

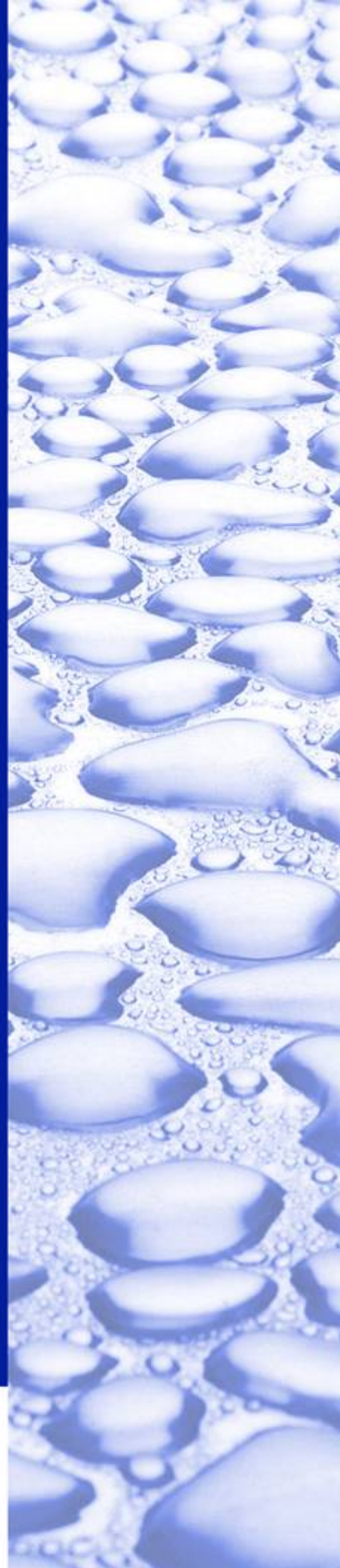


# ame

PUMP SPECIALISTS

**Inorganic Treatment  
Solutions**

Statement of Qualifications





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# Introduction



Severn Trent Services is a leading supplier of water and wastewater treatment solutions. We provide our clients with some of the industry's brightest minds, advanced technologies and quality products to provide truly efficient, cost effective solutions to water and wastewater challenges. Our broad range of products and services is concentrated around disinfection and filtration technologies and contract operating services.

There are many types of water purification applications – industrial, municipal, fresh water, salt water, potable water and wastewater. At Severn Trent Services, we offer the most complete line of disinfection, instrumentation and filtration equipment in the industry.

At Severn Trent Services, our domestic and international field and factory service personnel are well trained to support our products. Severn Trent Services has office locations in:

- Fort Washington, Pennsylvania (headquarters)
- Colmar, Pennsylvania
- Pittsburgh, Pennsylvania
- Tampa, Florida
- Sugar Land, Texas
- Torrance, California
- Abu Dhabi, United Arab Emirates
- Barcelona, Spain
- Kuala Lumpur, Malaysia
- Cancun, Mexico
- Cairo, Egypt
- Bogotá, Columbia
- Tamworth, United Kingdom
- Milan, Italy
- Shanghai, China
- Singapore

## Our Vision, Mission and Core Values

- Our Vision: Severn Trent Services will be a leader in global water and wastewater markets. Through innovative solutions and world-class service, we will consistently provide superior results for customers, shareholders, employees and society.
- Our Mission: At Severn Trent Services we endeavor to work with our customers, helping them to cost effectively achieve the highest standards of water and wastewater quality.
- Our Core Values: We value high performance, hard work, honesty and teamwork. We will hold ourselves accountable to the highest standards of safety, ethics, trust, quality and service. We will respect and always strive to do what is right for our customers, employees, suppliers, community and the environment.



## Health and Safety Statement



At Severn Trent Services the safety of our employees and the safe operation of our facilities are key values. In support of these values, we promote safe work practices and procedures. This will enable us to prevent injuries and illnesses, as well as damage to our equipment and facilities.

