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Treatment in Miniature

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Indoor treatment tanks of the Port of Portland's Living Machine

Treatment in Miniature

by Lisa Ekman

Forty feet beneath the quiet, airy lobby of the Oregon Health & Science University's waterfront building is a miniature sewage treatment plant. You wouldn't know it from above, but below the building's sixteen stories, which include a café, medical offices, and gym, the plant treats 30,000 gallons of sewage every day. Stepping into the treatment plant is a little like stepping into a bizarre sauna: hot and cramped, with a typical sweet smell of sewage. The treatment plant's machines range from refrigerator- to truck-sized, and they make all manner of clangs, hums, and thunks.

On work days, here's who you'll find standing in the middle of it all, a bright smile on his face: treatment plant operator Ken Johannes.

Johannes is one of the people who run this miniature sewage treatment plant. Being an operator means he's also a detective (things can go unexpectedly wrong in treatment systems), a pioneer (this plant is the first of its kind in the United States), and a tour guide (sewage planners and enthusiasts have come from all over the country to see the system). "It's been fun," he told me, as sweat streamed down his face.

Although OHSU was the first organization in Portland to build on site sewage treatment, the University's system fits in with an international trend. Cities all over

Stepping into the treatment plant is a little like stepping into a bizarre sauna.

Treated biosolids at the La Center treatment plant, ready to be applied as fertilizer at a local tree farm.

the world, including Portland, face a major sewage challenge: Changing populations mean changing wastewater volumes, but sewage infrastructure can be difficult to adapt. As cities grow, their sewage treatment may have to shrink.

Let's say a twenty-story condominium tower replaces a warehouse. The new building's showers, toilets, and washing machines add wastewater to the system, but the pipes underneath don't necessarily increase in size, because laying larger pipes might involve digging up miles of city streets.

To keep up with development, the city charges a fee for new buildings to connect to the sewer system. For a single house, the fee is just over $4,000, but for a large building like OHSU's Center for Health and Healing, the fee nears $600,000. More and more developers are looking at that price tag—and at the advantages of small-scale sewage treatment—and wondering whether it makes sense for them to treat their own wastewater.

Before developers dive into the world of sewage treatment, they have to weigh costs and benefits. Sewage containment and treatment involve complicated processes, and on site systems can be expensive to install and operate. Building tenants will worry about smells and public health. New buildings have to connect to the municipal sewer system anyway, in case of system failure, so builders can only avoid some of the city's fees. What, then, makes these systems worthwhile?

Portland's main sewage treatment plant is on North Columbia Boulevard near Smith and Bybee Lakes. On an average non-rainy day, the plant treats 73 million gallons of wastewater from all types of sources, including houses, businesses, and industry. Because the plant also treats rainwater and stream water, on rainy days it can accept as many as 280 million gallons.

City planners used to think that the main treatment plant would hit its capacity right about now, but by conserving water, Portland residents are creating less wastewater, and the treatment plant is not overburdened. Pipes are a different story, and on site treatment can allow for population growth without disruption to the current sewer system.

For a building owner, on site sewage treatment can mean lower system connection fees and sewer bills. If the system reuses the water it treats, occupants can save money on water bills, too. For an owner, on site treatment can also mean an increased perception of sustainability. Green building certifications like the Leadership in Energy and Environmental Design (LEED) ratings give points for innovative wastewater treatment.

On site sewage treatment has been used for years in rural homes, military ships, and cruise liners. As the processes enter cities, where municipal sewer systems already exist, what do building developers, owners, and occupants stand to gain by treating their own sewage? And how do they do it?

The Membrane Bioreactor

The main difference between Portland's municipal system and the OHSU Center for Health and Healing treatment system is, of course, scale: The municipal plant treats 73 million gallons each day, while the OHSU plant treats 30,000. The main difference in the treatment process itself is the membrane bioreactor, a technology that reduces the amount of space necessary for sewage treatment.

Here's how the system works: When people flush, wash their hands, dispose of

City planners used to think that the main treatment plant would hit its capacity right about now.

medical waste, or empty the pool, wastewater flows down through the building to the underground treatment plant.

There, screens filter out the garbage. Machines wash and compress the debris (think diapers, tampons, even cell phones) so it can be driven to a landfill.

The water then flows into microorganism-filled tanks, where different types of bacteria eat different components of the waste.

