VSEP Vibes Newsletter

Welcome to the New Logic Research Newsletter

FGD – The High Cost of Playing it Safe

At New Logic, customers usually contact us because they have a wastewater problem, often a serious one. VSEP is a powerful tool that we have, but really, we are in the business of problem solving. That is the essence of engineering. Engineering can be a dangerous business. Mistakes can be very costly. This is why engineers tend to be very conservative. Trying new things can open up a world of unknowns. You don't know what you don't know.

It seems that almost every day I get a call from a potential customer with a dead wastewater treatment plant that does not work. Many times, these are conventional treatment plants designed by conservative engineers. I am shocked at how often this happens. I have also seen this happen to very large and respectable engineering companies. At New Logic, we take pride in our project success rate. A bad project can do significant damage to our brand. It amazes me how many of the large engineering companies can install projects that don't work and they can stay in business.

Power plants use a wet scrubber system to remove SO2 and other pollutants from their flue gas. The scrubber water, known as flue gas desulfurization (FGD) wastewater, is very difficult to treat and discharge limits for mercury, arsenic, and selenium can be very low, some in the parts per trillion level. The wastewater is produced in a forced oxidation limestone scrubber. That is done by adding limestone and air to the scrubber, which reacts with the SO2 to produce gypsum. The scrubber is a highly oxidizing reaction vessel because oxidizing conditions are required for SO2 removal. The oxidation level changes in the scrubber because the scrubber receives varying composition of the flue gas due to variability in the coal. The limestone

Precipitated Solids Collected from VSEP Concentrate

fed to the scrubber can also change. There are many different metals in the limestone and ash and they can act as a catalyst for different reactions in the scrubber in addition to SO2 removal. Because the coal and the limestone composition can vary, the FGD wastewater will change and this makes conventional treatment especially vulnerable.

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Biological wastewater treatment is a textbook conventional method. In fact, the Romans used this technology. Conservative engineers often go to this because it is proven and safe. However, pilot testing this is not practical, so projections are made based on historical data. New Logic quoted a FGD project for an eastern power plant and the alternative offer was a digester, plus other treatment steps. The conservative engineers chose the digester and installed it last year. The system was commissioned last December by a very prestigious engineering company. The system failed on startup and now three months later, it is still not working. This was a multi-million dollar gamble that lost.

Conventional spiral membrane systems are also widely used and understood by conservative engineers. They are great on paper, but fragile in reality. The limitations are well known, and really smart engineers believe they can design a system with adequate pretreatment to prevent collapse. There are several companies out there now claiming they have figured out how to overcome spiral membrane limitations. The trouble is that these systems are pushed to the limit and even a 50 ppm change in mineral chemistry can lead to disaster. I learned of another failed FGD project that commissioned spiral membranes done by a very prestigious engineering company. The system and its elaborate pretreatment ran for a short period at 30% recovery and then finally stopped altogether. The membranes were completely cemented into the housing with gypsum and a come-along was needed to remove them for autopsy.

The list goes on and on. VSEP has been used for 15 years to treat FGD wastewater with virtually no pretreatment. It is very tempting to use spiral membranes because everyone knows they can produce very clean filtrate and they are relatively less expensive. But if they don't work, the cost savings are meaningless. VSEP has been demonstrated many times including studies with the industry group, EPRI. It has been shown that VSEP RO can meet PPT discharge limits and can run with stable flow rates, even on super-saturated gypsum wastewater like FGD. The EPA, in its rulemaking, designated VSEP as a best available technology for FGD water.

New Logic's patented membrane system uses torsional oscillation to create very high shear at the membrane surface that disrupts concentration polarization and prevents scaling. Other membranes are limited by solubility, but, VSEP can actually work like a membrane-crystallizer precipitating solids during the filtration process. Solids precipitate away from the membrane because of the shear and are then simply flushed out of the filter by laminar flow.