Every employee has the responsibility to prevent injuries by observing established work rules, by following the direction of supervisors, by practicing the principles taught in safety training and by providing ideas on how our safety efforts might be further strengthened. Severn Trent Services and its employees have the responsibility to comply with all national and local regulations related to safety and health programs. An effective safety program extends beyond normal work hours and, accordingly, safety in employees' off the job activities is encouraged.

Yet, as helpful as they are, safety rules by themselves cannot prevent injuries. The indispensable ingredients of a safe working environment are Management Commitment, a Knowledgeable Supervisory Staff, an Involved Safety Leader and a Conscious Work Force, where each individual is dedicated to the principle that injury prevention is an essential part of the planning and efficient execution of every job.

To this end, Severn Trent Services will strive towards continuous improvement of its Health and Safety Systems by a trained and committed staff and use a recognized safety management system to control, focus and record our achievements and activities.



# Inorganic Treatment Solutions- Media Filtration Processes for Drinking Water

## Arsenic Removal - Adsorption

Severn Trent Services offers a simple, proven and cost-effective arsenic removal treatment system to meet drinking water and non-drinking water application needs. The SORB 33 adsorption system reduces arsenic levels to less than 4 ppb. SORB 33 systems use Bayoxide<sup>®</sup> E33 granular or Bayoxide<sup>®</sup> E33P pelletized ferric oxide media. The Bayoxide<sup>®</sup> media are long-lasting and once exhausted can be sent to a non-hazardous landfill for disposal.

## Arsenic Removal - Coagulation/Filtration

Severn Trent Services offers the Omni-Flow<sup>™</sup> horizontal and vertical pressure vessel designs that incorporate our patented TETRA<sup>®</sup> LP<sup>™</sup> Block under drains to enhance hydraulic flow in our coagulation/filtration systems for the removal of arsenic or multiple contaminants from drinking water sources.

## Fluoride Removal

Severn Trent Services offers the SORB 09<sup>™</sup> fluoride removal system, a fixed-bed adsorption process for the removal of fluoride onto solid activated alumina. Treatment is conducted with a downward flow through two adsorber vessels in parallel configuration. The process is regenerative, using a weak caustic soda solution.

## Iron and Manganese Removal

Severn Trent Services designs and provides Omni-SORB<sup>™</sup> filter systems for iron and manganese removal applications. Omni-SORB is an advanced synthetic media to allow high hydraulic flow, up to 10 gpm/ft<sup>2</sup>. Omni-SORB is suitable for combined arsenic/iron/manganese removal where iron levels are not high enough to effect arsenic removal and as pretreatment with SORB 33<sup>®</sup> arsenic “Polishing”.

## pH Control

Severn Trent Services offers a CO<sub>2</sub> pH control system for drinking water applications up to 1500 gpm. The pH control system employs a new technology for Fine Micro Bubble (FMB) gas diffusion into an aqueous process stream.



## Nitrate Removal

Severn Trent Services offers the SORB 07™ nitrate removal process that uses NO<sub>3</sub>-selective anion resins to remove NO<sub>3</sub> via exchange with chloride (Cl) ions which enter the treated water. Treatment is conducted in pressure vessels similar to fixed bed ion exchange filters and the process is regenerative.

## Uranium Removal

Severn Trent Services offers the SORB 92™ uranium removal system consisting of pressure vessels to purify drinking water. Contaminated water enters the vessels and contacts an ion exchange resin designed to remove uranium. The treated water leaving the vessels contains <5 µg/L U.

## Water Softening

Severn Trent Services offers water softener systems to remove calcium and magnesium from water. The systems use a pressure vessel design and cation resins to provide continuous operation and assure treated water is always available.



# Arsenic Removal

Arsenic contamination of drinking water is a global concern and for over a decade Severn Trent Services has provided proven treatment solutions to ensure safe drinking water.

