



OVER 30 YEARS OF WASTEWATER DRIP DISPERSAL

1993-2026

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ABSTRACT:

This paper is a review of the applied sciences of onsite wastewater as they relate to Drip Distribution and related research papers affirming the application of drip technology in soils for Advanced treatment and Nutrient removal. Authors such as Dick Otis, Bob Rubin, Jim Converse, John Buchannan, Bob Siegrist, Jerry Tyler and many other notable researchers have evaluated drip distribution and added their expertise in a variety of subject matters to enhance the industries understanding of the effectiveness of wastewater drip technology. Research results showing enhance treatment and nutrient removal significantly better than traditional technologies are presented. Mathematical models that have been developed to predict treatment and nutrient removal levels are also presented.



WASTEWATER DRIP DEVELOPMENT

Wastewater Drip dispersal was first introduced to a broad audience of practitioners during training at the North Carolina State Extension "Operators training school" in the early 1990's. Tom Sinclair of "Wastewater Systems Inc.", of Georgia got the interest of Dr. Bob Rubin, of NC State and soon of Dr. Dick Otis, an EPA consultant.

Dick Otis of Ayers Associates as a consultant to the EPA did research on the sustainability of onsite wastewater systems. In his early 1990's paper, titled "Soil Clogging: Mechanisms and Control", covering a review of 25 referenced papers ranging from the year 1947 to 1984, came up with 11 notable recommendations;

1. Well drained, deep soils are preferred, low permeability, stratified, high water table soils should be avoided.
2. Shallow narrow trenched are preferred.
3. Water application should be intermittent and uniform.
4. Annual resting for a period of six months will extend life.
5. Minimize smearing, compaction and site disturbance.
6. Promote aeration of soil.
7. More evaluation of loading rates are necessary.
8. Effects of temperature need more evaluation
9. Soil stabilization agents need investigation.
10. Treatment through soil cannot be overlooked. More study needed.
11. Codes and regulation need to be more flexible.

Dr. Otis outlined both the best practices we knew and the areas that need more research. Long narrow trenches, shallow installations, aeration and the uniform, intermittent application of wastewater on soil predicted the benefits of drip distribution used in wastewater application.



- Zone where rapid biochemical transformations take place
- Microorganisms create new biomass in response to wastewater loadings
- Biomass fills soil pores to reduce infiltration and reaeration

In 1993 hosted, by Netafim USA the largest drip irrigation pipe manufacturer in the world, a group of 25 professionals who went to Israel to try to fill in the blanks. Sinclair and Netafim invited people from the Mid-Atlantic region and other selected are as including Dr. Rubin, Dick Otis plus mixture of regulators, engineers, developers, and interested parties. The group found that the Israel's "know how" to irrigate and distribute waster could not answer the question, "How much wastewater could you get through a particular soil?" The typical answer was, "as much as you want, as much as you need". This answer was not suitable for regions like the Mid-Atlantic.



Sinclair developed a system package called "Perc-Rite®" and received patent number 5,200,065 and approvals in Georgia and North Carolina. From then until now there has been two major drip tubing manufacturers competing for the US market, "GeoFlow" and "Netafim". Neither tubing manufacturers assemble complete equipment packages to handle wastewater applications to make their tubing sustainable, so Sinclair and others packaged and sold the necessary equipment and started soliciting state approvals. Sinclair licensed American Manufacturing Company, Inc. of Virginia to manufacture under the "065" patent in 1993.

Upon returning to the US, Dr. Rubin and Dick Otis determined that a better understanding of appropriate Loading rates for use in drip applications was needed. Rubin and Otis, facilitated by Tom Sinclair, dug up many systems in Georgia for evaluation. The results of this evaluation were presented in a report to Sinclair in 1994, "Evaluation of Hydraulic Loading Criteria for the "Perc-Rite®" Subsurface Drip Irrigations Systems". Otis suggested that in general those installations dispersing septic effluent should be time dosed with tubing installed 2' on center with an emitter every 4 sq. ft. and loaded somewhat equal to current drain field practices, should provide the best possibility of long-term sustainability. He equated a given length of tubing would be equivalent to a given sq. ft. of trench. He also determined that due to the small uniform dosing there is rapid reaeration,



American Manufacturing followed Sinclair's approvals for residential application with a proprietary approval in North Carolina in 1993 and a Waiver of experimental in Virginia in 1995. The Virginia waiver was achieved after demonstrating the technology in a multitude of successful repairs throughout the State. These early state approvals got the attention of academics in the industry and NOWRA, the "National Onsite Wastewater Recycling Association" (www.NOWRA.org). American, Geoflow, and Netafim were the manufacturers promoting the use of drip technology in wastewater to the states and most approvals reflect one or all of these manufactures. To date some states have approached approving the technology as a generic engineering standard. After drip became well accepted many of the ATU manufacturers supplied drip components in an effort to support their treatment unit sales.