With VSEP, the membrane is oscillated 50 times per second. This creates very high shear at the membrane surface that prevents concentration polarization. With standard spiral membrane systems, crossflow is used to create shear, but because of the friction and drag from the membrane surface, this shear decays and becomes non-existent at the membrane surface where it is needed most. Because of this, solids that are rejected by the membrane accumulate right at the membrane surface. This is known as concentration polarization. Because there is a very high solids concentration near the membrane, if the solubility of anything is exceeded, precipitation and scaling will occur. Even though membranes have a low energy surface and are hydrophilic, attaching to the membrane happens because there is no agitation or shear and solids are more concentrated at the membrane and less concentrated further away. Due to this and the proximity to the membrane, scale, oil, organics, and colloids will attach. With VSEP, this high concentration at the membrane does not occur because of the shear. Solids concentrations are uniform throughout.

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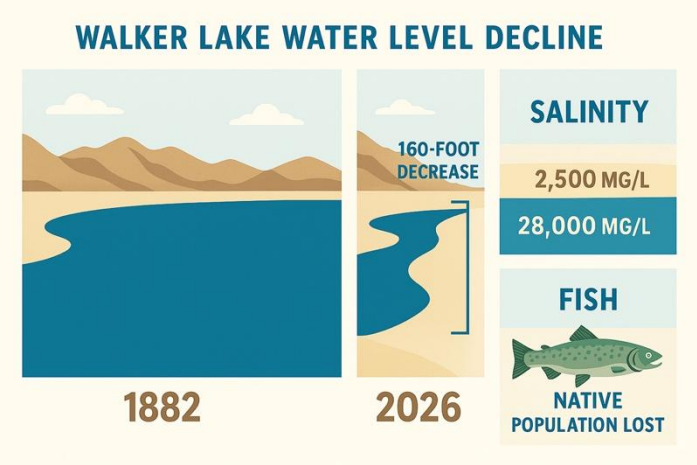
Walker Lake and the Growing Water Crisis in the American Southwest

Few places illustrate the mounting water crisis in the American Southwest as starkly as Walker Lake, a rare desert terminus lake in Nevada. Its survival depends almost entirely on Sierra Nevada snowmelt. For more than a century, upstream agricultural diversions along the Walker River have steadily reduced inflows, reshaping the lake from a thriving recreation hub into one of the most endangered water bodies. According analyses by the USGS, Walker Lake has lost 160 feet of elevation since 1882, as upstream diversions now consume most streamflow. Total dissolved solids have soared from 2,500 mg/L to 28,000 mg/L, creating conditions inhospitable to native fish such as the Lahontan cutthroat trout, last seen in the lake in 2009. Once a 30-mile-long oasis supporting fishing, bird-watching, boating, and camping, the lake's shrinking footprint and rising salinity have devastated Mineral County's recreation-based economy and jeopardized the future of the nearby town of Walker Lake.

Meanwhile, restoration advocates have made measurable progress. As of early 2025, the Walker Basin Conservancy had secured 57% of the water rights needed for long-term lake restoration, acquiring both surface water rights from ranches and relinquishing groundwater rights to stabilize regional aquifers. These efforts aim to boost inflows, reduce salinity, and eventually reestablish conditions that could support native fisheries.

Walker Lake's decline is not an isolated story. A March 2026 Newsweek analysis identified Walker Lake among the five fastest-declining lakes in the United States, alongside Lake Mead, Lake Powell, the Great Salt Lake, and California's Salton Sea. These water bodies are shrinking due to drought and human overuse, factors that collectively threaten drinking water supplies, hydropower generation, and regional agriculture. Walker Lake alone has



lost about 90% of its historic volume. Historical records show that major diversions on the Walker River began in the 1860s, eventually outstripping the river's average annual supply. For much of the last 50 years, stretches of the Walker River have run completely dry. This overuse has depleted groundwater tables as well, due to decades of supplementary groundwater rights issued to support surface water allotments. The result is a cascading ecological collapse: vanishing fisheries, deteriorating bird habitats along the Pacific Flyway, and communities struggling to sustain their cultural and economic identities amid shrinking water resources.

The story of Walker Lake reveals a deeper truth throughout the Southwest, century-old water rights frameworks no longer match modern hydrologic realities. Drought cycles are intensifying and agricultural demand remains high even as supplies diminish. Solutions will require rebalancing water rights to reflect ecological needs alongside agricultural and municipal demands. As the Southwest grapples with dwindling water supplies, Walker Lake stands as both a cautionary tale and a rallying point. The path to restoring this once-vibrant desert lake mirrors the path to securing a sustainable water future for the region.