## SORB 33® Arsenic Removal System



Severn Trent Services developed the SORB 33® adsorption process to reduce arsenic contamination across a range of water treatment application sizes, and the technology has been commercially proven to effectively and economically meet arsenic removal standards globally.

The SORB 33 arsenic removal system is simple-to-operate and requires minimal labor, it consists of one or more pressurized vessels constructed of steel. Contaminated water enters the vessels and passes through a robust ferric oxide media, Bayoxide® E33 (granular) or Bayoxide® E33P (pellets). As water passes through the media, arsenic is adsorbed and removed to a level below 4 ppb. The system requires no cleaning, no regeneration and no complex, labor-intensive steps.

## Bayoxide® Granular Ferric Oxide Media and Removal

Bayoxide® is a dry, robust, ferric oxide media designed with a high capacity for arsenic, providing long operating cycles and low operating costs. The Bayoxide media was designed with a high capacity for both arsenic (III) and arsenic (V). The media also adsorbs antimony, cadmium, chromate, lead, molybdenum, selenium and vanadium. The media's life expectancy is dependent on site-specific water quality and operating levels with change-out typically needed between nine and 36 months. The exhausted media is non-hazardous and can be sent to a landfill, passing Toxicity Characteristic Leaching Procedures (TCLP).

Unlike other arsenic removal technologies like ion-exchange resins, which require frequent backwashing using acid solutions and create a great deal of highly acidic and hazardous waste in the backwash process, no chemicals are used in the SORB 33 backwash procedure. Since the feed water is used for backwashing, the backwash water quality will bear similar characteristics to the feed water.

For over a decade, Severn Trent Services has provided the SORB 33 arsenic removal solution across Asia, Europe, Latin America and North America.

Spent Bayoxide media is removed from adsorber vessel(s) either by vacuuming or under hydraulic pressure. Vacuuming generates the minimum amount of wastewater.





## Additional Applications- Bayoxide® Media

Since the introduction of Bayoxide® E33 to the drinking water markets, Bayoxide® E IN-20 media has been developed for application to non-drinking water processes for arsenic, phosphate and for heavy metals removal. It has been used for arsenic removal from mining and industrial wastewaters, selenium removal from refinery wastes and for phosphate polishing of treated municipal wastewaters.

Examples of tested and commercialized non-drinking water applications of the Bayoxide® E IN-20 media include:

- Aquarium Phosphate Removal
- Mining & Metallurgical Effluents Arsenic Removal
- Food & Beverage Process Water Purification
- Groundwater Arsenic Remediation
- Domestic Wastewater Phosphate Polishing
- Refinery Wastewater Arsenic and Selenium Removal

## Bayoxide® Granular Ferric Oxide Spent Media Classification

One of the key advantages of Bayoxide iron oxide adsorbent is its ability to strongly bind arsenic as water passes through the media through a combination of adsorption, adhesion and other physical/chemical mechanisms. Testing has shown the spent media passed the US EPA's Toxicity Characteristic Leaching Procedure threshold (TCLP per RCRA 40 CFR 261).

Based on repeated results, Severn Trent Services strongly believes that the media will not be characterized as a hazardous waste unless preempted by more stringent state or local regulations. The spent media is considered a RCRA Subtitle D, non-hazardous solid waste, suitable for disposal in a sanitary landfill.

Final disposition and determination is typically the responsibility of the customer, since State or Federal agencies do not grant blanket "approval" or "disapproval" of spent materials, but rather allows the generator of such residuals to make a hazardous waste determination.

## Bayoxide® Granular Ferric Oxide Environmental Liability

Generating, managing, and disposing of arsenic-containing residuals in a regulatory compliant manner that is consistent with sound environmental stewardship can present a challenge to Utilities. Regulations are written such that the "generators" of a waste share in the responsibility for the complete "cradle-to-grave" process.