In 1999, under the guidance of Otis and other professionals schooled in the art, NOWRA took the step to sponsor several "Drip Summits". Manufacturers and industry professional together reviewed the state of the art and developed a Drip standard that was adopted by NOWRA in 2005, (NOWRA.ORG) "Recommended Guidance for the Design of Wastewater Drip Dispersal Systems". This multi-year process produced the first consensus document that defined key elements for successful design, installation and operation of a drip system. The NOWRA Drip Summits brought a wide range of professionals together to develop consensus understanding of how drip works and best design practices for the technology. Participating practitioners agreed that elements similar to what are in the existing plumbing code should be included when specifying drip, such as manufacturers certifying tubing to be usable in wastewater as with all other components. Academics taught basics of soils to wastewater engineers uneducated in the discipline such as water movement in soils;

Water moves in soils:

- from wet to dry
- from large voids to small voids
- in all directions in unsaturated soils
- downward by gravity in saturated soils.

This understanding is important since the early research on drain field always worked with a two dimensional gravel-soil interface. With Drip, the tubing is installed directly in the soil so the water will move in all directions. This is what makes drip so much different than other pressure distribution technologies.



Water movement through soil was demonstrated by Hepner: ASABE Publication Date 20 October 2007. L.D. Hepner, D. Linde, C. Weber, D. Smith. "Reduction of Bacteriologic and Chemical Constituents of Septic Tank Effluent with Depth using a Drip Dispersal System."

SUPPORTING RESEARCH

Many academics throughout the nation spent time researching many different elements of how the drip technology was useful in wastewater applications. The following are supporting research;

1994 – Duncan, C.S, R.B Reneau, Jr., Hagedorn 1994, Impact of effluent quality and soil depth on renovation of domestic wastewater in onsite wastewater treatment Proc. Of the Seventh National Symposium on Individual and Small Community Sewage Systems. ASAE, St Joseph, Mi pp219-228. This study supports the contention that treated effluent can be loaded on soil at a higher rate than septic effluent. The significant element of this study is that soil columns were dosed 6 times a day and showed that less than 1' of soil provided suitable treatment. This dosing regime, however, can only be achieved with drip technology.

2000 – Larry Hepner 1997-1999, Delaware Valley College, in-situ study of 6 technologies for on-lot systems. "New Wastewater Technologies for Pennsylvania", On-Lot Systems and Small Flows. Technology E provided research proving drip for Pa. is a viable alternative for onsite wastewater infrastructure. In the third year of this 5 year study, the researchers in Pennsylvania recommended that the Drip Technology be approved for the benefit of the citizens and mainstreamed for use across the Commonwealth. The research on drip did continue with the focus on Septic effluent as opposed to secondary treated effluent that was the focus of this first study.

Abstract. "The ability of a moderately well drained soil to treat septic tank wastewater at depths of 1,2,3, and 4 feet beneath the surface was evaluated using drip dispersal technology. Three drip dispersal systems of 1200 feet of tubing each were dosed with 400 gpd septic tank treated wastewater (loading rate of 0.17 gpd/ft²). Zero tension lysimeters were installed at 1,2,3, and 4 feet beneath of the surface to capture gravity water moving through the soil. Samples were analyzed for Fecal Coliform, Fecal Strep, BOD₅, NH₃-N, NO₃-N, and soluble P. Median value reductions of 99% for Fecal Coliform, 99% for Fecal Strep, 86% for BOD₅, 85% for NH₃-N + NO₃-N and 90% Soluble P were obtained at the 1-foot lysimeters. Based on these trials 1 foot of Aerobic soil appeared to provide significant treatment of septic tank wastewater when loaded at 0.17 gpd/ft² with a landscape linear load of approximately 6 gpd/LF."

Hepner guided this study that included statistician support from college staff. The statistical analysis showed no statistical difference between the application of secondary and septic effluent in the soil.