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It Begins - Vermont Could Set First Leachate PFAS Regulatory Precedent

Vermont is poised to take a landmark step in PFAS regulation with the introduction of Bill H.652, legislation that would prohibit the discharge of landfill leachate into the Lake Memphremagog watershed, even when routed through a publicly owned treatment works (POTW). If enacted, this could become the first instance in the U.S. where PFAS limits are enforced on leachate indirectly discharged through a municipal wastewater facility. The bill directly affects Vermont's only active landfill in Coventry, owned and operated by Casella Waste Systems Inc. Currently, leachate from the site is collected and transported to regional wastewater treatment facilities for processing and discharge. But H.652 would prohibit any direct discharge of leachate from the landfill into the Lake Memphremagog watershed or any indirect discharge, including the transfer of leachate to a wastewater treatment facility within the watershed for subsequent discharge

Lake Memphremagog, shared between Vermont and Quebec, supplies drinking water to more than 175,000 residents. The bill emphasizes the lake's ecological and economic significance, underscoring a shared international interest in protecting a vital resource. A central argument behind H.652 is that existing leachate treatment systems in Vermont are not capable of removing PFAS compounds to safe levels. Because PFAS are highly mobile and persistent, conventional wastewater treatment technologies, including those used at POTWs, are unable to effectively capture or degrade them.

As a result, the bill proposes a strict zero-discharge standard for leachate in the watershed, regardless of whether the leachate is treated or untreated. This would fundamentally change how landfill operators

and wastewater utilities manage leachate. This trend in regulation will potentially require on-site advanced PFAS treatment systems, out of watershed disposal, and significant infrastructure investments or redesign of existing leachate handling systems

While several states have adopted PFAS monitoring requirements for wastewater effluent, biosolids, and industrial discharges, Vermont's proposal is notable for two reasons. It takes direct aim at landfill leachate, one of the most concentrated PFAS waste streams in the municipal sector. Second, it closes the POTW loophole, recognizing that sending leachate to municipal wastewater plants does not remove PFAS and it simply passes through the system. If adopted, H.652 may serve as a regulatory template for other states facing similar watershed pressures, especially those upstream of drinking water intakes.

The bill signals a transformative moment for PFAS management in solid waste and wastewater sectors. Stakeholders will be watching closely. For PFAS technology providers like VSEP, this regulatory shift could accelerate demand for treatment systems capable of meeting these emerging standards. If Vermont moves forward, the Coventry landfill may become the first facility in the nation required to adopt next-generation PFAS treatment specifically for leachate destined for surface-water discharge.

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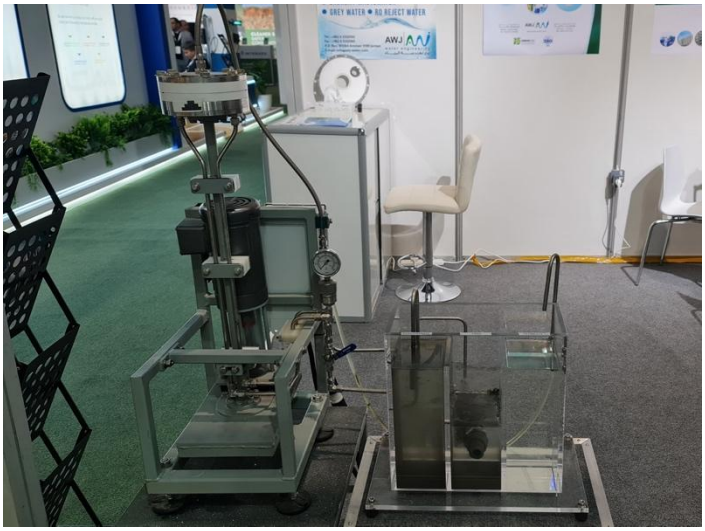
Rep Spotlight – AWJ Water Engineering

IFAT Saudi Arabia was held January 26 to 28, 2026, at the Riyadh Front Exhibition & Conference Center. This landmark event is recognized as the largest dedicated platform for waste management, water treatment, and environmental services worldwide. IFAT Saudi Arabia targets the following sectors:

- Water Treatment
- Waste Management
- Recycling
- Sustainability
- Environment
- Energy recovery

AWJ Water Engineering, located in Amman, Jordan, has been a VSEP distributor for more than 20 years. The Co-founder, Samer Khamis attended the IFAT Saudi Arabia to expand their market and showcase VSEP in the Kingdom. AWJ Water Engineering is expanding and has opened a new branch in Saudi Arabia.



