Reusing Irrigation Return Flow Water in Nursery Production: Opportunities and Considerations in Utah

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Contents

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Summary

Nursery operations in Utah rely mainly on municipal water for irrigation and often excessively irrigate to maintain plant health and productivity. Overhead irrigation systems commonly used in container nurseries generate substantial irrigation return flow (IRF), which is the portion of applied water that is not absorbed by plants or soil and flows off from the production site. This runoff often contains nutrients, sediments, and agrochemicals that can degrade water quality in downstream ecosystems, contributing to issues such as harmful algal blooms. At the same time, Utah's arid climate, variable snowpack, rapid population growth, and rising municipal water costs make efficient water use increasingly critical. Capturing and reusing IRF offers nurseries a practical strategy to conserve freshwater, reduce pollution, and improve water use efficiency.

This manual provides growers with step-by-step guidance for designing and implementing IRF reuse systems, including permitting requirements, drainage and storage infrastructure, filtration and treatment options, monitoring protocols, and integration with existing irrigation systems. Case studies from Utah nurseries demonstrate that reused water can be safely applied without reducing plant quality and can even offset fertilizer costs due to residual nutrients. By adopting these practices, Utah nurseries can reduce operational expenses, lessen environmental impacts, and strengthen long-term resilience.

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1. Overview: The need for water reuse in Utah nurseries

Irrigation return flow (IRF) refers to the portion of water applied during irrigation that is not absorbed by plants or soil and subsequently returns to water bodies or groundwater. In nursery production, especially in operations that rely on overhead irrigation, runoff can be substantial, with some systems losing up to 75% of applied water (Mathers et al., 2005). Meanwhile, only 13 to 26 percent of irrigation water may be retained in containers depending on spacing, substrate, and irrigation methods (Weatherspoon and Harrell, 1980). However, the amount of runoff can vary widely depending on factors such as soil type, slope, vegetation cover, and irrigation system design. Nursery IRF often carries nutrients, sediments, salts, pesticides, and herbicides, all of which can enter nearby waterways and contribute to nonpoint source pollution (Poudyal and Cregg 2019). Because IRF originates from fertilized and chemically managed production areas, it can degrade downstream water quality and create conditions that favor eutrophication, algal blooms, and ecological disruption (Dupont et al., 2020).

Utah has already experienced harmful algal bloom events linked to nutrient-rich runoff, highlighting the importance of preventing additional contaminant inputs to local watersheds. Utah Lake frequently experiences blooms driven by elevated phosphorus levels (Randall et al., 2019). Panguitch Lake faced closures in 2018 and again in 2023 due to toxic algae fueled by nutrient-laden runoff combined with warm temperatures and low water levels (Cortright GGV 2023). Yuba Lake experienced similar harmful blooms in 2023. These events illustrate how unmanaged IRF, including IRF nurseries, could worsen existing water quality challenges in Utah's lakes and rivers.

Given the significant runoff produced by overhead irrigation and the potential contaminants carried by IRF, finding sustainable strategies to manage and reuse this water is crucial. Utah's harsh and unpredictable climate, combined with it being one of the driest states in the nation, makes water reuse not just beneficial but necessary. With approximately 95% of the state's water supply originating from mountain snowpack, preparing for dry years is critical. As of March 9th, 2026, Utah's snowpack is near a record low, with 30% of weather stations tracking the lowest or second lowest reading (Brenner 2026). These conditions highlight the growing importance of reusing IRF water to support nursery production in Utah.

Nurseries rely heavily on irrigation for plant growth, and maintaining a sustainable, consistent water supply is fundamental. Reusing IRF offers a cost-effective solution, particularly as municipal water rates continue to rise. Reuse reduces freshwater demand, thereby easing the need for costly water treatment, and helps mitigate detrimental effect of IRF entering local watersheds (Poudyal et al. 2019). In addition to conserving water, reusing IRF water supports sustainable agriculture by improving water efficiency, reducing waste, and lowering reliance on freshwater sources (Poudyal et al. 2019). Through filtration and treatment, nurseries can safely reuse water across multiple irrigation cycles, conserving resources while supporting Utah's long-term water conservation goals (Majsztrik et al. 2017).

