
(from *The Humanure Handbook* by Joseph Jenkins)

# Proposal to implement greywater diversion and humanure composting at 3944 Pine Ave, Clearlake

Submitted to Lake County Environmental Health Department and Lake County Sanitation District by property owner Eric Torbet, 7/20/2021

## EXECUTIVE SUMMARY

**I propose to implement greywater diversion and humanure composting on my 0.47-acre property at 3944 Pine Ave, Clearlake, APN 039-402-390-000.** These systems together save water, close the nutrient cycle, spare the sanitation department one household's worth of sewage, and provide resilience in the face of natural disasters. The specific systems I propose are simple and robust, with safety and ease-of-use built in by design. The greywater diversion will employ a "branched drain" configuration, with no pumps or water storage, acting by gravity alone to deliver indoor wastewater to mulched tree basins. The humanure composting will employ an indoor sawdust bucket toilet in conjunction with an on-site outdoor thermophilic compost pile, to turn humanure and urine into rich, pathogen-free compost.

I propose stand-alone systems that do not rely on the public sewer or a septic tank. A future homeowner may decide to eliminate one or both of these proposed systems, in which case I have made it easy to make the switch to conventional sewage disposal.

I seek permission from the Lake County Environmental Health Department and Lake County Sewer to implement both of these systems. Due to their novel nature, these systems may require a special permit, like "Experimental" or "Pilot Project".

## BACKGROUND

**Greywater Diversion:** As California enters a perpetual state of drought, municipalities have begun permitting and even promoting home greywater diversion as a way to conserve water. In some early systems, mistakes were made, but now that many books and videos have come out on the subject, very safe and robust systems are currently being implemented. One mistake to avoid, for example, is storing greywater in a tank for more than 24 hours. The most robust systems simply rely on gravity and have no tanks at all. Another mistake to avoid is allowing the greywater to pond or to appear above surface. Proper sizing of drain basins and an ample layer of mulch easily prevents this problem.

Two simple greywater systems are called "laundry-to-landscape" (L2L) and "branched-drain" (BD). In L2L, the pump of the washing machine moves the drain water through plastic flexible tubing, and valves split and direct the water to more than one mulched basin. In BD, the drain water from sinks and showers flows by gravity alone, and the pipes are rigid, wide, and properly sloped (≥ 2%). There are also splits, but they are balanced wyes rather than valves. Again, the water is directed to mulched basins. Here is a drawing, from *The Water-Wise Home* by Laura Allen, of a home with both L2L and BD:

Some straightforward maintenance, usually annual, is required with simple greywater systems. Food particles, grease, and lint can build up, especially near the end of the pipe where the water exits into the basin, and must be periodically cleaned out. The mulch also decomposes over time and needs to be refreshed.

While L2L systems are permitted in most jurisdictions, BD systems are normally only permitted if they don't include the kitchen sink drain, due to the extra food and grease. But, successful kitchen BD systems *are* possible, provided that: 1) there is sufficient slope in the pipes; 2) food is well-screened at the sink itself; 3) grease is kept to a minimum; and 4) the output greywater is split up among more than one mulched basin, thereby lessening the per-basin burden.

*I know of no documented instance in which a person in the U.S. became ill from greywater.*

(from *Create an Oasis with Greywater* by Art Ludwig)

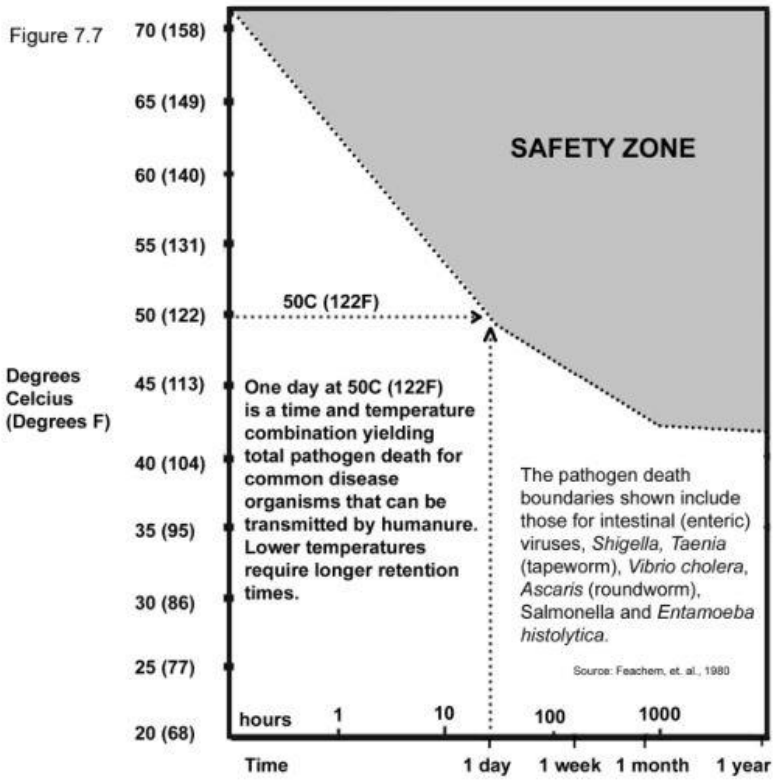
**Humanure Composting:** Transporting human waste in freshwater to either a treatment plant or to an underground septic system is viewed as "conventional", but it's a relatively recent innovation that both sullies our freshwater supplies and squanders a valuable resource, as well as resulting in the occasional mishaps that endanger public health. In many parts of the world, humanure has historically been recognized not as waste but as an essential agricultural resource, full of nutrients beneficial to plant and tree growth. For centuries, Asian countries would gather it up as "night soil", spreading it fresh on their farms, for example. While this practice of using fresh waste did return valuable nutrients back to the soil, it was highly risky due to the pathogens persisting in the soil.