AWJ has been a reliable distributor and has been a reliable business partner as both companies have grown. AWJ has overseen the installation of VSEP projects in the Middle East and also covers North Africa. They have a LP pilot machine and have conducted numerous pilot tests. Water is scarce in the region and this makes VSEP a very good treatment choice with lots of possibilities.
During the event, there was brisk attendance to the AWJ booth. They had a Series B VSEP demonstration machine in operation. This little machine is quiet and easy to set up. It plugs into any 15 amp single phase plug, so no special electrical is required, which can be a problem at a trade show. This demonstration machine was specifically designed to be used at trade shows. Because of the light hum and the motion, everyone who walks by will glance at it and it can attract a lot of traffic to a trade show booth.

The show was a success and New Logic wishes the best for the new branch location in Saudi Arabia and to Samer and his team.

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Rivers are Sewage Discharge and Drinking Water Intake Points

A major section of the Potomac 72" sewer line that carries up to 60 million gallons of wastewater per day collapsed on January 19, 2026, near the Clara Barton Parkway in Montgomery County, MD near Washington D.C. The collapse caused a massive release of untreated sewage into the Potomac River. Reports vary, but estimates indicate 243–300+ million gallons of raw untreated sewage have spilled so far, with initial overflow rates of up to 40 million gallons per day. The sewer pipe had been undergoing rehabilitation, and crews encountered rock blockages that may have contributed to the failure. Officials warn the public to avoid contact with the Potomac River, including boating, fishing, and allowing pets near the water. The primary concern is E. coli and other pathogens, plus chemical contaminants from raw sewage. Despite the severity, drinking water is claimed to be safe. Frozen river conditions earlier in February temporarily slowed spread but raised concerns about worsening contamination when thawing occurs. Emergency bypasses have been constructed. Repair of the pipeline is expected to take 9-10 months.

The Little Falls Station water treatment plant has a drinking water intake from the Potomac near the spill, but this is normally offline during the winter. This intake is used during the summer when river flows at another location feeding the Great Falls Station are low and demand is high. Officials have stated that this intake will remain offline until water quality is back to normal. The Little Falls Station supplies water to Washington D.C., Arlington, and Fairfax County, Virginia.

Having a raw sewage spill highlights the dangers of sewage treatment plants. Even if a POTW is working perfectly, it only removes some things. Conventional municipal sewage treatment plants are excellent at

removing biodegradable organic matter, solids, nutrients, and pathogens, but many modern synthetic or persistent contaminants pass through the treatment plant largely unchanged. Nitrogen and phosphorus are removed to some extent in conventional municipal sewage treatment, but not completely, and significant amounts often pass through the plant. This can lead to eutrophication, hypoxia, and algal blooms.

Typical POTWs do not remove pharmaceuticals, antibiotics, PFAS, microplastics, parabens, nanoparticles, pesticides, solvents, surfactants, and many other manufactured chemicals and products that end up in the sewer system. Even though downstream drinking water intakes will receive these persistent pollutants, most of them are not regulated or measured in drinking water. The biological treatment system used is the same technology the Romans used. As PFAS and other persistent consumer product become an issue for discharge, someday it may become necessary to upgrade ancient technology used for sewage treatment. We have a new article on this subject that can be found on our website: here.

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Rethinking Drilling Fluids

In the world of petroleum engineering, drilling fluids are the unsung heroes of every successful well. They cool and lubricate the drill bit, stabilize the wellbore, carry cuttings to the surface, and help control formation pressures. Whether the operation calls for water-based mud or high-performance oil-based mud, drilling fluid is the lifeblood of the drilling process. As drilling progresses, fluid returns to the surface loaded with cuttings, fines, polymers, emulsified oils, organics, and formation contaminants. Primary solids control equipment does a remarkable job removing larger particles, but the remaining mixture, dense, oily, and chemically complex, is notoriously difficult to treat. Historically, operators faced limited choices: haul it away, inject it, or send it to thermal desorption or third-party processors. These options come with rising costs, regulatory pressure, and environmental scrutiny.