2. How to get started on reusing water in nursery production

a. Getting a permit for water reuse

In Utah, collecting and storing up to 2,500 gallons of rainwater is allowed without the need for a formal permit; however, registration with the Utah Division of Water Rights is required. This free registration can be completed online at https://waterrights.utah.gov/forms/rainwater.asp. For any collection system exceeding 2,500 gallons, the Wastewater Reuse Act (Utah Code 73-3c) outlines the permitting process. Such projects must first be approved by the State Engineer and then the Director of the Division of Water Quality. Water reuse applications in Utah primarily include large-scale agricultural or landscape projects that require significant volumes of water. However, many nurseries in Utah would typically only need a permit for a lesser amount of water compared to agricultural or large landscape projects. In most cases, nursery operations would fall under 'onsite collected water' as a water source and 'onsite non-potable water reuse' as a permit category; therefore, the permit process can be faster than a typical water reuse project involving water rights. For assistance, contact the State Engineers at https://deq.utah.gov/water-quality/division-of-water-quality-contacts. Depending on the project's scope, additional permits from local authorities may be required to ensure compliance with regional water management plans.

Irrigation return flow from agricultural and nursery operations often contains elevated levels of nutrients and pesticides that exceed allowable discharge limits set by environmental regulations. Nitrogen, typically found as nitrate (NO_3^-) or ammonium (NH_4^+), can range from 10 to 50 mg/L, often surpassing the EPA's drinking water standard of 10 mg/L for nitrates.

Phosphorus, commonly present as phosphate (PO_4^{3-}), ranges from 0.1 to 2 mg/L, exceeding the EPA's recommended limit of 0.1 mg/L. Pesticide concentrations vary but can exceed EPA aquatic life criteria, which range from 0.001 to 1.0 µg/L for certain compounds (Poudyal and Cregg 2019). By capturing and reusing IRF, nurseries can significantly reduce pollutant discharge, ensuring compliance with EPA and Clean Water Act regulations while enhancing sustainability.

b. Installing water reuse infrastructure to collect irrigation return flow

A well-designed collection system is essential for capturing IRF and reducing water loss. According to Yeager et al. (1997), a well-planned system can recover up to 90% of applied irrigation water. The water capture and reuse design should reflect the nursery's water use and irrigation water needs. Shallow basins are effective for containing IRF and reusing it in the shorter term, while deep storage ponds offer long-term storage. Factors such as slope, production surface, production area, irrigation amount, and irrigation method can all affect runoff quantity and determine storage requirements. Nurseries can consult the USDA NRCS for guidance tailored to their site or contact the USU GLOW team at shital.poudyal@usu.edu

Water reuse systems such as catchment basins and tanks are increasingly adopted by nursery and greenhouse growers. Warner et al. (2018) reported that 75% of growers who implemented water reuse technologies continued their use, despite high initial costs for drainage and earthworks infrastructure. To effectively collect runoff, nurseries can shape production areas with gentle slopes that direct water to designated collection zones. French drains, gravel-filled trenches containing perforated pipes, can be installed alongside beds to guide water into underground piping systems. These systems then transport the IRF to storage tanks or retention ponds, enabling efficient reuse and minimizing off-site runoff.

Another effective approach is installing a network of channels or ditches around production areas to divert runoff into lined retention basins (Wilson & Broembsen, 2017). From there, the collected water can be pumped directly back into the irrigation system or transferred to additional storage. For small-scale nurseries or garden centers, storage systems such as concrete tanks or small basins can also be used (Wilson & Broembsen, 2017). In addition, installing liners beneath nursery beds helps prevent infiltration, protects groundwater and increases IRF collection (Wilson & Broembsen, 2017). Integrated capture-and-reuse system not only conserves water and reduces irrigation costs but also minimizes environmental impact and enhances the public perception of nursery operations as environmentally responsible (Wilson & Broembsen, 2017).

c. Irrigation return flow collection systems

Nurseries and greenhouses often utilize water collection systems to capture and store IRF for reuse. Common storage options include above-ground tanks, in-ground tanks, and retention ponds, each with unique advantages, limitations, and cost considerations. Above-ground storage tanks are one of the most practical and cost-effective solutions (Figure 1). A typical 1,000-gallon tank installation costs around $1,700 in 2024, approximately $800 for the tank itself, with the remainder covering site preparation, delivery, and setup (Sansano 2025). Installation involves preparing a flat, level site, removing rocks, and placing a layer of compacted sand or pea gravel as a foundation before setting the tank in place. Detailed installation instructions can be found at the tank manufacturer's website. Although tanks can be easy to install, they require a level ground, and can also be visually unappealing. Above-ground storage tanks are also exposed to sunlight and temperature fluctuations, and depending on shape and size, are difficult to clean and maintain. Clear or white tanks may promote algae growth, whereas black tanks may increase water temperature.