A safe way to process humanure is to simply compost it first, in a way that destroys all pathogens including round worm, the most persistent pathogen that is often used as a marker of pathogen presence. Safe composting requires a balance of carbon, nitrogen, moisture, and oxygen, as well as sufficient time and temperature.

The following chart from *The Humanure Handbook* by Joseph Jenkins indicates that pathogens in humanure die with sufficiently high temperature and/or a long enough time of decomposition. Mr. Jenkins predicts a new era when municipalities will gather up humanure (and kitchen scraps) from households and compost it in central facilities, but until that time comes, households can process their own humanure on-site in a safe way that does not endanger public health. The secret is achieving "thermophilic" decomposition, which occurs when there is a critical mass of organic material with the

correct carbon/nitrogen ratio, and this mass is insulated from cold exterior temperatures and provided enough oxygen and moisture. When such conditions occur, certain micro-organisms called thermophiles quickly break down the organic matter, thereby raising the temperature. The sustained elevated temperature is what destroys the pathogens. No external heater is required, as the thermophiles naturally raise the temperature.

Figure 7.7

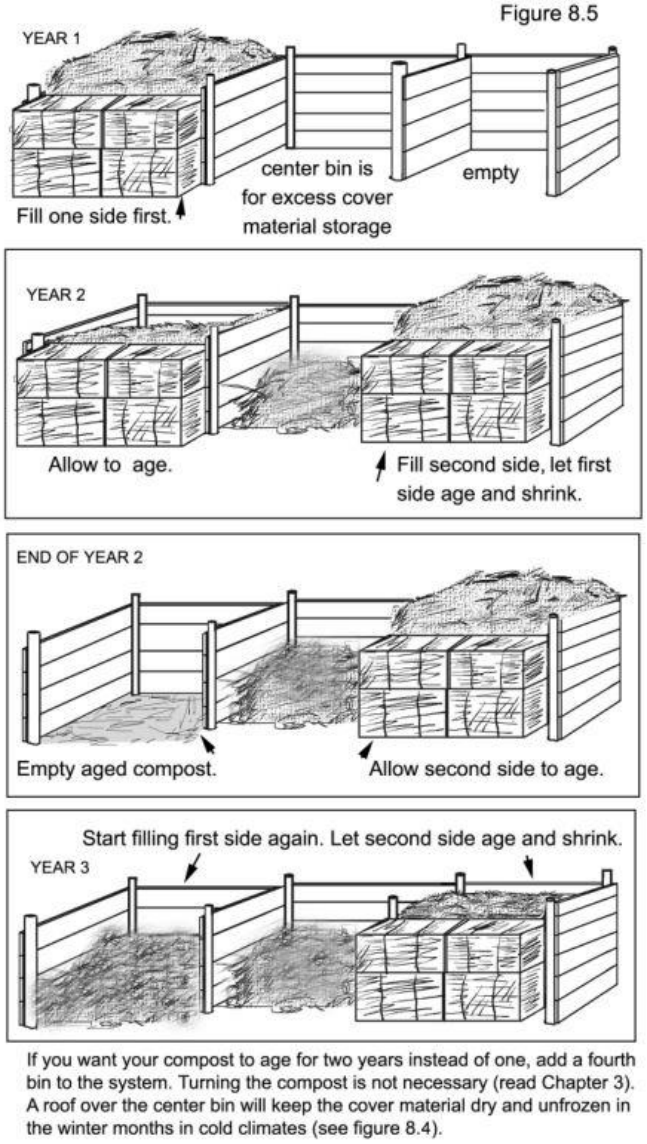



A humanure compost pile is begun with a thick layer of straw, which serves as insulation and as a sponge to soak up liquid. With this straw in place, there is no danger of leachate spilling out of the pile either into the groundwater or out beyond the pile on the ground surface. Inside the home, buckets of humanure + urine + sawdust are filled and then emptied regularly in the compost pile. The buckets are emptied in the middle of the pile and covered with straw. Within a day, the temperature of the pile rises, verified with a compost thermometer and recorded in a logbook. The decomposition process greatly reduces the size of the pile, so that new additions can be made for an entire year without overflowing the bin. After one year of additions, the compost pile is next allowed to mature/cure, a period in which mesophilic micro-organisms and worms further break down the compost. After this one-year period of rest, the compost is ready to spread in the yard. It is almost certainly pathogen-free, but just to be extra-safe, the compost can be buried underground, to fertilize non-vegetables (e.g.

flowers, trees, or even grains). Here is a diagram of a household compost bin system (from *The Humanure Handbook*):

THE CEASELESS CYCLE OF COMPOST MAKING

Figure 8.5




If you want your compost to age for two years instead of one, add a fourth bin to the system. Turning the compost is not necessary (read Chapter 3). A roof over the center bin will keep the cover material dry and unfrozen in the winter months in cold climates (see figure 8.4).

