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RECLAMATION OF SANITARY LANDFILLS: A CASE STUDY IN SHELBY COUNTY, TENNESSEE

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ABSTRACT--Approximately 30,000 sanitary landfills were in operation in the United States in 1976; today, there are <7,000. The remaining 23,000 closed sites can be reclaimed to actually enhance the surrounding community; cost is the only limiting factor. Abandoned sanitary landfill sites do have problems, namely leachates, methane build-up, and subsidence. However, with modern techniques and planning, these problems can be overcome. Across the nation, old landfills have been converted into golf courses, parks, ski resorts, libraries, and even methane power plants. In some cases, a community's property value has actually increased after reclamation of the local landfill. Shelby County, in southwestern Tennessee, currently has four closed sanitary landfills. Only one site has been fully utilized as a recreational facility. At this site, four soccer fields are home to over 150 league soccer teams. Two sites are home to airplane radio-control clubs, although most land at these sites is currently unused. The fourth site is completely unused and up for sale. All of these closed sanitary landfills have potential use as recreation areas, but, as is often the case, lack of money and initiative is preventing development.

Garbage is a fact of life. The United States alone produces approximately 227 million metric tons of trash each year. After recycling and combustion, at least 119 million metric tons of garbage still remain (Wingerter, 1989). The municipal solid waste alone produced each year totals 145 million metric tones or 1.5 kg of garbage per person per day. By the year 2000, this amount is expected to increase by 20% (Forester, 1988). The majority of the solid waste ends up in sanitary landfills. In 1976, approximately 30,000 landfills were in operation in the United States; the latest survey by the Environmental Protection Agency (EPA) showed only 6,584 (Forester, 1988). The approximately 23,000 landfills now closed offer an often overlooked opportunity for land reclamation in land-hungry urban/suburban areas.

The concept of sanitary landfill reclamation appears to be a recent idea. Over one half of the literature on the subject was written in 1989. The oldest source, an EPA summary report, is only 8 years old. The news media has made the garbage explosion a popular topic, and people are just beginning to realize the need for landfill reclamation. Incorporated into this reclamation concept is how to make new landfills more attractive to the community.

As can be expected, the majority of articles on landfill reclamation were found in the solid waste journals such as *World Wastes* and *Waste Age*. *BioCycle*, the journal of waste and recycling, appears to be the leading authority on the subject. Other journals discussing reclamation were those involved with environmental subjects such as *Audobon*, and the *Environmental Protection Agency Journal*.

Many other journals are recognizing the growing problem by incorporating brief articles containing the statistics of the garbage problem, but no discussions of landfill reclamation follow. It is the authors belief that as the need for landfill reclamation continues to grow, so will the number of articles on the subject.

The purpose of this paper is to discuss the methods of sanitary landfill reclamation being used today and to explore the current and potential uses for the reclaimed lands. Case studies across the nation will be examined, with specific attention being given to the current and potential uses of closed sanitary landfills in Shelby County, Tennessee.

Sanitary landfills developing waste settlement and methane build-up are sites most readily used for low level developments such as parks, golf courses, and open storage. However, with proper engineering, any use is possible. Franklin B. Flower, an extension specialist in environmental science at Cook College, New Brunswick, New Jersey, claims "Anything you want can be done with a landfill -- if you spend enough money" (Naber, 1987). Economics often dictate what can be done with a closed sanitary landfill. The land is cheap, but, depending upon development plans, the construction and maintenance price can run high. To merit expensive construction, a site must provide a property purchase-cost advantage that outweighs maintenance and building costs. For example, to build a truck transfer station, Buncombe County, North Carolina, paid only $494/ha ($200/acre) for a closed sanitary landfill site. This cost is compared to the $49,383/ha ($20,000/acre) land adjacent to the landfill. Even with the higher construction costs at the landfill site, the county saved money (Naber, 1987).