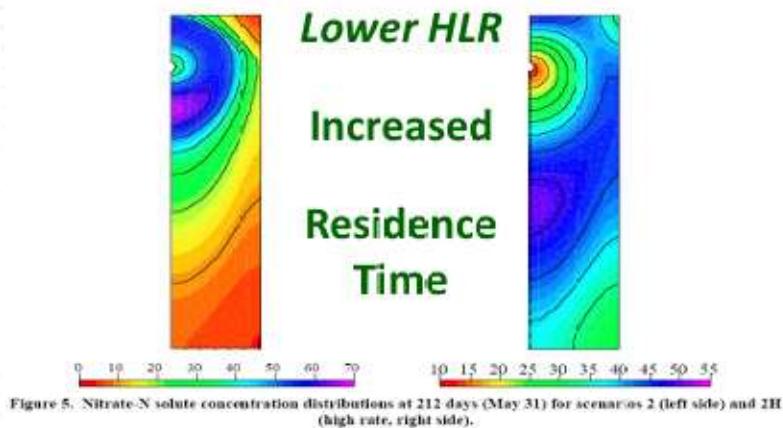


1999 Converse, Bohrer – “Soil Treatment Performance and Cold Weather Operations of Drip Distribution System.” Five drip distribution systems in Wisconsin were monitored to evaluate the performance of these systems in cold weather” Temperatures were monitored during the winter from 1998–2000. Despite two relatively mild winters in Wisconsin during this period many below freezing temperatures were recorded and no operational problems were experienced. The authors concluded; “With proper design and installation, drip distribution systems are an excellent alternative system for wastewater dispersal in cold climates.”

2000 J.G. Hayes, Jr. and A.N. Moore, “Long Term Impacts of Micro-Irrigation "Drip" Treatment and Disposal Systems in Delaware’s Marginal Soils”. This 8-year study revealed significant differences in the grab samples tested within the drain field wells as compared to the up-gradient and down-gradient wells. This long-term study (5 years longer than the Delaware Valley College studies) again demonstrates the sustainability and benefit of drip technology.

2004 TVA and EPRI 2004 Wastewater Subsurface Drip Distribution,” Peer Reviewed Guidelines for Design, Operation, and Maintenance”, EPRI, Palo Alto, CA and Tennessee Valley Authority, Chattanooga, TN. Chapter 1 Purpose and Objective leads with the following: “Subsurface drip irrigation, or more appropriately for wastewater applications, subsurface drip distribution (SSD) is the most efficient method currently available for application and subsurface dispersal of wastewater to soil. Because it is so effective, drip distribution represents a viable option for wastewater disposal for all soils types.” The booklet describes current best practices for design and prediction for nitrogen removal for both small and large flow systems.

2004 Beggs, Tchobanoglous, Hills, and Crites. “Modeling Subsurface Drip Application of Onsite Wastewater Treatment System Effluent” From the Abstract, “Various models developed over the years have been applied model infiltration, soil nitrogen and general vadose zone transport scenarios. Modeling results showed that a system designed for efficient irrigation generally minimized annual nitrate percolation. Nitrification of septic tank effluent prior to subsurface drip application increased nitrate percolation.



2011 Beggs, Tchobanoglous, Hills, and J.W. Hopkins. “Fate of nitrogen for subsurface drip dispersal of effluent from small wastewater systems”. From the abstract, Container tests were performed to determine the fate of water and nitrogen compounds applied to packed loamy sand, sandy loam, and silt-loam soils. Nitrogen removal rates measured from 63 to 95%. A Hydrus 2D vadose zoned model with nitrification and de-nitrification rate coefficients calculated as a function of soil moisture content the test results reasonably well. Applying the model to generic soils types, the greatest nitrogen losses (30–70%) were predicted for medium to fine texture soils and soils with restrictive layers or capillary breaks.

2007 Parzen, Tomaras and Siegrist. Colorado School of Mines, Golden, Co. "Controlled Field Performance Evaluation of a Drip Dispersal System Used for Wastewater Reclamation in Colorado". From an ASABE Publication of 20 October 2007, demonstrates that with two years of study of septic tank effluent applied to the soil with drip technology, there are positive attributes of drip dispersal systems that can include: 1) increased residence time of effluent, 2) can be placed at shallow depths, 3) used in odd-shaped areas, 4) provides for little site disturbance, 5) provides controlled equal distribution, 6) provides for reuse of constituents to accommodate plant requirements. The study used tracer tests and 3-D coring to evaluate effluent movement. The data revealed that effluent moves preferentially along the drip tubing as it infiltrates into the native soil. "The addition of STE to the shallow subsurface attenuates the natural variability of PH, water content and inorganic nitrogen in the soil." "Fecal coliform bacteria levels adjacent to the drip lines were very low or non-detectable."