As for the buckets of humanure filled up indoors, they comprise the actual "toilet". Generally, the bucket is hidden within a more visually appealing box. A supply of sawdust is kept next to the toilet, for the user to sprinkle on top. This sawdust absorbs the liquid urine and covers the material, resulting in almost no smell. Mr. Jenkins states that no ventilation is even required, but many users nevertheless install a small fan and vent to the outside, in order to create a small negative pressure in the toilet box. Fresh sawdust is the recommended cover material, and is obtained from sawmills or from sifted piles of wood chips, rather than from lumberyards where the cut wood was kiln-dried or pressure-treated.

Here are some examples of bucket toilets in homes (from *The Humanure Handbook*):


The rate at which a bucket is filled with humanure, urine, and sawdust is approximately 1 bucket per week per person. A single bucket added to the middle of the compost pile and covered with straw is enough to prompt thermophilic decomposition, according to *The Humanure Handbook*. The process of emptying the bucket is safe, and the user does not become contaminated. A small amount of water is sprayed into the emptied bucket, and this rinse water is added to the compost pile. A layer of fresh sawdust is then placed in the bottom of the bucket, which is then ready to be used again in the bathroom.

*Some would argue that a simple system of humanure composting can also be the most advanced system known to humanity… because it works well while consuming little, if any, non-renewable resources, producing no pollution and actually creating a resource vital to life.*

(from *The Humanure Handbook* by Joseph Jenkins)

## PROPOSED SYSTEM

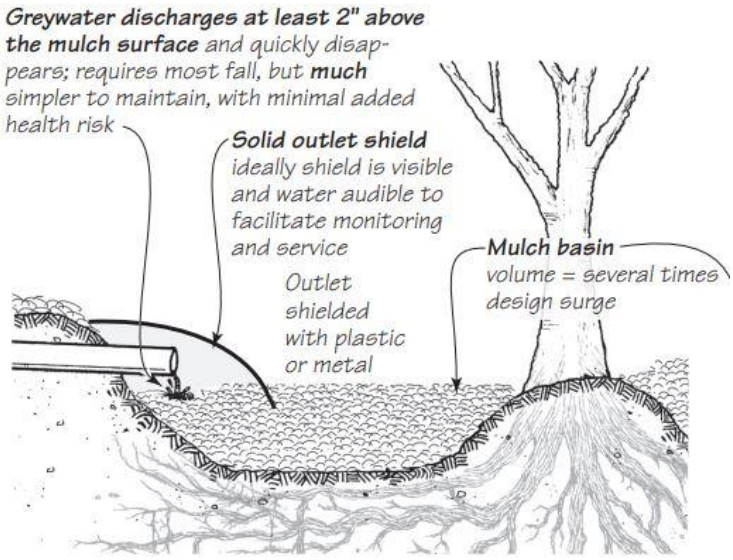
**The Property:** I am the new owner of the 0.47-acre vacant lot at 3944 Pine Ave, Clearlake, APN 039-402-390-000. This lot has approximately a 6.5% E-to-W downward slope and 2.5% N-to-S downward slope. The soil is severely compacted, due to years of parking/driving on it by neighbors, and consequently has almost no vegetation growing on it. At some point I will hire a tractor with appropriate implements to break up the hardpan, and build a short fence around the perimeter to discourage any further vehicle trespassing. My plan for the property is to build a small "eco-house" on the north end, designed with "green building" elements such as passive solar heating and cooling, rainwater harvesting, full electrification (no fossil fuels), and high-efficiency appliances. To save water and to close the nutrient cycle, I would also like to incorporate greywater diversion and humanure composting, which is the subject of this proposal. Finally, in the yard I will plant fruit trees, native bushes, perennial vegetables and vines, and annual vegetables and flowers. I will keep the yard well-mulched, using wood chips abundantly available from local tree trimmers.