Every arsenic removal technology produces a waste that contains arsenic. It is the responsibility of the Utility to test, manage, store, transport and manifest all “wastes” in an environmental responsible manner “cradle-to-grave”. To date, no sovereign immunity exists. As a result, an arsenic removal technology or company offering an arsenic removal technology can not eliminate a Utility’s liability or responsibility for sound environmental stewardship.

Based on capital costs, operations/maintenance and programmatic costs, Bayoxide media can offer a Utility an environmentally sound and overall cost-effective and safe solution.

### pH Adjustment for Optimum Arsenic Adsorption

Within the normal groundwater pH range of 6 to 9, metal oxide adsorbents display a range of capacities for adsorbing arsenic (As). Typically, these adsorbents can adsorb more arsenic by decreasing the pH value of water.

Arsenic adsorption capacity for Bayoxide media is not very pH sensitive. However, for alkaline waters above an 8.3 pH, capacity can be significantly increased and operating costs reduced via pH adjustment of the feed water. Chemical consumption costs add only about 5-10% to operating costs in order to increase the Bayoxide media capacity and reduce media replacement costs by 40-80%. Severn Trent Services has a model that can quantify the effects of pH adjustment on SORB 33<sup>®</sup> efficiency using a typical water analysis.

Further process optimization is available for waters that only require partial treatment where some water can be bypassed and blended to produce a water quality below the new 10 µg/L arsenic MCL. Only water to be treated for arsenic removal requires pH adjustment.



# Coagulation/Filtration

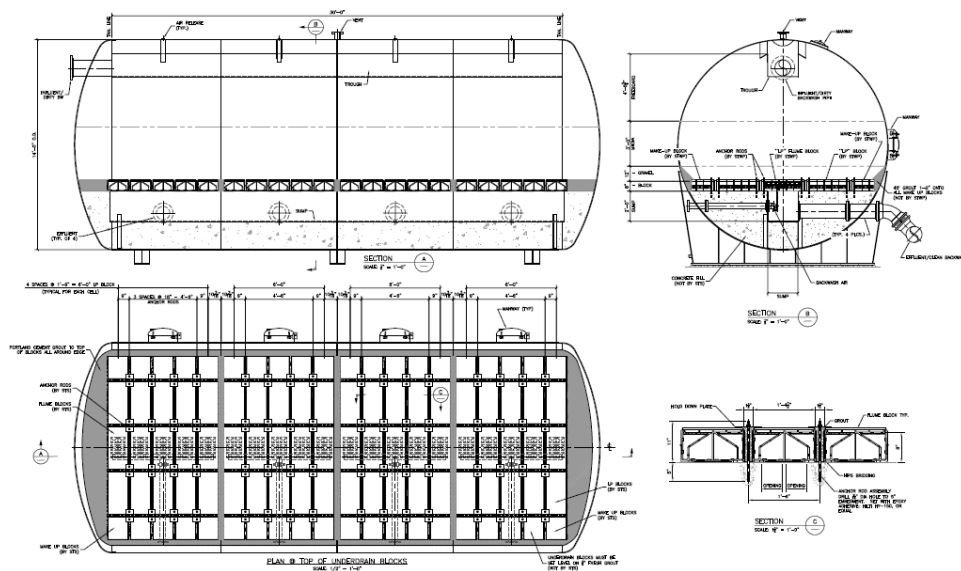
## Omni-Flow™ Coagulation/Filtration System

Severn Trent Services offers the Omni-Flow™ horizontal and vertical pressure vessel coagulation/filtration system designs which incorporate the unique and patented TETRA® LP Block™ under drains to enhance our removal of multiple contaminants from drinking water sources.

The Omni-Flow systems feature the TETRA® LP Block™ underdrain system. LP Block is a proven dual parallel lateral under drain design for potable water filters that provides even distribution of both backwash air and water, either separately or concurrently. The even air and water distribution achieved using the LP Block provides a superior media backwash which results in increased run times, enhanced filter performance and lower operating costs.