And in the case of oil drilling fluid, disposal also means watching expensive base oil, one of the most valuable components on the rig, be thrown away. A New Approach: unlike conventional membrane systems, which plug quickly when exposed to high-solids or oily fluids, VSEP uses high-frequency vibration to keep the membrane surface clean in real time. The result is something many engineers believed impossible: high-flux filtration on drilling mud. With VSEP, operators can filter drilling fluid producing a clean, clear filtrate, low in suspended solids and suitable for reuse.

The rejected solids are significantly reduced in volume, meaning lower disposal and transportation costs. For water-based systems, this means improved environmental performance and lower waste volumes. For oil-based systems, it

opens the door to something even more compelling: the recovery of valuable base oil.

Oil-based drilling fluids are prized for their lubricity, thermal stability, and ability to handle reactive formations. But that performance comes at a cost, literally. OBM formulations are expensive, and when contaminated mud is discarded, so is the base oil within it. VSEP gives operators the ability to reclaim that material. By separating the oil phase into a clean, reusable permeate, VSEP allows drilling crews to return recovered oil directly back into the mud system. This closes the loop, reduces new fluid purchases, and dramatically lowers disposal volumes. In an era when sustainability and cost control define competitive advantage, the implications are significant.

VSEP isn't just a laboratory prototype. Over decades of field deployments—from North Dakota to Norway, full-scale systems and pilot units have demonstrated consistent, repeatable performance across some of the toughest drilling muds on the planet. VSEP handles them all, delivering high recovery rates and stable flux while reducing waste and capturing resources that once went straight to disposal.

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The Story of the Matanza–Riachuelo River Cleanup

For generations, the Matanza–Riachuelo River, known simply as *El Riachuelo*, has been a symbol of environmental crisis in Argentina. Stretching 64 kilometers through 14 municipalities and the city of Buenos Aires, its 2,000 km² basin is home to 4.5 million people. Once listed among the ten most polluted places on earth, the river bore the burden of a century of industrial discharge, inadequate sanitation, and waste accumulation.

The river's transformation started not in a government office, but in the neighborhood streets. Local residents, tired of watching their communities struggle with contaminated water and deteriorating living conditions, filed a landmark legal case demanding action. The courts responded with a historic ruling requiring the cleanup of the basin and establishing a new entity: the Matanza–Riachuelo Basin Authority (ACUMAR). This organization brought together the national government, Buenos Aires Province, local municipalities, industries, and civil society groups. For the first time, every stakeholder shared one coordinated mission: restore the river.

El Riachuelo's problems were complex. More than 100 years of unregulated industrial activity had left layers of heavy metals, hydrocarbons, and untreated effluents in the water and sediment. Neighborhoods lacked proper sewage systems. Informal settlements relied on makeshift waste disposal. Infrastructure lagged behind population growth. Cleaning the river required more than removing trash or dredging sediment—it demanded a complete rethinking of how the basin functioned.

The cleanup effort is built around a multi-pronged plan designed to tackle pollution at its source and rebuild the region's environmental health. The strategy includes creating new sewage collection systems. These include large-scale sewer networks connecting underserved neighborhoods and

modern wastewater treatment plants to prevent raw sewage from entering the river. The plan includes expansion of drainage systems to manage stormwater. These upgrades ensure that the pollution entering the river declines dramatically over time. ACUMAR is enforcing stricter environmental rules on factories, including mandatory installation of on-site pretreatment systems and regular monitoring and compliance inspections. Decades of contamination left thick layers of polluted sludge on the riverbed. The plan includes dredging and safe disposal of contaminated sediments and clearing solid waste and restoring riverbanks.

Many families live in areas vulnerable to both pollution and flooding. The project provides new safe housing developments and urban improvements such as paved roads, lighting, and green spaces and better access to sanitation services. The river's revival is far from simple, and full restoration will take years. But for the millions who live along its banks, the effort represents something even more powerful than clean water: a promise that the environment—and the health of their communities matters. And slowly, the Matanza–Riachuelo is becoming not a symbol of neglect, but a story of renewal and hope.