So far, the treatment process hasn't been all that different from a typical municipal setup. But now the membrane bioreactor comes in. You can't see the membranes because they're covered in wastewater, but they're basically very fine screens about three feet tall, 1 ½ feet wide, and ¼ inch thick. When wastewater is pushed through, relatively clean water passes through the membranes, and bacteria and sludge stay behind.

After water has passed through the membranes, it's almost clean enough to discharge or reuse. From there, operators treat it with ultraviolet light. Then they can either send it out of the building and into the Willamette River, or chlorinate it for reuse within the building for toilet flushing, irrigation, cooling, or fire suppression. During the summer, building managers sometimes mix stormwater and groundwater collected from the building with the recycled water to create enough for the building's irrigation needs.

This miniature treatment plant doesn't process the sludge that stays behind the filter, so the sludge breaks down for two months, and is then piped to the municipal treatment plant.

In the building above, you might not have a clue that there's a sewage treatment plant underground, except when you visit the bathroom, where the water in the toilet sometimes has just the faintest brown tint. More amusingly, a sign above the toilet reads,

These signs, required by the state, are pretty much the only reminders that this building treats its own wastewater. Sometimes you can smell a municipal treatment plant from miles away; this one you can't even smell from upstairs.

The Center for Health and Healing is the first building with so many different uses (medical, academic, retail, fitness, research) to use a membrane bioreactor. In part because of its on site wastewater treatment, the building received the highest ranking in the Leadership in Energy and Environmental Design (LEED) ratings.

The University also saved about half a million dollars in sewer connection fees, and continues to save money on sewer and water bills. The University owns the treatment plant, but hired Johannes' company to design, build, maintain, and operate it.

Because of the building's many purposes, Johannes has done an above-average amount of detective work. One day, he was puttering around the operations room, checking systems, when he noticed that his computers were detecting high levels of ammonia. The ammonia was a sign that his microbes were in distress,

A tank at the small-scale municipal treatment plant in La Center, Washington.

and so he rushed to find and fix the problem. But it was too late.

When the bugs die off, Johannes can't just order more in the mail; they have to be picked up from another treatment plant and then carefully tended. Johannes at first reckoned the ammonia spike was a fluke, but then it happened again and again. After charting the spikes and asking around at the medical offices upstairs, Johannes was able to trace the spikes back to a specific office.

Johannes talked to the staff, and found out that this office also poured strong antimicrobial agents down the drain, as medical staff do in hospitals everywhere, causing some of the more mysterious die-offs he had dealt with. Now these chemicals are neutralized before they're poured down the drain, in accordance with the University's policy.

Less obvious culprits can also kill the bugs. Hot water can knock them out, as can products used to disinfect the swimming pools. Communication is the key, Johannes said, to avoiding problems. If he knows to expect a swimming pool cleaning, he can take steps to prevent die-offs.

Operators of large-scale wastewater treatment systems can't take these steps. A municipal sewer system suffers if a fry cook pours fat down the drain, but officials are unlikely to find the guilty party. Proponents of small-scale treatment argue that the very scale makes people more accountable for what they're pour-

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ing down the drain. Strong antimicrobial agents probably shouldn't go straight into any treatment system, but operators at the Center for Health and Healing have more control.

"It's a learning process," Johannes said.

A Question of Scale

Karsten Zuendel started a company that designs, sells, and operates miniature treatment plants. When we sat down for coffee, he told me that in Germany, people have traded the septic tank for the membrane bioreactor, a product his company sells. In these German developments, treated liquid waste is used to flush toilets and water gardens, while solid waste can be made into biogas for cooking and heating. Zuendel sees a future in which the U.S. will rely on small-scale sewage treatment, because the costs of rebuilding infrastructure will be so high. "In Europe and Japan they've already had to deal with this," he said. The implication: We're next.

Zuendel thinks a membrane bioreactor system could help developers in Damascus, a small town turned suburb about fifteen miles from Portland. In Damascus, he said, to hook up a house to the municipal sewer system would cost about $6,000—and that's before the monthly sewer bill.

If new developments used these miniature treatment plants, cities could avoid building extensive pipe systems underground.

Zuendel's company makes a treatment plant that comes in a shipping container and can treat the wastewater from 75 houses. This system, he said, would cost about as much as connecting to the municipal system would. It only treats household wastewater, so rainwater that falls on roofs, streets, and sidewalks would be funneled into bioswales and permeable surfaces.