The horizontal media pressure filter system is a large flow high capacity design in a single vessel. Each horizontal Filter is compartmentally designed to maximize flow and minimize system backwash requirements. The design enables a rigorous backwash sequence across each compartment, individually, to efficiently clean the system using the minimal flow.

- **Chemical Feed:** Severn Trent Services offers a chemical pace system for automatic chemical feed control. The system uses the influent flow rate and the influent and effluent concentrations to attain an operator-inputted set point value for effluent concentration.
- **Backwash Solids Management:** Severn Trent Services offers complete solutions with backwash water recovery and treatment. For those applications where backwash water is not allowed for discharge to the sewer or pond and requires collection and treatment, Omni-Flow is the ideal solution.





# Fluoride Removal

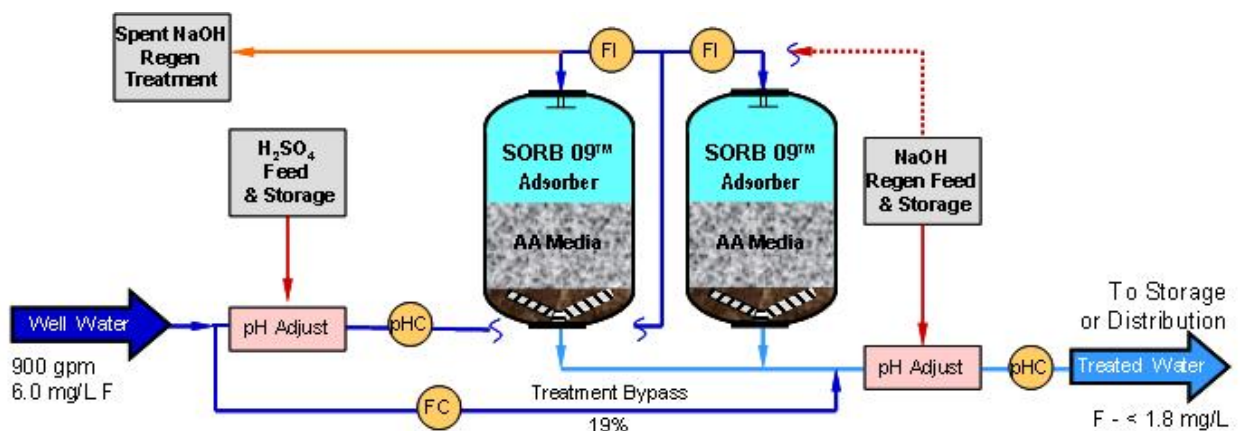
Fluoride, in dissolved form, can be found in well water sources for drinking water. High levels of fluoride can effect bone structure and lead to teeth discoloration. The USEPA MCL is 4.0 mg/L, and the secondary contaminant level (reporting) is 2.0 mg/L.

## SORB 09™ Fluoride Removal System

Severn Trent Services offers the SORB 09™ fluoride removal system, a fixed-bed adsorption process for the removal of fluoride onto solid activated alumina. Treatment is conducted with a downward flow through two or more adsorber vessels in parallel configuration. The process is regenerative, using a weak caustic soda solution.

## SORB 09™ Fluoride Removal System Process Design

- The SORB 09 system is designed to treat a maximum of 20 mg/L of fluoride
- The feedwater pH is reduced to 6 to allow for efficient fluoride adsorption
- Blended water pH is neutralized to near its original pH
- Uses a 6-step media regeneration and conditioning process
- Spent regenerant fluoride precipitation is available if the solution can not be discharged to a WWTP.





## SORB 09™ Fluoride Removal System Media Regeneration & Conditioning



The SORB 09 system operates continuously for a period of 4- to 30-days in a down flow fixed-bed adsorption process between regeneration cycles. Water flow to each adsorber vessel is controlled independently. Treated water is collected and discharged and the pressure differential indicators monitor the pressure drop across each media bed.

