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ADVANCED ONSITE TREATMENT AND DISPERSAL OFFERS NEW SOLUTION FOR MOBILE HOME PARKS

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ABSTRACT

Like many mobile home parks, the Paradise Cove Trailer Park began as a getaway RV park located in a picturesque location by the sea. As it's popularity grew, the park grew into a large mobile home park, outgrowing its wastewater infrastructure. With only septic tanks and seepage pits, the Owner resorted to frequent pumping, shifting sewage from one cluster of pits to another. Finally the Owner bought a pumper truck to handle the cost of transferring water out of failed seepage pits clusters on a daily basis. At that point, the Regional Water Quality Control Board stepped in with Waste Discharge Requirements and a schedule for repairs. The Owner agreed to upgrade collection, treatment, and disposal to substantially improve the system's performance and reliability. The resulting system will collect wastewater from the 257 mobile homes using a cluster approach. The park flow of 40,000 gpd with peaks of 60,000 gpd will be collected by gravity sewers draining to septic tanks with effluent screens. Multiple tanks will drain to lift stations to pump the water in small-diameter pressure sewers to a centrally-located treatment facility site in a discrete area of the park. Wastewater treated in twenty AX100 textile filters will achieve an advanced secondary level. Disinfection using a redundant UV-ozonation system will match municipal requirements for disinfection. From a dosing tank, the disinfected effluent is redistributed throughout a 20-acre area and dispersed in subsurface drip fields and seepage pit clusters. Key issues associated with the project were the task of navigating through multiple agencies to obtain a permit; identifying a suitable and reliable disinfection system; specifying automatic controls for a system with a large number of distributed components. One of the Owner's goals was to obtain incidental irrigation from the highly treated effluent, but regulations were seemingly conflicting or absent. This project is one case where a permit for a repair allowed multiple objectives to be met: (1) progress in onsite system technology, (2) incidental irrigation benefits in a water-poor state, and (3) preservation of public health. Incidental irrigation benefits were the vulnerable to prohibition, depending on interpretation where regulations are unclear. Standards for subsurface water recycling are needed to accommodate the agencies' concerns while maintaining the affordability of the system.

INTRODUCTION

Mobile home parks are a common sight in rural areas of California. Mobile home parks serve many purposes, such as affordable housing, housing for migrant workers, country getaways, and beach-front second homes. Frequently, mobile home parks use onsite wastewater systems. Unfortunately, many older parks exemplify what to avoid -- undersized tanks, plugged disposal fields, overflows, frequent hauling of sewage, etc. Despite this drawback, mobile home parks are a viable source of affordable housing, particularly in low-income desert communities experiencing sizable and sustained population growth. In the Coachella Valley of Riverside County, several mobile home parks are planned to accommodate migrant workers in an effort to improve their living conditions. The need for low-cost systems in an area with shallow depth to clay soils creates a special challenge. The experience at the Paradise Cove Trailer Park offers a new solution for the planned low-income parks.

THE IMPORTANCE OF SUCCESSFUL BIOMECHANICAL SYSTEMS

In California, mobile homes are an affordable housing option in a state with little affordable housing. It is essential that repairs to existing parks demonstrate that mobile home parks can have modern, effective, and reliable wastewater systems. The systems must be economically feasible and must fit within the limited space available in a mobile home park.

Fringe areas of the Los Angeles and San Diego metropolitan areas are experiencing a modest but steady growth in biomechanical treatment systems using a variety of dispersal methods. As local agencies and engineers gain experience in these systems, the size of systems using biomechanical treatment is growing. Most notably, the Los Angeles Regional Water Quality Control Board (RWQCB) required a comprehensive repair and replacement of the onsite system for the 257-home Paradise Cove Trailer Park in Malibu, California. The topics covered in this paper are (1) the steps taken to obtain the support of the RWQCB for a biomechanical system, (2) the selection of the treatment technology, (3) the challenges confronted in the design of the rehabilitation, and (4) costs for the system. By looking at the issues and challenges encountered to convert to a biomechanical system, the project provides a model for repairs in other mobile home parks and offers a technical approach that may be duplicated for new parks.