**Greywater Diversion:** I would like to divert all indoor water out to the yard. As well, I'd like to *not* be connected to the public sewer line (or to a septic system). Some greywater systems include a 3-way valve that allows the user to choose between the greywater system or the sewer, but I feel this is unnecessary as I don't plan on ever dumping anything toxic down the drain. If I ever will have something toxic to dispose (e.g. motor oil, paint), I'll do so in the garbage rather than in the drain (or will recycle it or bring it to a hazardous dump site). I will use soaps and detergents that are bio-degradable and contain no borax, as these are most suitable for greywater systems. I'll also avoid chemicals/cleansers like bleach and Drano, which are inimical to microbial soil life.

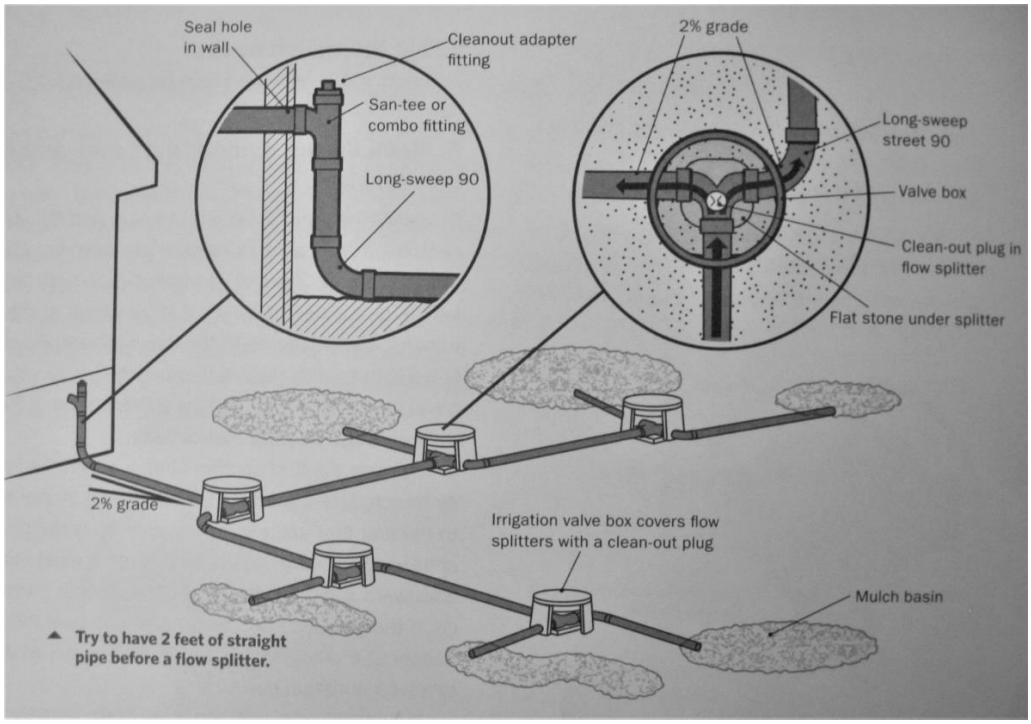
The greywater will be directed out to mulched tree basins. The basins are sized according to the amount of greywater expected, the water needs of the trees, and the percolation rate of the soil. Generally, more water is saved by under-irrigating the trees with greywater and occasionally adding supplemental water, as opposed to consistently over-irrigating. I expect my weekly water usage to be about 150 gallons per week. A rule of thumb (from *The Water-Wise Home* by Laura Allen) is that in a hot summer climate (such as Clearlake), the water needs of plants/trees in gallons per week is approximately equal to the square foot area of their canopies. Using this rule, the 150 gal/wk of greywater could therefore supply enough water for about 3 trees with canopy diameters of 8 ft. As mentioned, though, I'd like to purposely under-irrigate trees with the greywater, so I would direct the greywater to 4-6 basins, rather than to 3.