If new developments used these miniature treatment plants, cities could avoid building extensive pipe systems underground. In general, small treatment plants could give cities more flexibility. They could avoid making existing pipes larger, and avoid paying for pipes that aren't being used to their full capacities.

As an added benefit, the development could hook houses up to the treatment plant to reuse the water, just as OHSU does, for watering their gardens and flushing their toilets, saving residents money on their water bills.

Among the advantages of small-scale treatment, Zuendel said, is neighborliness. He thinks membrane bioreactors work because they bring human waste to a human scale. The municipal system is too large and anonymous to keep users aware of the issues their wastes pose. If a small-scale treatment plant isn't working properly because someone is flushing baby wipes, the neighborhood works together to correct the problem. When baby wipes are flushed into a municipal treatment system, it's much more difficult to find and educate those responsible.

Zuendel thinks it's time to reconsider the entire sewer system. "Why can't everyone have wastewater treatment in their basement?" he asks.

Feed me: the Living Machine

I stood in the lobby of the Port of Portland's headquarters, admiring the planters. They were made of shiny black stone, and were full of vibrant, healthy plants. Suddenly it occurred to me that I might be looking at sewage treatment in action. I was a little embarrassed to think that I didn't know, but what did a Living Machine look like? While I waited for Port engineers Dan Gilkison and Greg Sparks to show me around, I wondered: Was this a treatment plant, or just a planter?

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After I met Gilkison and Sparks, Gilki-

Indoor treatment tanks of the Port of Portland's Living Machine.

son assured me that I was in fact looking at the Living Machine—well, part of it. The tanks in this room represented a section of the Machine; I would see the rest outside.

The Living Machine is the invention (and brand name) of Worrell Water Technologies, a company based in Virginia. Worrell has built Living Machines at colleges, resorts, a zoo, and even a border crossing, everywhere from the U.S. to Ghana to the Netherlands. The basic idea of the Living Machine is to create small treatment plants that use natural processes. (It's worth pointing out here that large municipal treatment plants also use natural processes, albeit different ones from the Living Machine's.)

When the Port of Portland decided to build new headquarters, they aimed for LEED certification, which led project managers to look into sustainable wastewater processes. This Living Machine, which treats wastewater from the building's 450 employees, has been in use since May 2010.

"Early on in the design," Gilkison explained, "We made a decision to go with this system. It made the most sense for the footprint we had."

Sparks likened the Living Machine to a septic system. It's an apt comparison in terms of process—solids settle out and liquids pass through various substrates—but unlike most septic systems, the Living Machine takes up little space and doesn't leach effluent into the ground. Leaching into the ground would be especially problematic here, because below the Living Machine is a tunnel for pedestrians.

Here's how it works. The building's wastewater drains to an underground collection tank where solids settle out; liquids proceed to the Living Machine.

The first set of Living Machine cells is here in the lobby. Each is four or five feet tall, and full of what looks to the untrained eye like houseplants and gravel. Worrell Water Technologies describes these tanks as "tidal cells," because throughout the day, they fill with wastewater and then drain it out.

What looks like gravel is actually shale. Sewage-eating microbes form a film that clings to its surfaces, sort of like barnacles you'd see in tide pools. When the water comes in, the microbes munch on the sewage, and when the water flows out to the next step, they rest and reproduce.

You can't see any of this happening, because treatment takes place entirely within the black planters. The tanks never fill to the surface. And although some proponents of Living Machines say the plants' roots may provide benefits for the microbes, Gilkison said, "They're just the frosting on the cake. This could exist as just a rock planter."

Sparks chimed in: "Or it could be completely underground."

In fact, Sparks said, when the project's architects proposed a Living Machine in the lobby, some of the Port's engineers would have preferred it that way. For odor control and public health, underground sounded like a better place to treat sewage. "It was the cause of some interesting conversation early on," he said.

The tunnel below added other design challenges. With their stone walls, shale, and water, the tidal cells are heavy. Structural support and waterproofing became major concerns. "You don't want blackwater running into your public spaces," Sparks said emphatically.

After flowing through the tidal cells, wastewater passes through sand-filled tanks, which give it a finer cleaning. Then it's filtered, run through an ultraviolet light chamber, chlorinated, and reused within the building for cooling and for flushing toilets. Operators add drinking water, because some water is lost in the treatment process. The remaining sludge has to be pumped out every so often, just as sludge from a septic tank does.