2010 **decentralizedwater.org**, Drip Excerpts from WERF DEC1R06, Quantitative Tools to Determine the Expected Performance of Wastewater Soil Treatment Units. Chapter 2 reviews the mechanisms of soil-based treatment including nitrogen and the modeling of treatment capability as related to soil type and loading rates. Dosing regimes and application rates conform and are enhanced when using drip technology. [Guidance Manual, User's Guide, and Visual-Graphics Tools, STUMOD, N-CALC](#), See also: [State of the Science: Review of Quantitative Tools to Determine Wastewater Soil Treatment Unit Performance](#).

2014 Robert L. Siegrist **Water movement and fate of Nitrogen during drip dispersal of wastewater effluent into a semi-arid Landscape**, Presented at the Onsite Wastewater Conference, Soil Science Society of America, April 7-8, 2014, Albuquerque, NM. Robert L. Siegrist, Rebecca Parzen, Jill Tomaras, Kathryn S. Lowe a Civil and Environmental Engineering, Colorado School of Mines, Golden, CO 80401. Parzen (Colorado), by way of radio tagging of the STE nitrogen, as indicated and confirmed in Hydrus modeling, a majority of the effluent nitrogen applied by drip dispersal remained shallow in the soil proximate to the emitter and along the tubing.

August 2013, Tetra Tech, Inc, [Recommendations of the On-Site Wastewater Treatment Systems Nitrogen Reduction Technology Expert Review Panel FINAL REPORT](#) Submitted to: Wastewater Treatment Workgroup, Chesapeake Bay Partnership, August 2013 Prepared by: Tetra Tech, Inc., 10306 Eaton Place, Suite 340, Fairfax, VA 22030-2201. The report continued the study of drip as an appropriate BMP.

2012 Heufelder, George, Barnstable Col Mass, Mass DEP, "Investigation of the treatment of Drip Dis persal Onsite Septic Systems for the Removal of Selected Micro - Constituents and Contaminants of con cern". From the Executive Summary: "A preliminary investigation regarding the removal of selected Contaminants of Emerging Concern (CEC) by shallow soils-based onsite septic system technologies was conducted at the Massachusetts Alternative Septic System Test Center in 2010 – 2012. Untreated sep tic tank effluent was applied to a shallow (less than 9 inches) soil horizon in lined test cells. We report that removal efficiencies of selected pharmaceuticals, hormones and personal care products in drip dis persal systems are generally higher than those levels reported for non-soils-based treatment technologies. The removal efficiencies of the selected compounds using drip dispersal reported approach 100%. The data suggest that septic systems employing shallow soils-based means for ultimate disposal may offer comparable to better treatment for certain micro-constituents of wastewater compared to some municipal wastewater treatment facilities. The fire retardant TCEP (Tris (2-chloroethyl) phosphate) was not attenuated during treatment and, similar to the conclusion reached in other studies, may prove to be a particular challenge for wastewater treatment removal strategies."



2018 EPA – Chesapeake Bay Program, “Drip Irrigation and Peat Treatment System On-Site wastewater nutrient removal BMP Expert Panel Report”. This report states concerning Septic Drip: “Based on the data analysis previously presented, the Panel concurs that a 50 percent net TN reduction for drip dispersal is warranted when the following conditions are met”. Those conditions include 7 points and 13 sub points that mirror what was developed 10 years earlier and adopted in the NOWRA drip guidance. The application rates recommended are:

The net 50 percent BMP credits will only be provided for systems using loading rates as applicable for STE, regardless of effluent quality. Maximum soil texture-based area loading rates are as follows; however, States can require the use of lower rates at their discretion: o TG II 0.27 gpd/sf o TG III 0.17 gpd/sf o TG IV 0.12 gpd/sf. The BMP for Drip Dispersal will be listed in the EPA protocols I late 2019.

2017 Robert L. Siegrist, Decentralized Water Reclamation Engineering, a curriculum workbook. Before his retirement, Siegrist wrote this curriculum workbook and included 120 pages of discussion on drip dispersal providing guidance for future engineers. American was a reviewer of the book.