PARADISE COVE WASTEWATER SYSTEM -- DESCRIPTION AND HISTORY

The Paradise Cove Trailer Park is located on cliffs and lower lands adjacent to the Pacific Ocean. The park consists of 257 mobile home sites, arranged into upper and lower sections, separated by a vertical distance of approximately 150 feet. The lower section was built in the early 1940s, while the upper section was added in 1969 and expanded until 1973. The park is served by on-site septic systems with dispersal in seepage pits and/or leach fields.

A total of 29 septic tanks ranging from 1,000 to 7,500 gallons discharge primary treated effluent to a system of seepage pits and leachfields. The use of seepage pits greatly outnumbers the use of leachfields.
The typical system configuration consists of 5 and 10 mobile homes connected by sewers to septic tanks and a seepage pit/leachfield disposal network. Seepage pits are generally 5 feet in diameter and 30 feet deep. Seepage pit clusters serve one septic tank. Leachfields range from 50 to 100 feet long, about 24 inches below ground, each serving one tank.
As seepage pits failed, additional pits were added to prevent surfacing effluent. Leaky fixtures allowed thousand of excess gallons into an aging, hydraulically-overloaded system in certain areas of the park. Roots from mature trees searched for water and found them in nearby laterals, also causing failures.

ROLES OF REGULATORY AGENCIES

Five agencies were involved in the permit discussions to upgrade the septic systems with a single biomechanical plant:
1. State Housing Authority – the lead agency with responsibility for building safety and health issues for all mobile home parks.
2. City of Malibu and County of Los Angeles agencies – these agencies are occasionally asked by the State to review specific decentralized wastewater plans outside the scope of their expertise.
3. California Coastal Commission (CCC) – this agency maintains the position that it has final authority over any new building construction or repair within the coastal zone.
4. Los Angeles Regional Water Quality Control Board - this agency maintains the position that that it has final authority on all water related issues.
5. State Department of Health Services -- during the design stage, the agency was examined the subsurface drip disposal design to determine if incidental irrigation by subsurface drip dispersal should be viewed as irrigation with recycled water, requiring expensive monitoring.

Because mobile home parks are regulated by the State Housing Authority, county health officials had no authority in this case. Only if surfacing effluent left the property line of the park (e.g., to the beach) would the county have authority.

An attempt was made to repair the system using a conventional septic approach for a section of the park adjacent to a concrete-lined creek. The State Housing Authority indicated that it did not have the expertise to review the plan and directed the owner to submit plans to the local environmental health agency for approval. An "Approval in Concept" was given by the City of Malibu. This Approval in Concept was submitted the CCC for review and approval. Only after receiving CCC approval could the project be returned to the local agency for final review and approval. This approval took over one year and in the mean time, two things happened.
1. The RWQCB declared it would require Waste Discharge Permits for all commercial and multi-family homes.
2. California Assembly Bill 885 emerged indicating the need for statewide performance standards for onsite systems in sensitive areas, particularly coastal areas. In December 1999, the Paradise Cove Trailer Park was one of the first five properties told to submit a Report of Waste Discharge application. Failure to submit the application pursuant to Section 13268 of the California Water Code would have resulted in civil liability penalties of up to $1,000 per day.

The discharger clarified its intention to build a Septic Tank Effluent Pump (STEP)/Septic Tank Effluent Gravity (STEG) small diameter pressurized sewer to a centralized treatment system using packed-bed filters and ultraviolet (UV) light disinfection. Disposal would include a network of zoned seepage pits and zoned subsurface drip fields.

The Waste Discharge Permit was issued in May 2002 with the discharge limits shown in Table 1:

Table 1. Waste Discharge Limits

Constituent	Units	Average	Maximum
TDS	mg/L		1,000
TSS	mg/L	30	45
BOD5	mg/L	30	45
Turbidity	NTU	5.0	--
Oil and grease	mg/L	-- 15	
Nitrate + Nitrite + Ammonia + Organic Nitrogen as Nitrogen	mg/L	-- 101	
Total Coliform	MPN	70	--
Enterococcus	MPN	24	--

1. Point of compliance for total nitrogen is groundwater.

TECHNICAL APPROACH
ALTERNATIVES ANALYSIS

Upon receipt of the Waste Discharge Requirements (WDR) from the Regional Water Quality Control Board, an alternatives analysis was conducted to identify suitable treatment technologies that would fit the permit conditions. Specifically, the system had to be suitable for centralized treatment per the permit conditions. The system also had to be suitable for disposal using subsurface drip dispersal. Effluent BOD and TSS levels of 10 mg/L or less was preferred. The design team examined the following three technologies:

- **Orenco Advantex AX100.** This system operates as a recirculating packed bed filter that uses a textile material as the treatment medium. Sludge is kept in septic tanks through the use of effluent filters. The sludge decomposes anaerobically and is removed on a multi-year basis.
- **Biomicrobics FAST.** The FAST system is an aerobic, biological fixed film process. The system consists of a vessel packed with a submerged medium that is aerated to provide mixing and oxygen. Sludge is collected in the bottom of the basin, digested anaerobically, and removed on a multi-year basis.
- **Zenon/ZeeWeed ZenoGem process.** The ZenoGem process consists of a suspended growth biological reactor integrated with an ultrafiltration membrane system. Sludge is stored in a separate tank for removal several times per year.

Several criteria were used for evaluating the three treatment technologies as described in Table 2 below. Following the table is discussion of how subsurface drip dispersal and automatic controls affected the evaluation.

Table 2. Evaluation Criteria

Criteria	Description
Effluent Water Quality	Meets RWQCB requirements, suitable for final disposal by subsurface drip system
Operational Complexity, Reliability, Flexibility and Sludge Generation	Operator friendly, self-regulating system, automatic controls; accommodates changes; robustness and redundancy; sludge generation and its effect on complexity and cost
Capital Cost and Operation and Maintenance (O&M) Cost	Equipment, installation, energy, media replacement, chemicals needed, and labor
Aesthetic Impacts	Noise and odors
Land Requirement	Treatment process footprint, flexibility of installing treatment units in different configurations

The requirement of suitability for subsurface drip dispersal was made by the Owner who valued subsurface drip as an environmentally-preferred method of disposal. The Owner also hoped for coincidental irrigation as a bonus. While subsurface drip dispersal is an unnecessary cost for some mobile home parks, it may be the best dispersal solution for areas of Southern California where clay soils at shallow depth wreak havoc with conventional leach fields. Shallow clay soils are common in the Coachella Valley where several low-income parks are planned. The residents in these parks have limited resources to correct problems and can ill-afford to install conventional systems, only to have them fail within a short period.

For many mobile home parks, using automatic controls is not a primary objective. In this case, the Owner desired automated controls with telemetry for remote access by the operator. The income level of the park residents made this option affordable. However, automated controls are probably a luxury in affordable housing parks. With time, a park could incorporate more sophisticated controls once the workings of the biomechanical system become understood and the desire to reduce time or labor cost gains importance. The evaluation indicated that all three technologies were suitable, but the AX100 system scored highest in most areas, including cost of construction and energy cost during operations.

SITE INVESTIGATION

While conducting the evaluation, a site investigation with borings and percolation tests located areas where new seepage pits could go. Infiltration tests were conducted to locate suitable drip fields. Infiltration tests are allowed by the City of Malibu in lieu of shallow percolation tests. The engineering team selected infiltration tests as the preferred test method. In the test, water added to the soil is spread out in a horizontal direction, as opposed to a vertical direction used in percolation testing. This, better simulates the behavior of effluent in shallow drip dispersal systems. The loading rate for the drip fields was set at 0.2 gallons per day per square foot (gpd/sf) although the tests indicated suitable rates up to 0.5 gpd/sf. Using the lowest suitable rate for design would allow for greater doses per field when more water was available but would also allow for less water in the beginning and during periods of intermittent rainfall.

DESIGN OF A REPLACEMENT COLLECTION SYSTEM

One of the goals of the project was to replace the existing sewers. As with any underground utility repair, other utilities, paving, and lot improvements interfere, complicating the replacement or relocation of sewers. In some areas, sewers ran under the homes or in back yards with constrained access. New sewers installed in the streets, will keep down the costs for installation and maintenance. Existing septic tanks were considered too old and unreliable for further use. New gravity sewers were designed to flow to street intersections where large septic tanks will intercept the flow. Effluent filters in each septic tank hold back the sludge, keeping down the cost of sludge stabilization. A float in each tank wired to an alarm, will alert the operator to high water conditions. Filtered effluent from the septic tanks will flow to pump stations and pumped to the centralized treatment system. Typically, a pumping system must have a 24-hour reserve volume in the tank. In the event of an alarm condition where a pump fails, wastewater can accumulate without backing into homes, giving the owner time to fix the pump or call a pumper truck. Since several septic tanks drain to each pump station, the tankage at these stations would have been very large and expensive. Instead of the tanks, high water alarms and a portable emergency generator will provide the necessary redundancy. In a power outage, the pump stations will provide a storage capacity of six hours, giving the operator enough time to pump out each pump station and truck the water to the recirculation tank.