The first year of a new treatment plant usually presents challenges, and the Port's Living Machine is no exception. First off, the plants. Right away, Sparks explained, the plants grew quickly and everything seemed great. But then, thanks to high nitrogen levels, they didn't stop growing. Some grew so tall that they toppled over. Port staff chose new plants, and the ones they have now seem to be doing well.

More challenging was the process preparing the system for use. Employees moved into the building in two stages, but the increased wastewater still shocked the Living Machine's microbes, and operators had to send wastewater out to the municipal treatment plant. (Like other on site treatment plants, this one is required to have a backup system connected to city sewers.) The system's bugs had to be slowly built back up.

If Gilkison could give advice to future owners of Living Machines, he would tell them to allow enough time for the system to ramp up. "It takes longer than you think to develop an ecological system," he said.

"You're trying to compress natural ecological systems into a controlled space," Sparks added. "It's hard to get it to respond as a natural system would."

Worrell Water Technologies recommended a surprisingly low-tech solution: powdered milk. For three months, Port staff nursed the microbial population back to health by regularly pouring powdered milk into one of the building's janitorial sinks.

The building's schedule presented another challenge. Sewage-eating microbes need regular meals, and an office building doesn't produce much wastewater during evenings and weekends. At first, staff struggled to keep the microbial

Sewage-eating microbes need regular meals, and an office building doesn't produce much wastewater during evenings and weekends.

Outdoor treatment tanks of the Port of Portland's Living Machine.

population healthy. "The bacteria die and reproduce very rapidly," Sparks said, "and when people come in in the morning, there has to be enough of a bacterial response."

To keep the microbial population healthy, the system now metes out the wastewater gradually.

The Living Machine saves energy and water, benefiting the Port financially and from a sustainability perspective: Because of the Living Machine and other features, the building earned the highest possible rating in the LEED system. However, operating the system is not cheap. The Port has a contract with the company that built and maintains the OHSU membrane bioreactor, and Gilkison and Sparks estimated that the contract has run about $11,000 a month since the system's installation. After that initial ramp-up time, though, the operator will probably not need to visit as often. "Once the thing gets going," Gilkison said, "the costs should be lower."

The Living Machine's current mystery concerns the sludge. "We thought we would only have to pump the tank every three to five years," Gilkison said, "And it's more frequent than we expected. We're investigating why."

"Maybe we need to feed it differently," Sparks said thoughtfully.

"We're looking into it," Gilkison said,

"There's a lot of learning that goes on with something this new."

"We're still gathering information"

So far, the city's Bureau of Environmental Services (the bureau in charge of sewers) has interacted with small-scale sewage treatment in a few ways: It waived $550,000 of OHSU's sewer connection fee, checked both plants' backup connections to the city's sewer system, and has treated wastewater from both plants when they've had to use those backup systems.

Dean Marriott, director of the city's Bureau of Environmental Services, says he's intrigued by small-scale treatment technologies. "In a particular location," he says, "Maybe they could help us from having to make public investments to upsize our system. I'm not convinced at this point, though, that we should subsidize them."

The city's interest in pursuing small-scale treatment could depend on location. The Lloyd District, Marriott explained, has increasing density and a sewer challenge. Because much of the area was built on fill, some of its sewer pipes are buried 100 feet deep. Increasing the size of those pipes would be a big challenge—and, as Marriott puts it, "very, very expensive."

The city's [Portland] interest in pursuing small-scale treatment could depend on location.

About the Lloyd District and other increasingly dense areas, he says, "If people can handle these issues on their own, then maybe that makes great sense all the way around."

The Bureau is still learning about small-scale treatment technologies, Marriott says. A meeting the Bureau convened about natural wastewater treatment systems in December 2009 drew participants from OHSU, the Port of Portland, Clatsop Community College, Portland architecture and engineering firms, and other City of Portland bureaus. "We're still working on it," he says, "We're still gathering information, still talking to a lot of people."

His opinion so far? "I think that if people are thinking about doing this, they should do a pretty thorough cost/benefit analysis," he says. But he goes on to say, "A lot of times, with innovation, it takes some early adopters and enthusiastic people to say they don't care whether it pencils out exactly." Early adopters, he points out, are giving Portlanders the opportunity to learn about these systems.