PROBLEMS

Building on closed landfills is not easy. There are problems with which one must deal such as leachates, methane, and subsidence. Post-closure requirements enacted 18 March 1990 by the State of Tennessee require that sanitary landfill operators will be responsible for the landfill site for 30 years after the closing, even if the operator no longer owns or leases the land. Unfortunately, these requirements are in effect only for landfills which closed after 18 March 1990; nevertheless, many operators already follow similar procedures. Many other states have similar laws. It is expected that when the Federal Subtitle D Resource, Conservation, and Recovery Act is finalized, these requirements will be standard for all sanitary landfills in the United States (P. Patterson, Tennessee Department of Health and Environment, Division of Solid Waste Management, pers. comm.). The individual problems and methods of how they can be overcome are as follows.

Leachate--A major worry among people in the vicinity of landfills is the production of leachates, a liquid by-product of decomposing

garbage and rain, which may pollute the local water supply. With proper drainage, collection, and filtration systems, contamination of local water supplies can be avoided. Again, by law, landfill operators must take yearly samples of water in and around the closed site. These samples are tested, and, even if a minute trace of contamination shows up, steps must be taken to correct the leak before water supplies become contaminated.

Methane--Methane is another by-product of garbage decomposition and is readily found in sanitary landfills. If the methane is allowed to concentrate, it may become explosive. A well-designed ventilation system can free methane in small amounts to the atmosphere, reducing the danger of explosion. All landfill sites have methane wells which are monitored at least four times monthly as required by the environmental law. If methane levels reach to within 0.5% of normal air (15% methane to normal air is the explosion level), the gas is pumped into a holding container and later sold.

To protect a building constructed over a sanitary landfill, a 0.305-m layer of crushed rock, capped with a clay liner, can be placed under the foundation of the stucture. A series of horizontal perforated pipes placed in the rock transfer the methane to the surface (Naber, 1987).

Vegetation may also have a difficult time growing because methane can suffocate roots. The EPA conducted a 4-year study at the Edgeboro Landfill in East Brunswick, New Jersey, to determine the critical factors affecting vegetative growth on landfills. The study found that trees with shallower root systems, such as black gum and Japanese black pine, were more tolerant of the methane environment. Smaller plants (30-60 cm in height) appeared to be better suited to survival. Balled and burlaped roots also led to better growth when compared to bare roots. The study concluded that the most effective methane gas barriers for plant roots were a soil trench underlain by plastic sheeting over gravel or vented by means of vertical PVC pipes, a mound of soil (0.9 m high) with no clay barrier, and a soil mound (0.9 m high) underlain with 30 cm of clay. Even with these methane protectors, the best plants in the area were slow growers. The study also discovered that certain woody species more tolerant of a low oxygen environment similar to those found in frequently flooded areas will grow well on landfill soil where irrigation is frequently done (Gilman, 1981).

The results of this study do not state that plants will not grow on landfills. They demonstrate that, as with any landscape setting, certain species are better able to survive and flourish than others.

Subsidence--According to David Claibo of the Memphis Browning Ferris Industries (BFI), a building can be erected on a closed landfill after 5 years because the site takes that long to settle. Sometimes the landfill settles as much as 6.1 m. A method used to speed up the subsidence process is pounding, which simply involves raising a heavy (7.3-9.1 metric tons) steel or concrete weight to approximately 30 m and then dropping it. A lighter weight (1.8-5.4 metric tons) dropped from 9 to 12 m, 3 to 15 times, on the same location causes densification from 3 to 6 m. The cost of pounding (lighter weights about $\$0.91/m^2$ and heavier weights up to $\$1.83/m^2$) is a saving of approximately four to one over placing foundation piles on bedrock. After pounding, building footings and floor slabs should not settle after construction. The only limitation to pounding is that it is safe for buildings of only one or two stories (Naber, 1987).

The best method for avoiding problems of subsidence with closed sanitary landfill sites is initial planning for ultimate use even before garbage is dumped on the site. Schemes such as the terracing of side slopes to prevent shift and the installation of storm water pipes at the site to deter erosion can be used. Internal collection systems to pump out leachate need to be installed early. When reclaiming an old site, a thick (1.8 m) layer of topsoil, good records of buried wastes, and the original topography records make the job easier (Naber, 1987).