A benefit of using the effluent filters in the septic tanks is the reduced cost of using of small diameter sewer pipes from the septic tank outlets all the way to the treatment plant.

CENTRALIZING THE TREATMENT SYSTEM

For this particular mobile home park, several factors resulted in selecting a centralized treatment system. The lower section of the park is located next to a creek with a risk for contaminating the creek from seepage pits and the aging system.. By relocating disposal to higher ground, the risk is substantially reduced. For the other areas of the park, ease of operation and lack of disturbance to residents were important criteria. A centralized location allowed the Owner to provide better security in an “out of sight, out of mind” location. A single fenced yard will ultimately house the controls, AX100 pods, disinfection system, and dosing tank.

AX100 System. The AX100 secondary treatment system starts with two 30,000-gallon recirculation tanks installed underground. Sized for peak flow, the tanks, function as surge tanks as well as recirculation tanks. Pumps in the recirculation tanks pump the flow to clusters of ten AX100 treatment pods that will reduce the BOD and TSS to 10 mg/L each. The modular feature of the pods provided the flexibility needed to fit into an odd-shaped lot. The large size of the pods resulted in only twenty pods required for all 257 homes. The system was designed to cycle wastewater through the pods repeatedly with about 20% of the flow discharging during each run cycle. Each pump will be protected by an effluent filter. Because of the modularity, the AX100 system should be suited to other mobile home parks as well.

Disinfection System. Locating a satisfactory disinfection system proved problematic. The RWQCB required the use of ultraviolet light (UV) disinfection, which was thought to be the best approach at the time. Several UV systems were rejected for diverse reasons. One system could not handle intermittent flows. For another, the 60,000 gpd design flow was too small. The controls were inadequate on a third and the manufacturer’s sales and technical support staff were not responsive for a fourth unit. Ultimately, a redundant UV-ozone system was selected. Manufactured by Pur-O-Tech in Escondido, California, the skid-mounted system will disinfect with UV followed by ozonation. The system provides the level of redundancy required for large municipal treatment plants. Pre-filters for the disinfection system will backwash automatically to the recirculation tank. As a bonus, ozonation boosts the oxygen content of effluent, keeping it fresh and odor free.

The disinfection controls will fully integrate with the controls for the secondary treatment system for access through one telemetry system. A data logger was designed into the system. The data logger was added to monitor system performance and track the maintenance history of the system. The data logger receives inputs from a flow sensor, flow switch, ozone meter, and pressure switches. Information from the data logger can be used to record total run hours on the disinfection system, to track ozone concentrations in the treated wastewater, and to examine general system maintenance alarm history.

Although very reliable, this type of disinfection system is only suited to larger applications because of equipment and economic limitations. For smaller mobile home parks or in areas where trained operators are not available, other disinfection options should be considered (e.g., UV, peracetic acid, and chlorination).
Dosing Tank. Available land for the treatment system was located in the middle of the geologically worst area for wastewater disposal. The need to pump to the treatment system and subsequently pump to disposal areas was unavoidable. A dosing tank will control the flow of pumped effluent to the multiple drip fields and seepage pits. Initially, the dosing tank was sized with a six hour emergency capacity. A larger emergency storage capacity was considered unnecessary because of an emergency generator located at the treatment plant,. However, the experience of a nearby system showed that the flows during a 4-day Fourth of July weekend would necessitate a larger storage capacity.

DISPOSAL SYSTEM

The disposal system will consist of new and existing seepage pits and new drip fields. The drip fields will accommodate 50% of the peak flow or about 75% of the normal flow. Due to unfamiliarity with subsurface drip disposal, the RWQCB required seepage pit capacity sufficient to accommodate all flows during conditions of saturated soils (wet weather). While it is understandable that the agency would want to proceed cautiously with an unfamiliar technology, this resulted in added costs with questionable merit, given the extensive use of drip fields in other states.
The drip fields will be installed in slopes not exceeding 30%. Check valves located on every third line will prevent water from draining to the lowest line when the pump shuts off and the pressure drops. Drip lines will also be spaced farther apart at the lower end of the fields to further prevent excessive water at the toe of slope.