As for the actual sizes of the basins, this depends on the soil type and its percolation rate. For my property, the soil is "gravelly clay", which means I can expect a slower percolation rate compared to sandy soil. Another rule of thumb (from *The Water-Wise Home* by Laura Allen) is that with clay soils, one needs about 1 sq ft of infiltration area per gallon of greywater per day. To be conservative, the daily greywater production should be set to the maximum daily use rather than to the weekly average use divided by 7. In my situation, I expect, on a busy laundry day, a maximum daily use of about 65 gallons. Using the just-mentioned rule of thumb, this means my tree basins should have an area of about 65 sq ft. If I have 6 basins, then each basin should have an area of at least 11 sq ft. to sufficiently percolate a high surge (and avoid standing water for more than 24 hours). A mulch basin, with a greywater pipe feeding into it, looks like this (from waterwisesb.org):

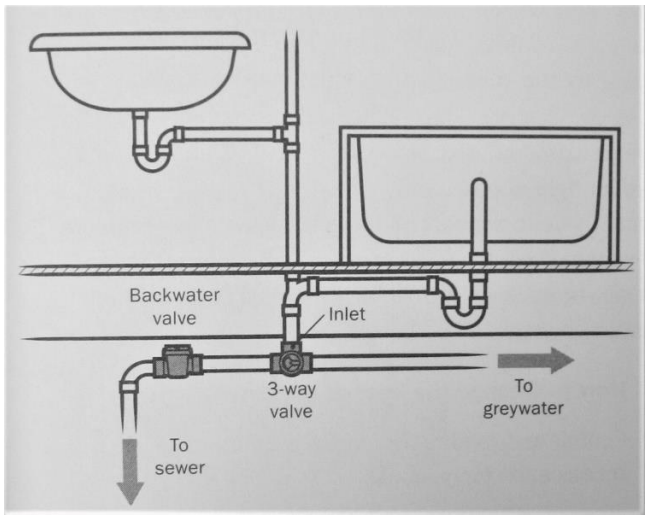
*Shielded above-grade, above-mulch outlets are preferred whenever possible. They are far less clog prone, easier to find, inspect, and maintain. These can go for years w/o maintenance.*




In the above diagram, the greywater falls on top of the mulch, but the pipe exit is covered by a shield, so that there is no exposure to the greywater before it safely sinks down into the basin. In a branched-drain system, the greywater simply flows through the pipes by the aid of gravity, eventually spilling out into the basin. The drainpipe coming out of the house is split with "wye" splitters, to direct the greywater to multiple mulch basins. A hole is drilled in each wye splitter, then threaded with a plug, to allow for occasional visual inspection of the water flow, to ensure that it is flowing and splitting correctly. Here is a diagram of a typical branched-drain system serving 6 basins (from The Water-Wise Home by Laura Allen):



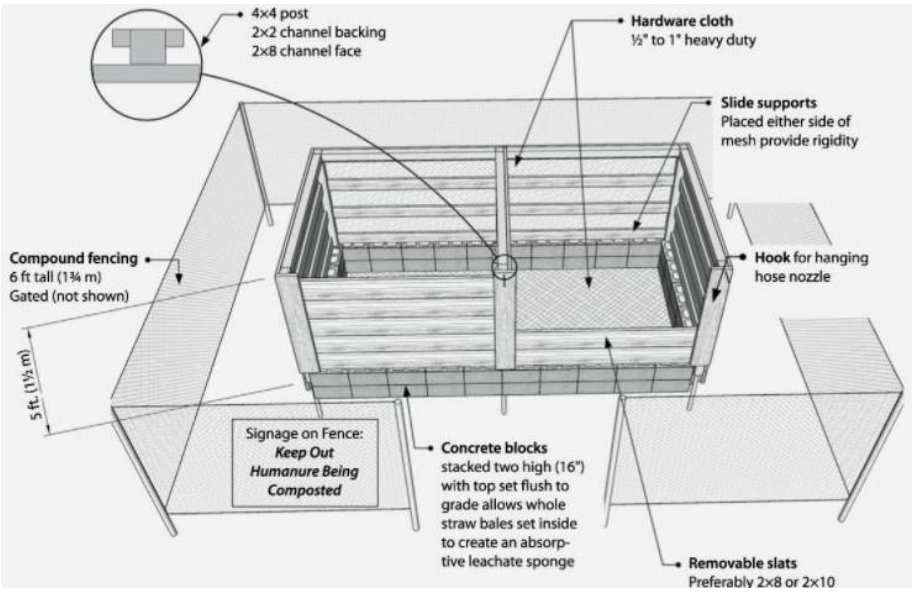

I propose to have something very similar to the above diagram for my home at 3944 Pine Ave. It will be a branched-drain system with laundry water included (i.e. there won't be a separate laundry-to-landscape system). As I mentioned above, I don't need to ever divert greywater to the sewer. However, a future owner of the home may decide to install a 3-way valve to do so. This valve could be easily spliced in the drainpipe, on the exterior of home but before all the wye splitters. A "backwater valve" is also spliced in, as a safety measure to prevent raw sewage from backing up into the greywater system. Here's a diagram that shows this optional diversion (from *The Water-Wise Home* by Laura Allen):