Marriott is proud that this innovation is taking place in Portland. "You don't have to go to New York or Boston or someplace to find somebody who knows something about it," he says, "That's pretty exciting, that we're growing that kind of expertise right here."

Compact in La Center

Critics of Portland's two on site wastewater treatment plants point out that although they can fully treat wastewater, they don't treat the sludge their buildings create. If the city of Portland were to invest in small-scale treatment in certain neighborhoods, it would need to have a plan for the solids.

Solids are controversial; there are few easy ways to get rid of them. For years, treatment plants across the country created controversy by dumping them in landfills, barging them and dumping them at sea, or incinerating them. Some wastewater treatment plants make them into fertilizer, but that too is controversial, because when sewage sludge is applied to edible crops, people worry about the heavy metals and other chemicals that may have accumulated in it.

Solids are controversial; there are few easy ways to get rid of them.

As far as small-scale sewage treatment is concerned, the town of La Center, Washington, a small town about forty minutes from downtown Portland, is a good place to look. This is a city that's growing: Between 2000 and 2009, the city's population grew from about 1,500 to about 2,500. In 2006, city managers realized their wastewater treatment system wasn't going to accommodate the expected kind of population growth the city expected. They'd have to build a larger treatment plant, but their site was only ¾ acre, and couldn't be increased. They'd either have to move, or expand the plant's capacity without increasing its size.

... the city's [La Center] new system provides an interesting example of what a small-scale treatment plant can do with new technology in little space.

La Center's sewer system is much less complicated than Portland's. It serves far fewer people, and doesn't collect stormwater or industrial wastewater. That said, the city's new system provides an interesting example of what a small-scale treatment plant can do with new technology in little space.

Sue Lawrence, Wastewater System Supervisor for the City of La Center, told me over the phone that the treatment plant would be the first thing I saw when I drove into town. She would have been right, except that the treatment plant is so small, and so visually and olfactorily unremarkable, that I drove right past it. I was all the way in the downtown area before I realized I'd better turn around. On the second try, there it was: a smattering of beige buildings right next to some of the city's sparkling wetlands.

Lawrence has worked here since 2006, and has run the plant before, during, and after the construction project. In her office, she explained how the city decided to install a membrane bioreactor: "We couldn't meet the ultimate flows on our site without one," she said, "When we decided to leave the plant where it is, we basically chose the MBR."

After securing a loan from the Washington Public Works Trust Fund, the city hired an engineering firm to design the plant. In the end, the project, which increased treatment capacity six-fold, came in a million dollars under the $13.7 million budget. The plant now serves about 3,000 people a day, but could serve up to 6,000.

We started our tour at a computer screen that shows all aspects of the plant's operation, everything from how much water is coming into the system to how much is leaving. As Lawrence clicked through the various processes, she told me the city's entire wastewater system has three employees. "It's pretty automated," she said, looking at the screen.

Step one of the process is the same as step one at most treatment plants: Take out what shouldn't go through the treatment process. Here, debris is screened out by rotating drums. "Screening is very important to a membrane system," Lawrence told me, explaining that sharp objects could cut the membrane screens. "You don't want glass pieces, plastic, hypodermic needles—stuff like that—to go through." After we watched the drums rotate for awhile, Lawrence led me downstairs to where the screened objects go. I was astonished to see two Rubbermaid garbage cans, with household-style trash bags inside. I peered in to see a surprisingly colorful mix, including corn kernels, cashews, a long rag, and what looked like straw from a broom. Lawrence told me that the plant operators empty these trash cans every other day. This tells you right away about the small scale; at Portland's main plant, this debris is measured in truckloads per day, not trash cans per week.

Next, the liquid waste goes into outdoor tanks where the plant pumps in air, allowing microbes to eat the biological components. We walked past several tanks in various processes of settling and microbe munching, and then we talked about the

Treated wastewater to be reused within the La Center treatment plant.

central part of the plant: the membrane bioreactor.

As at OHSU, you can't see the membrane bioreactor itself, because the system is enclosed in tanks. La Center currently only uses one of its two tanks, but as the city's population increases, they'll begin to use both. As at OHSU, what goes into the membranes is sewage—a mix of bacteria, solids, and water—and what comes out the other side is basically water. Lawrence showed me a section of one of the pipes that discharges water from the membranes, and I was surprised at the water's clarity.