The EPA and the Chesapeake Bay Program goal is to reduce nitrogen across the entire Bay watershed. States such as Virginia have codified this goal in regulation and require on-site wastewater system designs to provide for nitrogen removal for all alternative systems. Many alternatives include “pretreatment with pressure distribution” available to designers to specify that meet these regulations. Perc-Rite® Septic Drip systems are now listed with the EPA to meet the criteria.

Listed below are relative supporting documents: ☐

- FINAL REPORT – Recommendations of the OSWWT Systems Nitrogen Reduction Technology Expert Review Panel Feb 2014, ,
https://www.chesapeakebay.net/documents/Final_OWTS_Expert_Panel_WQGIT_approved_07142014.pdf ☐
- Drip Irrigation and Peat Treatment System On-site Wastewater Nutrient Removal BMP Expert Panel Report, Panel Report,
https://www.chesapeakebay.net/channel_files/26340/osww_bmp_report_4-30-18.pdf
- Appendix G (07 18 2018) – Technical Requirements to Enter Advanced On-Site Wastewater Treatment Practices into Scenario Builder and the Phase 6 Watershed Model.
https://www.chesapeakebay.net/channel_files/27557/septic_systems_technical_appendix_07_19_18.pdf
- Guidance Manual, User’s Guide, and Visual-Graphics Tools, STUMOD, N-CALC
- State of the Science: Review of Quantitative Tools to Determine Wastewater Soil Treatment Unit Performance

The EPA and Chesapeake Bay Program work represents the important recognition that, in appropriate soils, drip dispersal of septic effluent is environmentally beneficial to the receiving environment. American Manufacturing Company, Inc. continues to support research and development of best practices for the recycle of wastewater into the soil. It is our hope this information can be used by the regulatory community and academics to enhance regulation and our understanding of onsite wastewater treatment in soils.

February 2023 Onsite Wastewater Technology Report:

Regulators have often been hesitant to accept septic drip as a treatment system. The application of septic effluent distributed by a shallow placed drip system results in the aerobic treatment of an anaerobic effluent. Since it is very hard to sample in situ systems due to the unsaturated movement of water in soils, researchers need to create alternative methods of sampling.

George Heufelder, M.S., R.S., sponsored by Barnstable County Department of Health and Environment at the "Massachusetts Alternative Septic System Test Center" issued a report on Perc-Rite® Septic Drip Treatment.

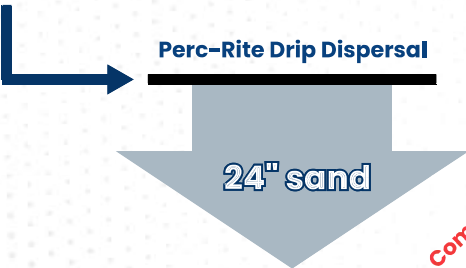
ABSTRACT

This unprecedented and unique study compares the treatment of septic tank effluent and three advanced treatment modes at the point of soil discharge and at a location 24 inches beneath a standard stone-in-pipe leach system with that of a Perc-Rite® Drip Dispersal System at a similar vertical soil depth. Results indicate that selected contaminants in percolate collected from the Perc-Rite® Drip Dispersal System are less than and/or comparable to concentration levels collected from the septic tank effluent leach system and three advanced treatment modes for fecal coliform, nitrogen, and phosphorus.

Perc-Rite
Drip Dispersal

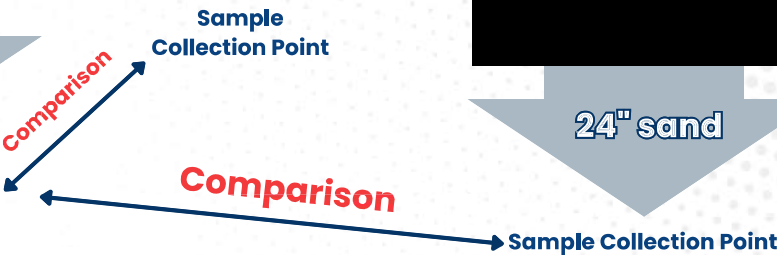
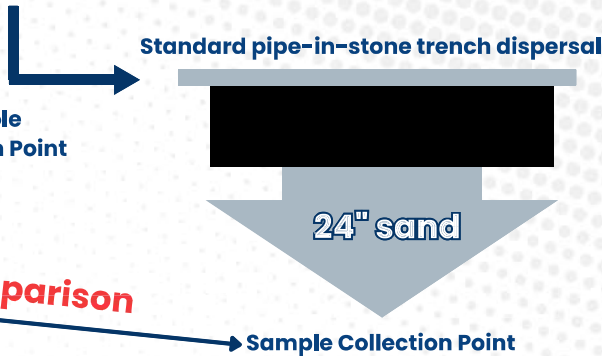
(and standard pipe-in-stone
trench following septic tank)