CASE EXAMPLES IN OTHER CITIES

Belleville, Michigan--Perhaps the best example of landfill reclamation is from Wayne Disposal Inc. in Belleville, Michigan, near Detroit. Here, closed and open sites work together. From the closed sites, methane is extracted to generate electricity within the company's own power plant. This plant produces 33,000 kw daily, which is enough energy to fulfill the needs of 1,800 homes in addition to meeting the company's own requirements. The energy alone is worth one-half million dollars, and it represents only 15% of available methane.

Due to subsidence and the chance of a building's foundation penetrating the landfill's protective clay liner, the owners determined a conventional structure should not be built upon the site. Instead, Wayne Disposal Inc. built a greenhouse which "floats" on the surface. Known as Willow Run Farms, the greenhouse raises herbs and experiments with new agricultural techniques. Since the greenhouse system uses the company's own electricity and incorporates the methane produced by the landfill for its heating needs, the farm is efficient enough to compete with herb growers in warmer regions.

Mike Miller, the Director of Planning and Development at Wayne Disposal Inc., has plans to convert an additional 16.2-ha closed site into a leaf composting operation (Logsdon, 1989). Currently, there are 20 leaf composting programs located on closed landfills in Michigan. These programs divert 272 metric tons of leaves per day from open landfills (Goldstein, 1989).

Riverview, Michigan--In Riverview, Michigan, a Detroit suburb, a closed sanitary landfill has been covered with clay and transformed into a ski resort area with a ski slope. This recreational facility increased the property values of the surrounding area and led to the construction of $300,000 homes nearby. There are plans to increase the ski slope distance an additional 91.4 m; the transfer of soil to increase the slope and slope distance will result in a depression which will then become a lake and park area. This landfill also has a methane reservoir which produces approximately 7 megawatts of energy on a continuing basis (Logsdon, 1989).

Boston, Massachusetts--Halley/Aldrich Inc., of Cambridge, Massachusetts, is a foundation engineering firm which has worked on approximately 50 landfills in the past 10 years. The firm has helped design the John F. Kennedy Presidential Library, some of the University of Massachusett's buildings, and the Massachusetts State Archives Building. These buildings are all located on Columbia Point, a former landfill. The sanitary landfill closed in the 1950s was not developed until the 1970s. This site is perfectly located near Boston proper. David Thompson, Executive Vice-President of Halley/Aldrich Inc., believes that if the landfill had been located outside the Boston city limits, the buildings would not have been built there (Naber, 1987).

Naples, Florida--An innovative recovery method has been tested at the Collier County landfill in Naples, Florida. Here, landfill reclamation involves excavating the existing landfill site according to conventional surface mining techniques. The landfill's contents are then separated into soil, recyclables, and combustibles, all of which may be used in a variety of beneficial applications. Following the excavation procedures, the site can be up-graded and redeveloped to include state-of-the-art liners, drains, and ventilation systems and then used again. In New York, demonstration sites at the Staten Island Fresh Kills landfill and Saratoga County's Edinburg landfill have been chosen to display this new technique.

SHELBY COUNTY, TENNESSEE

City of Memphis, Shelby Drive and Malone Street--This sanitary landfill site in Memphis, Tennessee, was operated by the City of Memphis between 1972 and 1977. Currently, the land is being leased

by the Whitehaven Radio-control Club which flies radio-controlled model airplanes. The club has 107 members, although only about 25 "die-hard" members use the facility most weekends. During the fall, the club has a public picnic including ultralight airplane and radio-controlled airplane demonstrations and competitions. This picnic has had up to 200 participants in the past.

The Whitehaven Radio-control Club is also the current caretaker of the area, mowing the grass and picking up litter. Unfortunately for the club, the land was bought by an anonymous trust in 1988, and the club is now using the site on a temporary basis. No plans for development or use by the new owners are available at this time (T. Valley, President of Whitehaven Radio-control Club, pers. comm.).