In contrast, ground storage tanks provide a more discreet and well-insulated option as the surrounding soil maintains a stable, cooler temperature and prevents some sunlight exposure, reducing harmful algal bloom (Fitch and Gillespie 2017). However, in-ground systems are more expensive (ranging from $2 to $9 per gallon). Installation requires excavation of a hole larger than the tank, preparation of a compacted base, and careful backfilling to avoid shifting. Detailed installation instructions can be found on the tank manufacturer's website.

For larger-scale water storage and stormwater management, bigger retention ponds are commonly used (Figure 1). These systems involve selecting a suitable site, excavating to a depth of 4 to 5 feet or more, shaping the basin, and installing inlet and outlet structures to regulate water flow. According to the U.S. Environmental Protection Agency, construction costs typically range from $1,000 to $3,000 per acre of drainage area (in 2024), depending on land value and site conditions. A key risk for retention ponds is harmful algal blooms, which are fueled by nutrient-rich runoff containing nitrogen and phosphorus. The United States Department of

Figure 1: Retention pond (left) and above ground storge tank (right) to collect Irrigation return flow in nusery.

Agriculture provides detailed construction guidance in its publication Ponds Planning, Design, Construction, which may be a useful resource for growers planning to install these systems.

d. Strategies to minimize algal bloom and biofilm formation

Algae and biofilm buildup in IRF collection systems can clog pipes, reduce water flow, and introduce harmful pathogens. Effective strategies to prevent these issues include:

- Reducing nutrient levels in IRF water by only applying the recommended amount of nutrients and diluting the nutrients in the collection system.
- Using black or opaque tanks and reducing sunlight in retention ponds.
- Implementing aeration in holding ponds to disrupt algae growth.
- Flushing irrigation lines regularly to prevent sediment and biofilm accumulation.
- Applying algaecides or biological controls when necessary, ensuring compliance with environmental regulations

By incorporating these practices, nurseries can maintain high water quality, reduce system downtime, and promote sustainable water reuse.

e. Water treatment and monitoring system installation

Fertilizer and pesticide residues in IRF are generally not a major concern for crop health, as they are typically present at low concentrations due to plant uptake and natural degradation processes. The primary issue with recycled irrigation water tends to stem from the accumulation of salts, particularly from fertilizers and pathogens. Salt in reused water can be effectively managed by frequent or continuous monitoring of electrical conductivity (EC) levels and implementing periodic dilution practices when the EC is higher. Although pesticide residues are rarely found at harmful levels, advanced membrane filtration technologies such as ultrafiltration and reverse osmosis have been shown to effectively remove pesticides and herbicides from runoff when needed, ensuring safe water reuse in nursery and greenhouse operations (Fisher, 2009).

Pathogens are a significant concern in recycled irrigation systems. Waterborne pathogens such as *Pythium, Phytophthora*, and *Fusariu*m species can easily spread through recirculated water, infecting a larger number of plants. These organisms thrive in moist conditions and can produce swimming spores (zoospores) that are efficiently transmitted in water. Once established, pathogens can persist in biofilms, plant debris, and greenhouse infrastructure, making them difficult to eradicate without effective water treatment and sanitation (Fisher 2009). A variety of treatment strategies are available to manage waterborne pathogens, depending on the system's needs and available resources, as explained in Table 1.

Table 1. Water treatment strategies

Treatment Method	**How It Works**	**When to Apply**
Filtration	Removes debris and organic matter; Essential pre-treatment for all other methods.	Before collecting IRF in the storage
Chlorination	Controls pathogens by oxidation; most effective at pH 6 - 7.5.	After IRF is collected in storage
Chlorine Dioxide	Strong oxidizer, effective at removing biofilm; effective at low concentrations; shock or continuous use possible.	After IRF is collected in storage
Ozone	Oxidizes cell walls, removes biofilm; high initial cost, low operating cost; short residual activity.	After IRF is collected in storage