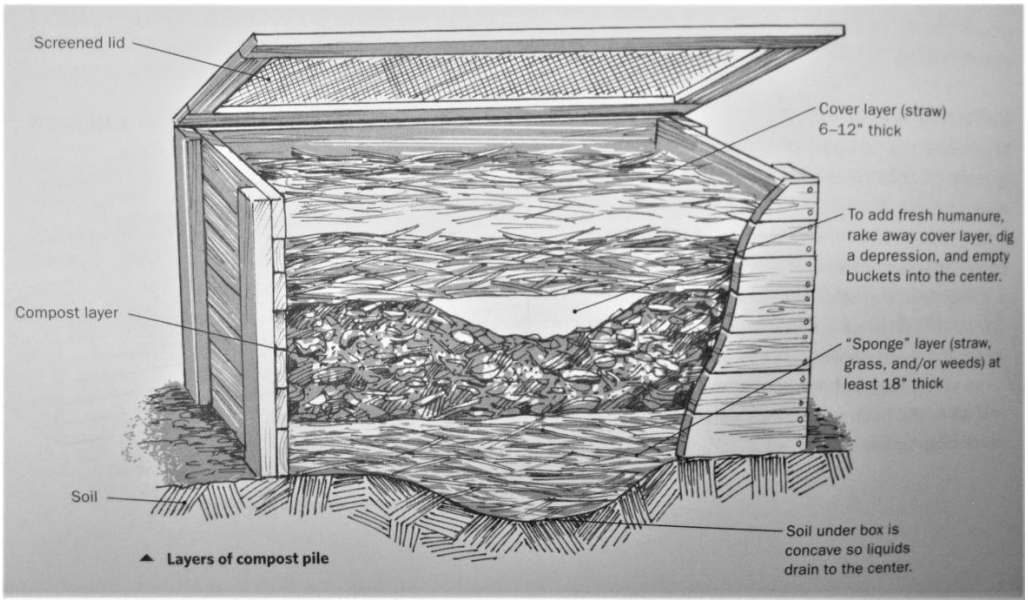
The future owner may even decide to abandon greywater diversion completely, in which case all the wye splitters and associated pipes could be removed, and the main drainpipe coming out of the home could just go straight to the sewer (i.e. no 3-way valve needed).

**Humanure Composting:** In conjunction with the above-described greywater system, I'd also like to implement humanure composting on my property at 3944 Pine Ave. Specifically, I'd like to implement the system fully described in the book *The Humanure Handbook* by Joseph Jenkins and already introduced in the Background section of this proposal. With such a system, there is again no need for a sewer line or conventional septic system. All urine and excrement is deposited in the indoor toilet bucket (along with sawdust), which is then added weekly to the dedicated outdoor on-site compost pile. The bucket toilet will be situated in the bathroom of the house. According to Mr. Jenkins, a sawdust covering in the bucket is sufficient to completely eliminate malodors. Nevertheless, some users choose to install a small fan in the cabinet containing the bucket, to create negative pressure and to vent any fumes to the outside. These fans are really only needed when there is urine diversion, which I will not have. If a fan for some reason does become necessary, it would be straightforward to drill a hole through the wall to pass a vent pipe.

To facilitate the weekly trip to the compost pile and to avoid traipsing through the house with a bucket of humanure, I will install a trap door at floor level that can be accessed from the outside. The compost pile is where the humanure is converted into pathogen-free compost. In the Background section, I showed a 3-bin system. Here's another design (from *Essential Composting Toilets* by Gord and Ann Baird), showing some added detail:



The fence around the compost pile is to keep unauthorized people out, which may or may not be necessary. Maintenance tools such as a rake and shovel remain next to the pile, not to be used for any other purpose. A source of pressurized water is also necessary, to rinse out the emptied buckets, with the rinse water going into the pile itself. The Bairds recommend hardware cloth on all sides, including the bottom, to keep out vermin. As for the pile itself, here is a cross-sectional view, from *The Water-Wise Home* by Laura Allen:




A pile is started by laying down a thick layer of straw on the ground, possibly with a depression in the ground as shown in the diagram above. This straw safely absorbs any liquids (leachate) from the pile, preventing spillage and above-ground blackwater around the pile. When a new bucket of humanure + urine + sawdust is added, the dedicated rake is used to create a depression in the middle of the pile, where thermophilic decomposition occurs. The raking moves the older compost out to the perimeter, where it further undergoes mesophilic decomposition. A thick layer of straw covers the pile, to eliminate odors (thereby not attracting flies or animals) and to trap in oxygen, as well as to provide insulation so that thermophilic temperatures can be attained.