The process is relatively simple. "The membranes are really just a physical barrier to separate the water from the solids," Lawrence said, "and the great thing is that they have such a small footprint for the flow they put through."

The membrane bioreactor has so far proved relatively easy to use, although Lawrence said that in the winter, cooler water temperatures mean the sludge becomes thicker and can stick to the membrane. She also described the challenges of peak times such as New Year's Eve, when the town's casinos are full and the plant has to cope with spikes of waste. I asked if she has to work on New Year's Eve, and she shook her head no. "It's not that difficult to operate," she said.

Most of the treated wastewater flows into a nearby river. Before it does, the plant further disinfects it with ultraviolet light. The plant holds some water back, chlorinating it to be reused for cleaning and cooling. Because of this water reuse, La Center's treatment plant now saves $15,000 a year on water bills. Lawrence described the water bills they now pay as "a household amount."

Unlike OHSU and the Port of Portland, the La Center treatment plant fully processes solid waste. La Center's solid wastes are aerated, stored, processed, dewatered, and dried in a separate building. This process requires a substantial amount of energy, so the treatment plant runs it only a few days each week.

When they're ready to be used as fertilizer, the biosolids slide down a chute and into a trailer, which will be driven to a nearby tree farm. From a distance, the contents of the trailer looked like gravel. Up close, I was surprised to find that the biosolids had an acrid odor, difficult to pinpoint, but didn't smell like sewage.

Because the plant doesn't accept industrial wastewater, the La Center biosolids have low concentrations of heavy metals. They receive the highest quality rating for biosolids, which means they're relatively easy to get rid of. La Center's biosolids also tend not to produce controversy: Applying biosolids to trees for reforestation causes much less public concern than applying them to edible crops does.

As I left the treatment plant, I told Lawrence about how I hadn't even noticed it when I first pulled into town. "The fact that you drove right by it—that's a good thing," she said.

Where Do We Go From Here?

As small-scale wastewater treatment becomes more popular, technologies will change. The very existence of OHSU's membrane bioreactor and the Port's Living Machine demonstrates that people have an interest in treating wastewater at different scales. Engineers may find ways to process all wastewater (including sludge) on tiny sites, as a proposed Seattle building will do. Technologies new to the United States may allow for on site users to heat their buildings with biogas created from sewage, as people do in China. Maybe central treatment plants will capitalize on the energy embedded in sewage by using fuel cells. Or perhaps lower-tech solutions will gain traction. Some Portlanders already break the rules and put composting toilets in their basements, applying the composted waste on their gardens.

Whatever the case, small-scale sewage treatment is at a crucial stage in its development. As cities make plans to cope with their aging infrastructure, small-scale treatment may become more appealing. The costs and benefits at this point are subjective. Financially, small-scale treatment doesn't yet pencil out. That said, if water or wastewater treatment becomes more expensive, or replacing small sewer pipes becomes financially prohibitive, small-scale treatment may become commonplace. But what about values that are harder to quantify? No one can yet say whether it's more sustainable for a building to treat its own sewage or for it to connect to the existing sewer system.

Maybe it was because the La Center treatment plant was new, or maybe it was the simple elegance of the small system, or maybe it was the walking trail through the neighboring wetlands, but I began to think that if I worked in wastewater treatment, I'd want to work in La Center. The city has achieved something remarkable in small-scale sewage treatment: It's managed to increase capacity while saving energy, water, and land.

Is it realistic to hope that small-scale sewage treatment will help solve some of the Portland area's complicated sewage challenges? La Center has a mere 13 ½ miles of sewers, while Portland has over 2,000. La Center's treatment plant serves 3,000 people, while Portland's serves over 600,000. Maybe miniature treatment plants can help in increasingly dense areas like the Lloyd District. Or maybe as Portland's water use patterns continue to change, city planners will come up with other solutions to the problems wastewater poses. The best solution will probably consist of a combination of solutions.

Is it realistic to hope that small-scale sewage treatment will help solve some of the Portland area's complicated sewage challenges?

Even if applying its systems to Portland would be impractical, I can't help but admire La Center's sewage treatment. Sometimes when I think of Portland's sewage challenges, I think of the moment when I stood next to Sue Lawrence as she surveyed her small wastewater treatment plant, beaming, and said: "This has been a really fun project for us." M

Lisa Ekman is a sewer enthusiast in Portland, Oregon.