UV light	Disrupts the genetic material in the cell; IRF should have low turbidity; no residual effect.	After IRF is collected in storage
Copper ionization	Copper ions disrupt cell walls to kill pathogens; residual effect is present; less effective if pH of the water is > 7.5.	After IRF is collected in storage
Peracids	Oxidizes cell membranes to kill pathogens; effective over a wide range of pH range.	After IRF is collected in storage
Heat treatment	Kills pathogens by subjecting them to higher temperature; expensive; no residual effect; cooling required	After IRF is collected in storage

f. Testing irrigation return flow water quality

In addition to treatment, regular water quality monitoring is essential to ensure that IRF water remains safe for reuse in nursery production. Testing should assess multiple parameters, including pH, EC, turbidity, dissolved oxygen, nutrients, pathogens, and chemical residues. Automated systems such as Bluelab Guardian, Hanna Groline, and Netafim NMC Pro are capable of continuously monitoring key metrics like EC and pH, alerting growers if values drift outside of acceptable ranges. The Environmental Protection Agency and the Utah Division of Water Quality recommend periodic testing based on water source variability and system design (Utah Division of Water Quality, 2025). Key testing recommendations include:

- Conducting baseline water quality assessments for pH, EC, turbidity, dissolved oxygen, and nutrients before implementing reuse systems.
- Frequent or continuous monitoring of IRF water quality for pH, EC and dissolved oxygen
- Routine testing (monthly or quarterly) for nutrients (nitrogen, phosphorus), pesticides, and heavy metals.
- Implementing corrective measures if contaminants exceed recommended thresholds.

a. Connecting the irrigation return flow storage unit to the irrigation lines

As shown in Figure 2, connecting collected water to irrigation systems typically involves drawing water from a storage tank or retention basin, passing it through a filter to remove debris, and using a pump to deliver it into the main irrigation line. From there, the water should be distributed through drip emitters or sprinklers as a part of the existing irrigation system. This setup supports efficient and safe reuse of IRF. Pressure boosting pumps or pressure regulators may be required to maintain the desired pressure in the irrigation lines.

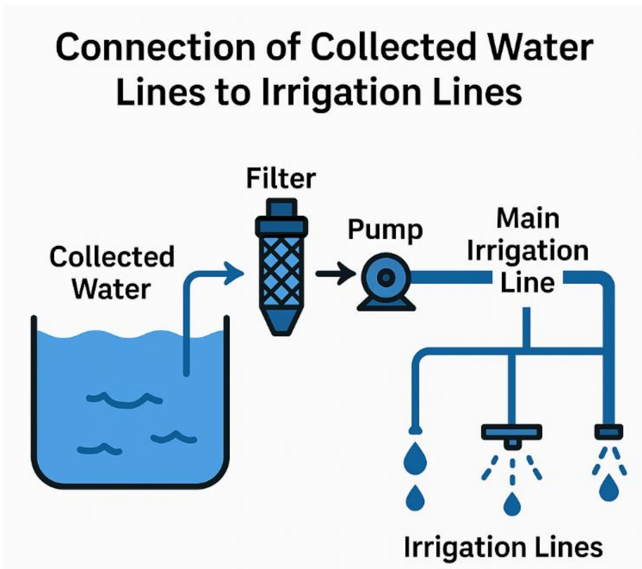

Figure 2: Connection of collected irrigation return flow to irrigation lines in a nursery reuse system.

3. Benefits of Reusing Irrigation Return Flow Water

Implementing an IRF water reuse system in nursery operations provides numerous advantages, ranging from economic savings to environmental sustainability.

a. Cost savings on water procurement and fertilizers

Water reuse lowers the demand for freshwater for irrigation, increases the water resiliency of nursery operation and lowers production expenses. In Utah, where water rates are rising and freshwater availability is declining, implementing water reuse can offer substantial long-term financial benefits. A case study by Pitton et al. (2018) at a Southern California nursery analyzed the cost benefits of using recycled irrigation runoff water. Before system implementation, the nursery relied mostly on municipal water, which cost $2.2 - $2.9 per 1,000 gallons. In contrast, the cost of recycled water ranged from $0.92 - $1.21 per gallon without subsidies, and $0.43-$0.53 per 1,000 gallons with NRCS grants and rebates. As a result, the nursery saved $235,769 in 2015 and $384,465 in 2016.