The regeneration cycle is initiated based on the influent monitored fluoride and flow rate treated. The regeneration cycle can be initiated automatically or manually. In both instances, one adsorber vessel is taken out of service, at a time, while the other remains in service or can be in the idle step.

Regeneration consists of a down flow caustic (NaOH) flow with a 50% NaOH stream diluted to 1% with untreated well water. The pH indicator monitors the pH levels of the spent regeneration. Following regeneration, the spent caustic is displaced with the treated water in the adsorber and then collected in a tank for blending and disposal with the spent brine.



# Iron and Manganese Removal

## Omni-SORB™ Iron & Manganese Removal System

Severn Trent Services designs and provides Omni-SORB™ Filter Systems for iron and manganese removal applications, for combined arsenic/iron/manganese removal where iron levels are high enough to effect arsenic removal and as pretreatment with SORB 33 arsenic “Polishing”.

Typical system designs consist of two automated filters in parallel operation.

Backwashing frequencies for Omni-SORB Systems depend upon the water’s iron and manganese concentrations. For a water containing 1,500 µg/L Fe or 400 µg/L Mn, backwashing is done every 25-40 hours of operation. Longer service cycles occur between backwashes with lower levels.

## Omni-SORB™ Filter Media

The Omni-SORB granular filter media from Severn Trent Services was specifically designed to provide removal of soluble, reduced iron and manganese from well waters. Omni-SORB is not a processed mineral; rather, it is an engineered product using refined manganese dioxide that has high catalytic activity for oxidation and adsorption of these metals. These catalytic properties allow the media to have higher hydraulic flow and efficiently used without the addition of potassium permanganate ( $K_2MnO_4$ ), a strong oxidant required for Fe and Mn removal with greensand and other media.

Severn Trent Services offers the Omni-SORB media in 1 metric ton (2205 lbs) bulk sacs or 100 lb fiber drums. The media has the WQA Gold Seal of Certification for compliance with NSF/ANSI 61.





# pH Control

Severn Trent Services offers a CO<sub>2</sub> pH control system for drinking water applications up to 1500 gpm. The pH control system employs advanced technology for Fine Micro Bubble (FMB) gas diffusion into an aqueous process stream.

## CO<sub>2</sub> pH Control System Design Principle and Operation



The pH control technology uses a traditional reverse osmosis membrane to molecularly disperse carbon dioxide gas into a side stream of water. The chlorine dioxide gas is passed through the membrane and the water is then passed perpendicularly across the exterior of the membrane. The carbon dioxide gas is forced, under pressure, through the membrane where it is absorbed into the water to form carbonic acid. Once the side stream is reintroduced into the main process stream, the contact time is reduced from 50 to less than 20 feet, since the gas has been molecularly dissolved.

The pH control system operates at pressures just above the main process stream pressure, minimizing degassing and increasing system efficiency. Additionally since the delivery of the carbon dioxide gas is dominated by the pressure of the gas storage tanks, there is no requirement to pump water and incur the associated costs of doing so.

The pH control system has four components; the gas storage system, gas regulator and switchover panel, gas controller panel, and side stream membrane unit and piping. The pH control system is easy-to-operate and maintain.