## OPERATIONAL USE

In the previous sections, I explained the motivation behind and the design of the greywater diversion and humanure composting systems that I am proposing. In this section, I'll focus on the use of these systems, including daily use and periodic maintenance.

**Greywater Diversion:** The beauty of a well-designed greywater system is that it doesn't require much attention. If the basins are sized to accommodate the highest daily water surges, for example, then there should never be any standing water for more than a 24-hour period. If the branched-drain pipes are properly sloped and the wye splitters are leveled to split evenly, then greywater should flow smoothly by gravity alone to all the mulch basins without any blockages.

The daily use requirements are only that I be mindful of what I put down the drain. As noted earlier, I will avoid dumping substances that are toxic to soil and plant life, such as Drano, bleach, paint, and other chemicals, and will use soap that is biodegradable and borax-free. For the kitchen, I will have a good filter screen in the sink to keep food particles from ever entering the system. I eat a low-oil plant-based diet, so the amount of grease going down the drain will be minimal. In the layout for my home, I have positioned all plumbing fixtures along the same wall, so that they all share the same drainpipe. The laundry washing machine drain is positioned at the rear, so that it serves, with its soapy drainwater, to keep the whole drainpipe free and clear of any buildup. Finally, I plan to spend a lot of time in the garden and will naturally glance at the mulch basins and notice any problems.

As for periodic maintenance, one task is to occasionally (1-3 times/year) replenish the mulch in the basins, because it decomposes over time. I'll use freely available wood chips for mulch. Another maintenance task is to make sure the pipes exiting into the basins are free of debris, that nothing is blocking the free flow of the greywater into the basins. This (probably annual) task requires removing the shield over the pipe exit for examination and clean-up. Another (probably annual) task is to check that the wye splitters continue to evenly split the water flow. This involves turning on a sink, removing the plug from a wye splitter, and observing the water flow. If there is a flow imbalance, then the wye splitter needs to be better leveled and/or cleaned. Finally, over time the tree associated with a basin will grow and its canopy (drip line) will increase in radius. The basin will need to be re-shaped, to keep directing the greywater to where the roots are (under the drip line).

If there is ever a serious blockage in the system upstream of the mulch basin exit points, a clean-out port in the drainpipe can be accessed. This clean-out port is located near the exit from the house, as

shown in the branched drain schematic layout on p. 10. This would be a rare occurrence, though, probably never necessary.

**Humanure Composting:** Like greywater diversion, a humanure composting system is, if properly designed, very robust and free of any major problems. In the case of a natural disaster where the street sewer lines or the water mains become incapacitated, an on-site compost pile can still safely process humanure without creating a public health hazard. In fact, the thermophilic temperatures achieved in the compost pile are sufficient to destroy not just pathogens but also pharmaceuticals, something that sanitation districts and septic systems are unable to do, according to *The Humanure Handbook* by Joseph Jenkins. The bucket toilet + compost pile system I propose is not a "compost toilet", however. There are commercial compost toilets that attempt to compost or at least somewhat desiccate the humanure within the toilet itself, however these do not reach thermophilic temperatures and do not render the humanure safe. Many compost toilets also divert urine for the purpose of keeping the humanure contained to a small volume, something appropriate for a motor home, for example. Urine is an essential component in my system, though, as it adds urea to the compost pile, which in turn provides the right carbon to nitrogen ratio needed for thermophilic decomposition.

The daily use requirements of my humanure composting system are to continually add sawdust to the bucket toilet, enough to absorb the urine and to cover everything. When this is done, there should be no smell at all. As the toilet bucket fills, it becomes obvious when it needs to be emptied. The sawdust should ideally come from fresh hardwood, such as from a local firewood supplier. I will ensure an ample uninterrupted supply.

About once a week, a full bucket is carried (through the exterior trap door) to the nearby on-site compost pile. Using the dedicated tools, the covering straw on the pile is raked aside and a depression is created in the middle of the pile. The making of this depression naturally moves aside the previous week's deposit, now largely decomposed but requiring further mesophilic decomposition. The bucket contents are dumped in the depression and the bucket is rinsed out with a dedicated spray hose and brush. The rinse water is dumped on the pile. The straw is then raked back on top to fully cover the pile, thereby eliminating malodors, trapping in oxygen, and providing insulation. With the same spray hose, I can also wash my hands with bar soap.