Septic tank effluent



Advanced On-Site
Treatment Technologies

- Advanced Treatment Units Compared
- Recirculating media filter
 - Sequencing batch reactor
 - Fixed activated Sludge Treatment



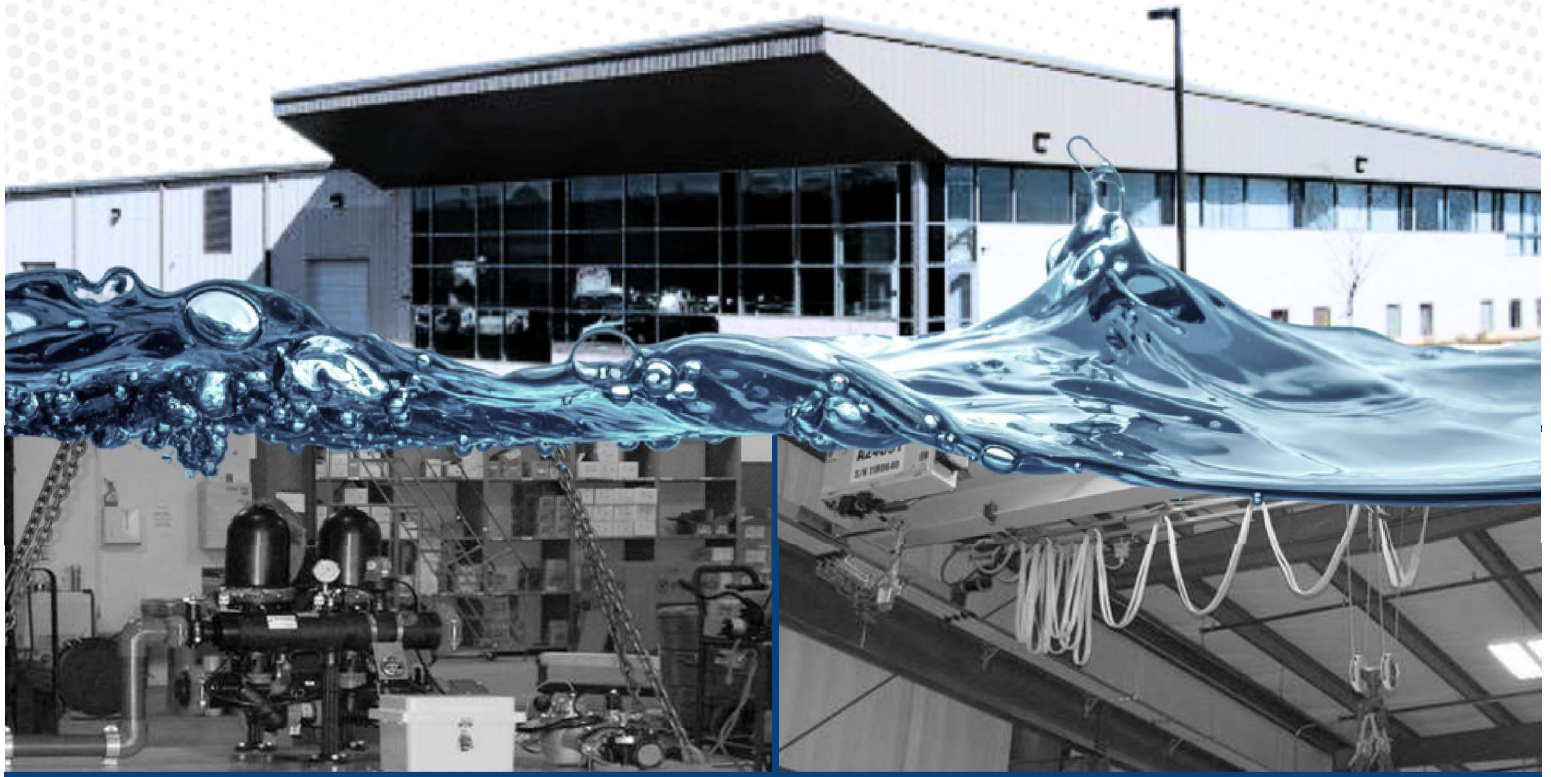
February 23, 2025 Vernon I/A Approval

1.10 This I/A Approval is based on information submitted by the Applicant indicating that the technology will effectively distribute and treat the effluent.