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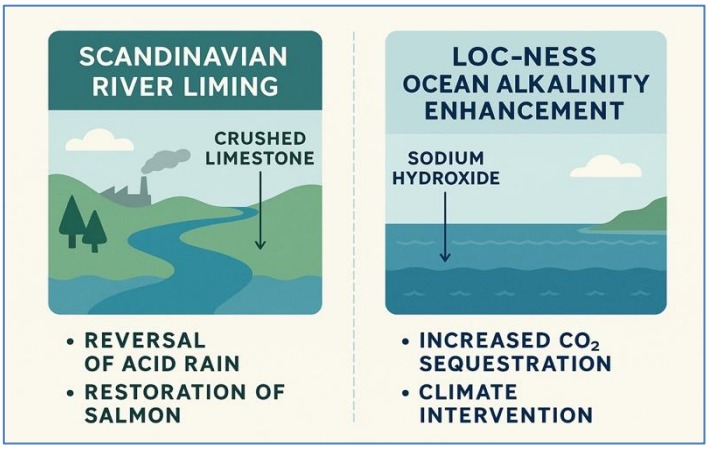
Geoengineering - Salmon Streams to the Open Sea

For decades, scientists in Scandinavia have been quietly rewriting the story of acidified rivers and disappearing salmon. In the late 20th century, much of northern Europe faced a growing ecological crisis. Acid rain, driven by industrial emissions, was sharply lowering the pH of lakes and rivers across Scandinavia. The result was catastrophic for freshwater ecosystems, especially iconic Atlantic salmon populations whose survival hinges on water chemistry. To counter this, scientists and fisheries managers turned to river liming, a practice in which crushed limestone is added to acidified rivers to raise pH and restore acid-neutralizing capacity. This work became one of the region's most successful environmental restoration campaigns.

Research shows that acidification had exterminated or seriously reduced Atlantic salmon populations in 40–45 Norwegian rivers. River liming became essential to restoring these ecosystems. After liming was introduced, scientists observed significant increases in fry and parr densities, and within about a decade, annual salmon catches rose to roughly 45 tons, representing 11–12% of the total salmon catch in Norwegian rivers. The practice is described as having successfully treated the acid rain problem in Scandinavia, with benefits extending to salmon and shellfish populations. The Scandinavian experience became a model of how targeted chemical interventions, applied carefully and monitored long-term, can rehabilitate damaged ecosystems. But this work was restorative, aimed at returning rivers to their natural state, not at transforming them.

Today, off the coast of Massachusetts, scientists from the Woods Hole Oceanographic Institution (WHOI) are exploring a related but far more ambitious idea. Their project is the United States' first federally permitted experiment in ocean alkalinity enhancement (OAE). The purpose is not restorative,



but, a proposed climate intervention that uses chemistry to help the ocean absorb more CO_2. In this experiment, researchers released 65,000 liters of sodium hydroxide, a strongly alkaline solution, into the Gulf of Maine. Tagged with dye to track dispersion, the alkaline plume temporarily raised local seawater pH from 7.95 to 8.3, approximating pre-industrial conditions. Over the five-day field trial, scientists measured up to 10 tons of atmospheric carbon entering the ocean as bicarbonate.

The project's monitoring using gliders, sensors, and underwater vehicles detected no significant short-term harm to plankton, fish, or lobster larvae. While promising, these findings remain preliminary and unreviewed. Unlike Scandinavia's river-liming efforts, this project isn't trying to restore a damaged ecosystem. Instead, it aims to accelerate natural processes to remove atmospheric carbon at large scale. It is, by definition, geoengineering and that distinction matters.

This work raises many questions. Early results show no immediate harm to local marine organisms, but longer-term effects, especially on adult fish and marine mammals, remain unknown. Altering ocean chemistry intentionally may have unforeseen consequences. Companies are already exploring OAE for carbon credit markets, prompting fears that economic incentives may outpace science.