In addition to water cost savings, IRF also contains residual nutrients that can offset fertilizer needs. Research at Michigan State University and multiple other locations have found that IRF often has measurable amounts of nitrogen, phosphorus, and potassium, allowing producers to recover some additional value from water reuse. Nutrient concentrations ranged from 8.3 to 21.7 $mg \cdot L^{-1}$ for nitrogen and 1.4 to 8.3 $mg \cdot L^{-1}$ for phosphorus (Taylor et al. 2006; White et al. 2006 & 2007). These findings suggest that reused water can partially replace fresh fertilizer inputs in nursery systems.

b. Enhanced water-use efficiency in nursery operations

By capturing and reusing IRF, nurseries can maximize water-use efficiency mainly by extending the life of the same water. This practice allows growers to irrigate with the same water multiple times, reducing overall consumption while still maintaining optimal moisture levels for plant growth. Studies show that water reuse systems in nurseries can improve irrigation efficiency by minimizing losses due to runoff (Dupont et al. 2020).

c. *Reduced* e*nvironmental Impact*

Unmanaged and uncontained IRF can contaminate the watershed and waterways (Majsztrik et al. 2017). Reusing IRF can minimize these environmental risks by limiting IRF from reaching surrounding ecosystems. By implementing proper filtration and treatment strategies, captured water can be safely used to irrigate plants, which can both limit pollution and conserve freshwater (Broembsen and Wilson 2017; Utah Division of Water Resources, 2025).

d. Improved sustainability credentials for nurseries

Water reuse is increasingly viewed as a best practice in sustainable nursery management. Water reuse practices demonstrate environmental responsibility and resource conservation, which can enhance a nursery's reputation. These practices can earn customers goodwill and increase revenue by qualifying for financial incentives tied to environmental stewardship.

4. **Best Practices and Recommendations**

The easy, effective and best way to conserve water is by avoiding over irrigation and the best way to minimize the movement of nutrients and pesticides from nursery production areas is by sensible agrochemical application. Properly designed and well-maintained irrigation systems can reduce IRF and the export of contaminants from the container production site. Practices such as using micro-irrigation where feasible, adopting sensor-based scheduling, and optimizing overhead systems through uniformity checks help ensure that water is applied only when and where crops need it. Strategic site design, including gentle slopes, gravel pads, and vegetated buffer areas, enhances drainage and directs runoff to collection zones instead of surrounding landscapes. These practices not only reduce the volume of IRF generated but also lower the concentrations of agrichemicals that leave the production area.

Once runoff has been captured, growers may integrate filtration and treatment technologies to safeguard water quality before reuse, depending on the IRF water quality. Filtration systems such as regular self-cleaning filters, rapid sand filters and slow sand filters remove suspended solids, while treatment options such as chlorine, ultraviolet light, ozone, or peroxides target pathogens and biological contaminants (Majsztrik et al., 2017). Ecological systems, including vegetated buffer strips, constructed wetlands, and denitrification bioreactors, provide additional removal of nutrients and pesticides and can be scaled to match operation size (Majsztrik et al., 2017). Combining multiple technologies in a treatment train improves the reliability of contaminant removal and reduces grower concerns related to phytotoxicity, pathogen spread, and equipment clogging. When paired with efficient irrigation practices, these treatment strategies enable nurseries to safely reuse water, reduce dependence on freshwater supplies, and minimize environmental impacts while strengthening long-term resilience.

5. **Case Studies and Examples**

Multiple water reuse programs are implemented across Utah, as mentioned by the Utah Division of Water Resources (2005). Communities across the state have integrated reclaimed water into both agricultural and municipal systems. Early reuse efforts were primarily agricultural, such as the Heber Valley Special Service District, which supplied treated effluent to irrigate alfalfa as part of a zero-discharge strategy, and the Ash Creek Special Service District, which supplied reused water to irrigate agronomic crops. Similar agricultural reuse operates in Cedar City, Roosevelt, Francis, and Santaquin, which support pasture or alfalfa irrigation to reduce reliance on freshwater supplies. Implementing water reuse has proven beneficial in various contexts, offering valuable insights for nursery producers. Below are notable case studies and practical lessons learned.

a. Progressive plants water reuse trial, Copperton, UT

In 2024, Progressive Plants, a commercial nursery in Copperton, Utah, conducted a grower-led case study to evaluate the use of runoff water for irrigation. The trial showed that reused water containing agrochemical residues did not negatively impact plant growth or the visual quality of dogwood, spirea, or hydrangea. In fact, the hydrangea exhibited improved visual appeal with reused water. This study demonstrated that runoff collection and reuse are feasible and safe practices in nursery operations in Utah.