AMERICAN

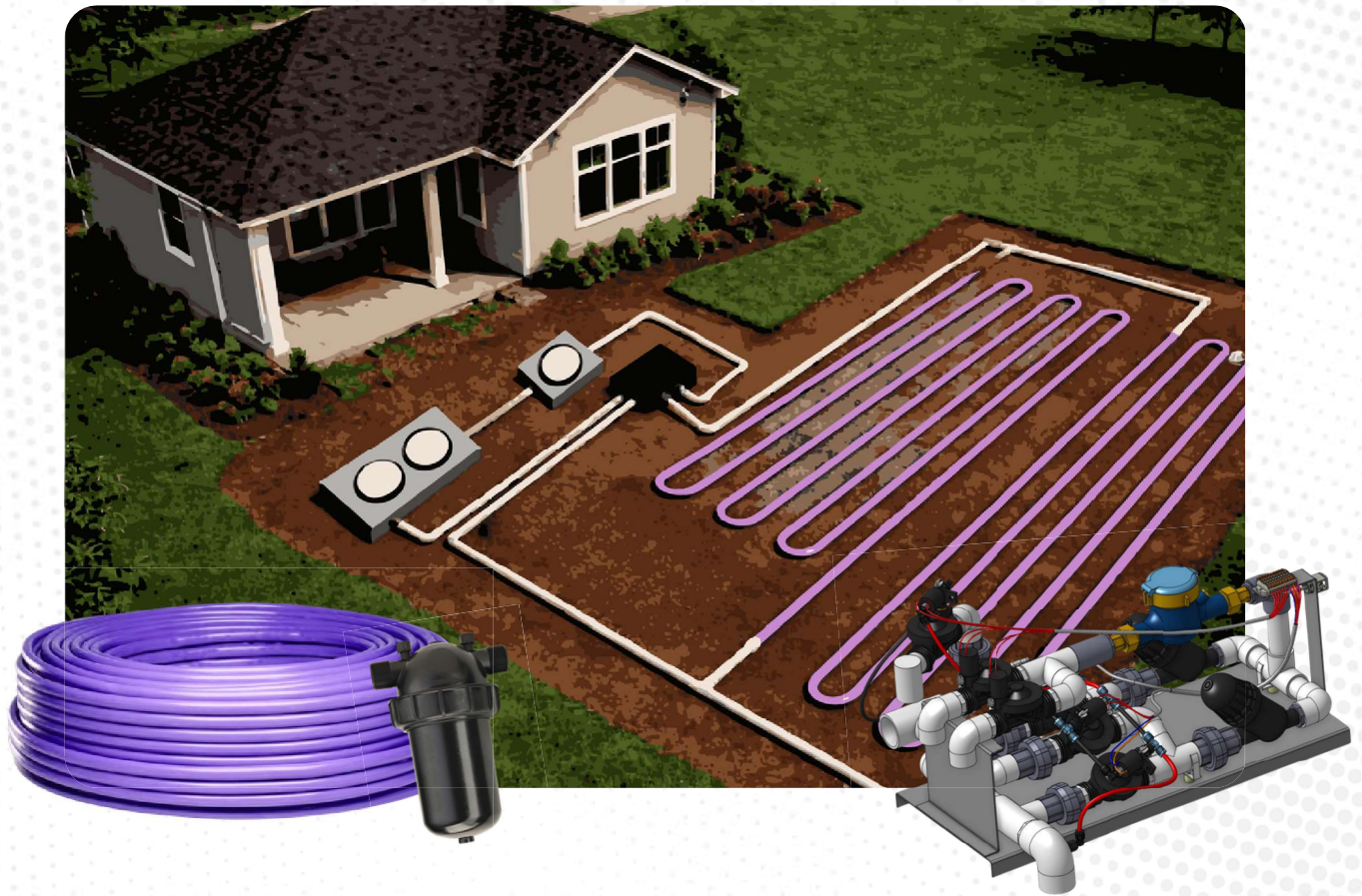
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