efficiently carry and discharge the flood water or flood flow of a river or stream.

**Flowing Well/Spring**--a well or spring that taps groundwater under pressure so that water rises without pumping. If the water rises above the surface, it is known as a flowing well.

**Freshwater**--water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

**Gage height**--the height of the water surface above the gage datum (zero point). Gage height is often used interchangeably with the more general term, stage.

**Gaging Station**--a site on a stream, lake, reservoir or other body of water where observations and hydrologic data are obtained. The U.S. Geological Survey measures stream discharge at gaging stations.

**Giardiasis**--a disease that results from an infection by the protozoan parasite Giardia Intestinalis, caused by drinking water that is either not filtered or not chlorinated.

**Greywater**--wastewater from clothes washing machines, showers, bathtubs, hand washing, lavatories and sinks.

**Groundwater**--(1) water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table. (2) Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth‘s crust.

**Groundwater, confined**--groundwater under pressure significantly greater than atmospheric, with its upper limit the bottom of a bed with hydraulic conductivity distinctly lower than that of the material in which the confined water occurs.

**Groundwater Recharge**--inflow of water to a groundwater reservoir from the surface.

**Groundwater, unconfined**--water in an aquifer that has a water table that is exposed to the atmosphere.

**Headwater(s)**--(1) the source and upper reaches of a stream; also the upper reaches of a reservoir. (2) the water upstream from a structure or point on a stream. (3) the small streams that come together to form a river.

**Hydrologic cycle**--the cyclic transfer of water vapor from the Earth‘s surface into the atmosphere, from the atmosphere via precipitation back to earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.

**Impermeable Layer**--a layer of solid material, such as rock or clay, which does not allow water to pass through.

**Infiltration**--flow of water from the land surface into the subsurface.

**Leaching**--the process by which soluble materials in the soil, such as salts, nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

**Lentic Waters**--ponds or lakes (standing water).

**Lotic Waters**--flowing waters, as in streams and rivers.

**Nephelometric Turbidity Unit (NTU)**--unit of measure for the turbidity of water. Essentially, a measure of the cloudiness of water as measured by a nephelometer. Turbidity is based on the amount of light that is reflected off particles in the water.

**Non-point Source (NPS) Pollution**--pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff.

**Oxygen Demand**--the need for molecular oxygen to meet the needs of biological and chemical processes in water. Even though very little oxygen will dissolve in water, it is extremely important in biological and chemical processes.

**Particle Size**--the diameter, in millimeters, of suspended sediment or bed material.
Particle-size classifications are:
[1] Clay—0.00024-0.004 millimeters (mm);
[2] Silt—0.004-0.062 mm;
[3] Sand—0.062-2.0 mm; and
[4] Gravel—2.0-64.0 mm.

**Parts per million/billion**--the number of "parts" by weight of a substance per million or billion parts of water. This unit is commonly used to represent pollutant concentrations.

**Peak flow**--the maximum instantaneous discharge of a stream or river at a given location. It usually occurs at or near the time of maximum stage.

**Percolation**--(1) The movement of water through the openings in rock or soil. (2) the entrance of a portion of the streamflow into the channel materials to contribute to groundwater replenishment.

**Potable Water** – Treated Water that meets drinking water quality as defined by regulatory agencies for safe human consumption.

**Potentiometric Surface/Piezometric Surface**--the imaginary line where a given reservoir of fluid will "equalize out to" if allowed to flow; a potentiometric surface is based on hydraulic principles.

**Prior Appropriation Doctrine**--the system for allocating water to private individuals used in most Western states.

**Public Water Use**--water supplied from a public-water supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools.

**Rating Curve**--A drawn curve showing the relation between gage height and discharge of a stream at a given gaging station.

**Reach**--any length of a stream or river. The term is often used by hydrologists when they're referring to a small section of a stream or river rather than its entire length.

**Recharge**--water added to an aquifer. For instance, rainfall that seeps into the ground.

**Reservoir**--a pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

**Retail Water** – A company specialized in the distribution and sale of water to end customers. A retail water utility may treat its own water or buy treated water from a bulk water supplier.