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TVA Reverses on Kingston – Keeps Nine Coal-Fired Units Online

The Kingston Fossil Plant is a 1.4 GW nameplate coal-fired power plant near Kingston, Tennessee. It is operated by the Tennessee Valley Authority (TVA). It was built in 1951 and at the time was the largest coal-fired plants in the world. It was built primarily to provide power for the Oak Ridge National Laboratory. The plant has nine coal powered generating units and consumes five million tons of coal each year. Under pressure from the government, in 2024 it was announced that all nine coal-fired units would be retired in 2027. This plan included bringing new gas, solar, and battery storage power online.

TVA has issued a new Supplemental Environmental Impact Statement (SEIS). This document is intended to address continued operations, changes in energy demand, and regional energy supply. The recent SEIS released by TVA outlines a major shift in the course of action for Kingston. They now expect to keep the nine coal-fired generating units in operation even after new gas power is brought online. Solar was planned but now will be abandoned. This reverses previous planned retirement. The SEIS cites higher-than-anticipated regional power demand as the primary reason for altering the original retirement plan. Contributing factors include Increased data-center electricity usage, regional population growth, and rising employment. These factors caused demand to exceed forecasts used during the original decision.

The SEIS described in recent reporting focuses on TVA's revised preferred alternative for the Kingston Fossil Plant — specifically, whether to retire or continue operating its coal-fired units. However, none of these SEIS summaries include discussion of ELG (Effluent Limit Guidelines) compliance strategies, upgrades to NPDES-regulated wastewater systems. The most recent published ELG update (2024 progress report) assumes retirement of the coal units, stating TVA is not planning additional upgrades to FGD or BATW systems because the plant was scheduled to cease coal combustion. This means TVA has not yet re-issued updated plans reflecting the new possibility of continued coal operations.

While not specific to the new SEIS scenario, prior ELG/NPDES compliance documentation indicates that Kingston would still be required to meet the EPA's 2024 updated ELG rule. If TVA officially keeps the coal units running, it will eventually need to issue updated wastewater-treatment plans to comply with the ELG rule — but it has not done so yet.

TVA will need to prepare a plan for meeting the 2024 EPA ELGs for flue gas scrubber water treatment. Given the history with ash ponds there, the plan should also include handling of CCRs and effluents generated from that. Coal is an abundant and inexpensive fuel source. The reason many are against coal fired power plants is because, unlike other fuel sources, combustion gases from coal require scrubbing to remove sulfur. This generates a wastewater that if not treated properly can pose a danger to the environment. However, this fear is unwarranted. Advancements in wastewater treatment allow for treated water that is ultrapure. Advanced RO membrane filtration such as the VSEP system has been used for more than a decade at full-scale in power plants and can remove mercury, arsenic, sulfur, selenium.

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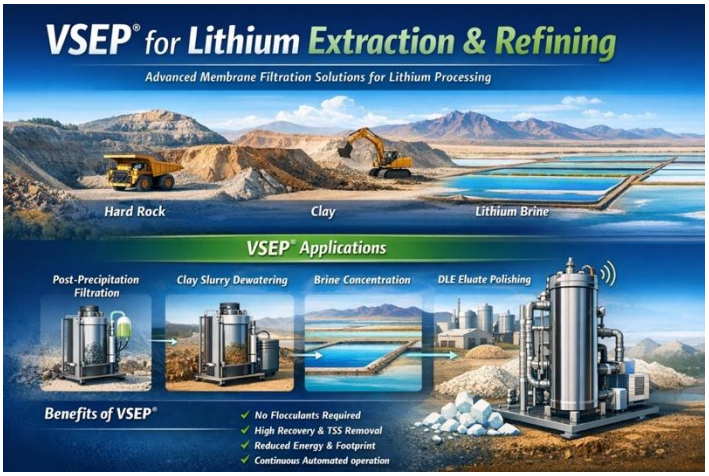
VSEP Membrane-Assisted DLE

As the lithium industry races to meet surging global demand, Direct Lithium Extraction (DLE) technologies are reshaping how brine resources are processed. Traditional evaporation ponds can take more than a year to produce concentrated lithium brine and require immense land area and favorable climate conditions. In contrast, DLE systems based on adsorption and ion exchange (IX) recover lithium directly and selectively, producing purified lithium solutions within hours rather than months. These advanced systems operate effectively even on complex brines containing high concentrations of sodium, potassium, magnesium, and calcium.