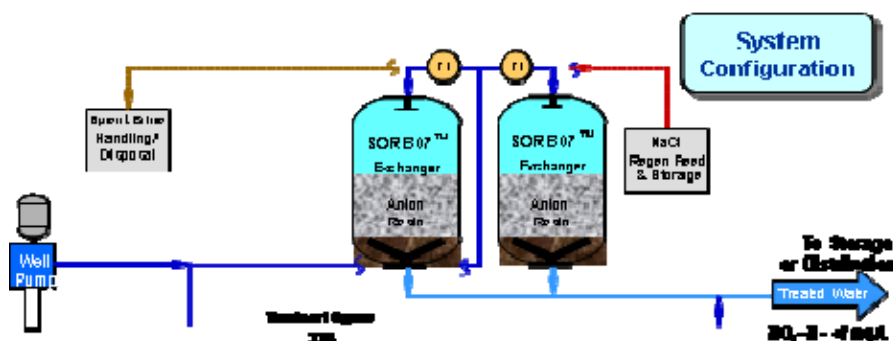


# Nitrate Removal

Ground waters are more prone to nitrate ( $\text{NO}_3$ ) contamination than surface waters since nitrate is a soluble nutrient found in fertilizers and sewage that percolates through the ground and into aquifers. The USEPA MCL is 10 mg/L as  $\text{NO}_3\text{-N}$  or 44 mg/L as  $\text{NO}_3$ . The difference in limits is that the  $\text{NO}_3\text{-N}$  analysis reports only the nitrogen content, not the nitrate content.

## SORB 07™ Nitrate Removal System

Severn Trent Services offers the SORB 07™ nitrate removal process that uses  $\text{NO}_3$ -selective anion resins to remove  $\text{NO}_3$  via exchange with chloride ( $\text{Cl}$ ) ions which enter the treated water. Treatment is conducted in pressure vessels similar to filters or adsorbers. The process is regenerative meaning that the resin must be regenerated on a frequent basis with salt ( $\text{NaCl}$ ) to remove the  $\text{NO}_3$  ions into a concentrated spent brine so that the resin can be used for further treatment. The process flow diagram is depicted below.



Severn Trent Services designs around our SORB 07 resins specially developed for the removal of nitrate with brine regeneration. If brine hauling from a treatment site is required, Severn Trent Services offers a reverse osmosis (RO) unit to concentrate the brine by 2.5- to 3-times and two spent regeneration tanks to minimize freight costs. Use of potash ( $\text{KCl}$ ) may be applied to generate a low grade  $\text{KNO}_3/\text{KCl}$  fertilizer byproduct.

## SORB 07™ Case Study

A SORB 07 system design to treat 1,500 gpm of well water containing 20 mg/L  $\text{NO}_3\text{-N}$  to a blended level of <7 mg/L is summarized here. The system consists of two 14'-Ø exchangers each containing 539 ft<sup>3</sup> of resin. 67% of the water is treated and blended with 33% that bypasses the exchangers. Each exchanger is regenerated every 2.4 days after treating 1.7 million gals. The estimated treatment cost is \$40 per Acre Ft or 12.4¢ per 1,000 gals.



# Uranium Removal

Uranium occurs naturally in some ground waters in various parts of the world. It is a mildly radioactive substance and a heavy metal poison. It is harmful to the human body if ingested in elevated concentrations. The USEPA has set a MCL of 30 µg/L U for drinking water in 2002.

## SORB 92™ Uranium Removal System

Severn Trent Services employs the SORB 92™ uranium removal system consisting of pressure vessels to purify drinking water. Contaminated water enters the vessels and contacts an ion exchange resin designed to remove uranium. The treated water leaving the vessels contains <5 µg/L U.

On a routine frequency, generally every 2-6 months, the vessels are taken offline and regenerated with brine in a simple process similar to that of water softeners. Spent brine contains only a few pounds of uranium and can be discharged to a sanitary sewer for treatment in a wastewater treatment plant.



# Water Softening

Hard water has excess calcium and/or magnesium, causing limescale – a white chalk-like scale deposits or calcium buildup. Severn Trent Services offers water softener systems to remove calcium and magnesium from water. The systems use a pressure vessel design and cation resins to provide continuous operation and assure treated water is always available.

Hard water containing calcium and magnesium is passed through a resin bed loaded with sodium ions. A cation resin is used. The resin attracts calcium and magnesium ions and releases sodium ions to the effluent water. When the exchange capacity is exhausted, a brine solution (made from salt) is passed through the resin bed to regenerate it with sodium ions. The spent brine solution goes to drain and the regenerated resin can now continue to soften water.



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