The six- to twelve-inch depth of installation is a benefit of drip fields that could be valuable to other mobile home parks, particularly where shallow soils are a problem. Root uptake, evaporation, and a higher humus content in this zone help the effluent to disperse. However, care must be taken to protect the field and prevent the tubes from becoming exposed or damaged. Frost was not a consideration in this climate.
In areas of shallow clay soils (e.g., Coachella Valley), a low hydraulic loading rate in the drip field helps to overcome this condition. In areas where inadequate vertical separation to bedrock causes chronic disposal problems, drip dispersal should be a viable remedy. Where conventional leach fields are undersized, switching to a drip field could overcome the problem because drip fields almost always require less land. However, drip fields need a higher effluent quality, i.e. more treatment than is possible from a conventional septic tank.

Recycled Water?

An issue surrounding subsurface drip disposal in California is whether the incidental root uptake that occurs in subsurface drip fields should be considered irrigation with recycled water. Title 22 State codes require onerous and costly monitoring for water recycling. Overhead spray and other above ground methods are the only methods used by municipalities. To apply the criteria of Title 22 to subsurface drip dispersal seems excessive. When RWQCB asked the State Department of Health Services (DHS) to determine whether the drip dispersal should fall under Title 22, DHS expressed concern that some drip fields would be located in areas where people would walk. The orientation of DHS was that areas covered by grass or other areas meant for human egress should not have drip fields under them. This effectively reduced the areas where drip could be used and will increase the potable water needed for irrigation for this project. In an arid state, the lost opportunity for incidental irrigation is unfortunate.

Incidental irrigation does occur from subsurface drip disposal fields. In California, the threat of applying

Title 22 requirements to subsurface drip fields is a deterrent to reducing potable water usage. Title 22 was not developed with onsite drip systems in mind, but rather recycling of treated effluent from municipal treatment plants. For the present, until subsurface drip disposal is securely established in California, the ability to optimize incidental irrigation is effectively curtailed on projects involving the State. Once subsurface drip is established, this issue should be resolved in a public forum with stakeholders to set safe, reasonable, and affordable parameters for drip disposal and its potential use to augment irrigation from other sources.

Costs

The engineer's estimate for construction of the complete replacement of the collection, treatment, and disposal system for the park was $1.6 million. The contractor's bids ranged from $2 - $3 million, which included complete repaving of all streets at $0.5 million. The lowest bid was submitted by a firm with strong experience in onsite systems so was selected with confidence. As of January 2004, the start of construction was delayed as the result of a brainstorming session with the contractor, engineer, and owner where cost savings were found that would also result in reduced impact to residents. Changes to the treatment system layout are in progress.

If the ultimate constructed cost stays at $2 million, the cost will be $7,800 per dwelling unit. Given that this is a rehabilitation with existing streets, utilities, and other interferences, this cost is competitive with conventional sewer infrastructure. For new construction, the cost would be substantially reduced without these interferences.

CONCLUSIONS

Mobile home parks offer affordable housing in urban and rural settings. In some areas of Southern California, existing mobile home parks act as role models for the growing number of parks in rural areas. Unfortunately, several older parks have failing septic systems. The Paradise Cove Trailer Park is undergoing complete replacement of its collection, treatment, and disposal system. The RWQCB permit conditions allowed design of a STEP system, AX100 packed-bed filters, redundant UV-ozone disinfection, seepage pits, and subsurface drip dispersal. The system will provide advanced secondary treatment. Disposal of 70% of the average flow by drip dispersal represents an important benefit for incidental irrigation. The multi-agency regulatory setting made for a slow start in upgrading the system and somewhat limited the potential for incidental irrigation. However, the agencies worked collaboratively throughout the project development phase to accommodate unforeseen changes. The construction cost of the system at $7,800 per dwelling unit is comparable to the cost of constructing conventional sewer with centralized municipal treatment, although a conventional system rarely offers the benefit of onsite irrigation.