The temperature of the pile, especially the top center part, will be regularly measured with a compost thermometer and recorded in a logbook, along with the time of reading and number of hours after the bucket was added. In this way, I'll have a written log of maintaining thermophilic conditions (115°-135° F), to have the peace of mind that I'm successfully eliminating pathogens. I will need an ample supply of straw for the compost pile. In Clearlake, there is a feed & grain store where I can purchase it, or I can also produce it from grains that I plan to grow in my garden. To keep the compost pile from getting too wet in the event of rain, I'll either cover it with a tarp or construct a simple roof.

As already mentioned in the Background section of this proposal, it takes one year for a single standard-sized compost pile to fill. An annual task, therefore, is to start a new pile. To do this, the existing pile that had been sitting for one year undisturbed, undergoing mesophilic decomposition and curing, must be distributed in the yard. Before distribution, it may be useful to send a sample to a lab for analysis. The lab will test for roundworm and other pathogens commonly found in human feces. Even if the analysis comes back negative (i.e. no pathogens), it's still advisable to not distribute the compost above ground or where edible crops could touch it. In other words, it will be buried and covered with soil, and distributed around trees, bushes, and possibly grains and vertically-supported vines. The distribution of the compost will be carried out with dedicated tools (shovel, pitchfork, wheelbarrow), not to be used for other purposes. The vacated bin is then inspected and repaired if needed, and a new thick layer of straw is laid in, making it ready for new humanure bucket additions.

## CONCLUSION

I hope I have made my case for greywater diversion and humanure composting at my future residence at 3944 Pine Ave in Clearlake. The greywater diversion should save me about 150 gallons per week, or about 10 units per year (1 unit = 100 cubic ft). The humanure composting closes the nutrient cycle and provides resilience in the face of natural disasters. Both together spare the sanitation department one household's worth of sewage waste.

I imagine the main concerns of the local authorities are the legalities of such systems, the potential hazards to public health, and the future salability of the home. I believe that the greywater system that I'm proposing is basically legal in California. The only controversial element is the inclusion of the kitchen sink, but with proper care this should not pose a problem. The trick is to split it up among

more than one mulch basin, to properly screen out food particles, and to not dump grease down the sink. As I've argued earlier, the simpler the greywater system is (by relying on gravity alone), the more robust it is. With properly sized basins and adequate mulch, the greywater system should be perfectly safe and well-functioning. Finally, in regard to future salability, a "user's manual" will accompany the greywater system so that future homeowners know exactly where the pipes are and what the maintenance tasks are. As well, if a future owner wishes to attach to the public sewer line, including a 3-way valve or eliminating the greywater system should be straightforward.

*The Humanure Handbook* by Joseph Jenkins points out that backyard composting of humanure is not technically waste or sewage disposal, but rather a form of recycling in which humanure is turned into pathogen-free compost. As such, it is not governed by waste or sewage regulations. In fact, residential backyard composting of organic matter is generally exempt from any regulations at all (unless the compost is sold). Finally, while "composting toilets" are regulated in some states, the sawdust bucket toilet in my proposed system is not such a toilet, as explained earlier, as the composting occurs not in the toilet but in the outdoor compost pile.

As far as safety and public health are concerned, in many respects a backyard humanure composting system is safer and more robust than either public sanitation or a septic system. For example, sewer pipes can break from old age or from an earthquake, releasing sewage into the ground water. Over-burdened sanitation systems can inadvertently release sewage into open waterways. Even fully treated wastewater may contain contaminants like pharmaceuticals, which can affect wildlife (e.g. salmon). Septic systems require regular professional maintenance, which if not done and left to overflow, create a smelly nuisance to both the homeowner and the neighborhood. Finally, flush toilets often fail or become clogged, requiring *immediate* repair (not always possible). My proposed humanure system does not suffer from any of these flaws. The user is actively involved in its operation and maintenance, and consequently is able to keep small problems from becoming big problems. As long as common-sense measures are taken to ensure that the compost stays confined to the compost pile (as detailed in earlier sections), then Nature does all the work of converting the humanure into a valuable, pathogen-free soil amendment. As with the greywater system, a future homeowner can easily install a flush toilet and hook up to the public sewer line, if so desired.

I realize that what I'm proposing is unorthodox and novel, and would understand if the County Health department would want to periodically inspect my systems. These systems could be labeled a "pilot project" or an "experimental/alternative septic system", in order to receive approval.