**Return flow (irrigation)**--irrigation water that is applied to an area and which is not consumed in evaporation or transpiration and returns to a surface stream or aquifer.

**Riparian water rights**--the rights of an owner whose land abuts water.

**Saline Water**--water that contains significant amounts of dissolved solids.

Fresh water
Less than 1,000 parts per million (ppm)

Slightly saline water
From 1,000 ppm to 3,000 ppm

Moderately saline water
From 3,000 ppm to 10,000 ppm

Highly saline water
From 10,000 ppm to 35,000 ppm

**Seepage**--(1) The slow movement of water through small cracks, pores, Interstices, etc., of a material into or out of a body of surface or subsurface water. (2) The loss of water by infiltration into the soil from a body of water, or field.

**Sinkhole**--a depression in the Earth's surface caused by dissolving of underlying limestone, salt, or gypsum. Drainage is provided through underground channels that may be enlarged by the collapse of a cavern roof.

**Sprain**--an archaic term (1600's) referring to a spring or branch of a river.

**Spring**--a water body formed when the side of a hill, a valley bottom or other excavation intersects a flowing body of groundwater at or below the local water table, below which the subsurface material is saturated with water.

**Subsidence**--a dropping of the land surface as a result of groundwater being pumped. Cracks and fissures can appear in the land. Subsidence is virtually an irreversible process.

**Supernatum** --the top level of a fluid at rest; important in many applications of water and wastewater treatment. In particular, it is of concern and often measured in settling tanks and skimmers.

**Surface Water**--water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

**Suspended-Sediment Concentration**--the ratio of the mass of dry sediment in a water-sediment mixture to the mass of the water-sediment mixture. Typically expressed in milligrams of dry sediment per liter of water-sediment mixture.

**Suspended-Sediment Discharge**--the quantity of suspended sediment passing a point in a stream over a specified period. When expressed in tons per day, it is computed by multiplying water discharge (in cubic feet per second) by the suspended-sediment concentration (in milligrams per liter) and by the factor 0.0027.

**Suspended Solids**--solids that are not in true solution and that can be removed by filtration. Such suspended solids usually contribute directly to turbidity.

**Thermal Pollution**--a reduction in water quality caused by increasing its temperature, often due to disposal of waste heat from industrial or power generation processes. Thermally polluted water can harm the environment because plants and animals can have a hard time adapting to it.

**Transmissibility (groundwater)**--the capacity of a rock to transmit water under pressure. The coefficient of transmissibility is the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer one foot wide, extending the full saturated height of the aquifer under a hydraulic gradient of 100-percent. A hydraulic gradient of 100-percent means a one-foot drop in head in one foot of flow distance.

**Transpiration**--process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, such as leaf pores.

**Tributary**--a smaller river or stream that flows into a larger river or stream. Usually, a number of smaller tributaries merge to form a river.

**Turbidity**--the number of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Turbidity is measured in nephelometric turbidity units (NTU).

**Unsaturated zone**--the zone immediately below the land surface where the pores contain both water and air but are not totally saturated with water. These zones differ from an aquifer, where the pores are saturated with water.

**Water Cycle**--the circuit of water movement from the oceans to the atmosphere and to the Earth and return to the atmosphere through various stages or processes such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transportation.

**Water Year**--a continuous 12-month period selected to present data relative to hydrologic or meteorological phenomena during which a complete annual hydrologic cycle occurs. The water year used by the U.S. Geological Survey runs from October 1 through September 30 and is designated by the year in which it ends.

**Water Quality**--a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

**Water Table**--the top of the water surface in the saturated part of an aquifer.

**Water Treatment** – physical and chemical separation processes to remove constituents from various sources of water to achieve a water quality that meets specified goals.

**Watershed**--the land area that drains water to a particular stream, river, or lake. It can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds can contain thousands of smaller watersheds.

**Well (water)**--an artificial excavation put down by any method for the purposes of withdrawing water from the underground aquifers.

**Withdrawal**--water removed from a ground- or surface-water source for use.

**Water Bulk Supply Agreement** - BOT - New Build Only - bulk supply agreement for provision of treated water. Drafted for small scale plants, whether for a utility or for an industrial customer.

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