Adsorption-based DLE relies on selective materials such as ceramic, spinel, or manganese-oxide sorbents. These are engineered to bind lithium ions more strongly than competing cations. Lithium attaches to the sorbent surface during the loading phase and is later released using a water rinse or mild chemical wash, completing a repeating cycle of adsorption, washing, desorption, and regeneration. These materials exploit lithium's small ionic size and unusually high hydration energy to achieve high selectivity and often deliver recovery rates greater than ninety percent.

Ion-exchange DLE operates on a similar principle but uses engineered MnO_3 or TiO_3 based lattices containing exchangeable cation sites. These structures, supported in polymer matrices, offer well-defined selectivity coefficients that strongly favor lithium over other ions in the brine. During operation, Li^+ exchanges with H^+ or Na^+ bound to the media, and the resin is regenerated with an acidic solution to produce a lithium-rich eluate. This acidic eluate then undergoes neutralization and impurity removal steps because even highly selective media release residual sodium, potassium, magnesium, and calcium during regeneration. The need for this polishing is highlighted in standard DLE



flowsheets, which show pH adjustment and impurity removal as an essential post-regeneration sequence.

Despite their strengths, both adsorption and IX systems are highly sensitive to feed quality. Suspended solids, colloids, organics, and trace hydrocarbons can rapidly foul sorbents and IX beds, shortening media life and reducing extraction efficiency. The International Lithium Association underscores that brine chemistry and pretreatment are critical determinants of DLE performance and reliability. This is one of the key reasons that membranes, particularly high-shear systems such as VSEP, have become an essential complement to IX- and adsorption-based DLE.

Membranes stabilize DLE feeds by removing solids and contaminants that would otherwise plug extraction media. Unlike conventional spiral-wound membranes, which struggle with fouling and scaling under high-TDS conditions, VSEP applies vibratory shear at the membrane surface. This shear suppresses cake formation and concentration polarization, enabling continuous operation on brines containing high suspended solids or difficult colloidal loads. In a DLE context, VSEP ultrafiltration can remove clay fines, silica, organic material, and oil droplets before the brine ever reaches the

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adsorption column or IX bed, protecting the selective media and helping maintain consistent lithium-loading performance.

Once lithium is extracted from the media and transferred into the eluate, membranes re-enter the flowsheet as precision polishing and concentration tools. After neutralization, nanofiltration removes multivalent cations such as Mg^{2+} and Ca^{2+} that interfere with lithium-carbonate or lithium-hydroxide conversion. This selective rejection step is well documented in membrane-assisted DLE flowsheets and is often required to achieve the impurity specifications needed for battery-grade products. VSEP reverse osmosis concentration steps then increase the lithium concentration of the eluate, reducing the thermal load on evaporators and crystallizers. VSEP's high-shear allows these RO and NF steps to operate at higher recoveries and with greater resistance to fouling than conventional membrane systems, significantly improving OPEX, process reliability, and reducing the thermal load.

Collectively, this integration of membranes with IX and adsorption technologies creates a robust, modular, and scalable processing platform. Membranes ensure clean, stable brine quality prior to DLE, while NF and RO enable the polishing and concentration required to prepare the lithium-rich eluate for final refining. With brine compositions becoming increasingly variable across geothermal, oilfield, and low-grade sources, membrane-assisted DLE is emerging as one of the most resilient solutions available for high-purity lithium production.

If the next decade of lithium supply will depend on flexible, selective, and environmentally efficient extraction technologies, then the combination of adsorption or ion-exchange DLE with VSEP membrane pretreatment and post-extraction concentration is poised to play a central role in meeting that demand - reliably, efficiently, and at industrial scale.

Thank you for subscribing to our newsletter. I hope you find it informational and fun. You are one of 3,200 professionals and industry stakeholders who receive this newsletter each month.

About the newsletter author:

Greg Johnson is CEO of New Logic Research and is responsible for the development of VSEP technology since 1992. gjohnson@vsep.com

New Logic Research, Inc.
2527 Aviation Way
Minden, NV 89423 USA
775-783-7600
www.vsep.com
info@vsep.com

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