b. Washington County's water reuse initiative, Washington, UT

In 2024, Washington County, Utah, secured federal funding to develop a water reuse project aimed at addressing water scarcity. This initiative focused on treating and repurposing wastewater for non-potable applications, such as irrigation and industrial processes, thereby conserving potable water resources.

c. Magna Water District's Reuse Program, Magna, UT

The Magna Water District in Utah has implemented a water reuse program that treats secondary effluent for irrigation purposes. This approach not only conserves freshwater but also provides a reliable water source for landscaping and agricultural needs.

d. Statewide Reuse Applications in Utah

Utah has seen numerous water reuse applications across various counties, highlighting a growing trend towards sustainable water management in the state.

6. **Practical Insights for Nursery Producers Planning to Reuse Water**

- *Assess Water Quality*: Regular monitoring of IRF water is essential to identify contaminants and determine the necessary treatment levels before reuse.
- *Invest in Appropriate Treatment Systems*: Selecting suitable filtration and disinfection technologies ensures that reused water meets safety standards for irrigation.
- *Understand Regulatory Requirements*: Compliance with state and federal regulations is crucial. Engaging with local water authorities can facilitate the permitting process and ensure adherence to legal standards.

- *Engage Stakeholders*: Collaborating with local communities, customers, and regulatory bodies fosters transparency and may provide financial and moral support for water reuse initiatives.
- *Monitor and Adapt*: Continuous evaluation of the water reuse system's performance allows for timely adjustments and improvements, ensuring long-term success.

By examining these case studies and applying the lessons learned, nursery producers can effectively implement IRF reuse practices, promoting sustainability and operational efficiency.

7. Water Reuse in Nurseries and the Great Salt Lake

As already stated, nursery operations use substantial amounts of fertilizers, pesticides, herbicides, and other agrochemicals as part of routine plant production, generating agrochemical-laden IRF. Allowing nursery IRF to enter regional waterways, including the Great Salt Lake watershed, would degrade water quality and contribute to nutrient loading in an already sensitive and declining terminal lake system. The Great Salt Lake cannot flush contaminants through the outflow, so any additional agrochemical runoff from nurseries would accumulate and further stress the lake ecology. Nurseries represent a small fraction of total water users in Utah, and therefore, IRF from nurseries already has minimal impact on increasing the lake's overall water level; however, if allowed to reach the Great Salt Lake, they can have disproportionate water-quality impacts.

Nurseries in Utah mainly rely on municipal water for irrigation; reusing IRF significantly extends the useful life of that treated water. This practice reduces the volume of polluted water IRF reaching waterways and simultaneously lowers the demand for costly municipal water supplies. By cycling water multiple times within the nursery, growers reduce their operational costs and ease the burden on expensive regional water-treatment and stormwater-management infrastructure. Importantly, water that ultimately flows to the Great Salt Lake should not be laden with agrochemicals. Therefore, keeping nutrient and pesticide-laden IRF on-site prevents the export of contaminants to a terminal ecosystem that cannot dilute or process them efficiently. Therefore, nursery water reuse supports better environmental stewardship, protects water quality, and strengthens Utah's long-term water resilience.

8. Conclusion

Reusing irrigation return flow (IRF) water offers Utah nurseries a practical, science-based strategy to conserve freshwater, reduce pollution, and enhance long-term operational resilience. As water scarcity intensifies statewide due to declining snowpack, growing municipal demand, and increasing water costs, IRF reuse transforms an often-overlooked waste stream into a valuable, dependable resource. By capturing runoff, installing appropriate storage and treatment systems, and monitoring water quality, nurseries can safely reuse irrigation water multiple times without compromising plant health or production efficiency. Case studies from Utah and beyond show that IRF reuse not only reduces water purchasing costs but also recovers nutrients, lowers fertilizer expenses, and minimizes the movement of nitrogen, phosphorus, pesticides, and sediments into sensitive watersheds. For Utah's terminal systems, such as the Great Salt Lake, mitigating nutrient-laden runoff is especially critical for protecting ecological function and water quality. Ultimately, IRF reuse positions nursery operations as leaders in sustainable water management, demonstrating stewardship, improving environmental outcomes, and strengthening the resilience of Utah's green industry for decades to come.

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