Shelby County, Walnut Grove Road/Shelby Farms--This site was operated by Shelby County from 1971 to October 1988. Part of the site closed in 1981 and is being used as a recreational area. A BMX bicycle course has been built, and four soccer fields are available for the booming amateur soccer leagues in Memphis and Shelby County. These fields are used by 118 youth soccer teams and approximately 40 adult teams for both game play and practice. The West Tennessee Soccer Association uses the fields year-round for league play and tournaments.

In the summer of 1990, the fields were closed for natural recovery of grass growth, opening only for tournaments scheduled for December 1990 and June 1991, with possible spring 1991 league play. After the June 1991 youth soccer tournament, the fields will again be closed for a full year for formal maintenance and refurbishing by the Shelby County Landfill and Cemetery Department (N. McDonough, Assistant District Director, West Tennessee Soccer Association, pers. comm.).

The remaining section of the landfill, which closed in 1988 has great potential for additional recreational areas. This site is included in the long-range plans for the expansion of the Shelby Farms Recreational Area operated by the Shelby County government. The area will be used for additional playing fields of yet undetermined nature. Unfortunately, the county's current concern with the site is a slight ground water pollution problem which was first detected in 1987. Shallow contamination by chlorides and some organics had been found, but authorities are uncertain of the extent of the contamination. The site has also had a problem with methane.

David Newsom, Administrator of Landfills and Cemeteries for Shelby County, believes these problems may appear to have been solved by a re-capping project completed in the spring of 1990. No final assessment has yet been made. The site is yet to stabilize, and vegetational growth has been delayed by the hot dry weather during the summer of 1990. Paul Patterson of the Tennessee State's Division of Solid Waste Management explains that the landfill was constructed before the strict standards were established.

BFI, Shelby Drive and Getwell Road--This site opened in early 1976 and was closed in April 1981. The land was leased by BFI. After the closing, the owner grazed cattle on the site. Presently, the site is unused, and the land is for sale. The owner, Roy C. Nixon Realty Company, is not optimistic about anything ever being built on the site due to the fact that it is a closed landfill; therefore, the property is being offered at a very low price. Buddy Keller, a realtor with the company, did admit that "You never know; someone could build a golf course on the land."

BFI, Sykes Road--This site opened in early 1973 and was closed in April 1981. The current land owner is BFI. Upon closing, the site was offered to both Shelby County and the City of Millington for use as a park. Both turned the offer down due to lack of funds for such a development.

Currently, a small portion of the site is being leased by the Millington Barnstormers, a radio-control club. The rest of the site is unused except during the fall when people are allowed to cut and harvest hay grown on the site. David Claibo of BFI Memphis said that BFI has thought of possibly developing the site into a sod farm, open storage, or apartments, but no plans are currently under consideration.

BFI, Old Millington Road--Perhaps the sanitary landfill with the most reclamation potential is the new BFI site just outside of Millington, Tennessee. This landfill opened in the fall of 1988, and already plans are being made for its use after its closure in 25 to 30 years.

The area incorporates 387 ha of which only 20 ha at one time are disturbed. As a section is filled in, very strict development and engineering plans are followed to prevent leachate contamination, methane build-up, and erosion on the resulting terraced mounds. These procedures will encourage growth of grasses and secondary forests to bring the bare land back into use for wildlife.

Currently, all unused portions of the landfill are being used as a wildlife refuge in conjunction with the National Wildlife Enhancement Council. Wildlife conservation methods being practiced include grass and vegetable plantings for animal forage. Strip mowing helps prevent weed infestation and promotes more grass growth which results in less erosion. Browning Ferris Industries is in the process of building a 10-ha lake and developing the Greentree Reservoir, a duck-feeding site. The Tennessee Wildlife Resources Agency claims that, within 3 years, this landfill site's wildlife level should have increased enough to spread out and increase wildlife population levels within an 8-km radius. After the landfill does close, the area will continue to be used as a refuge area. Nature trails, observation platforms, and a visitor/education center could easily be built (Endress, 1989).

CONCLUSIONS

This paper has suggested several ways of converting unused abandoned sanitary landfills into productive-use sites. With proper treatment for leachate, methane, and subsidence problems, abandoned sanitary landfills can again become productive land areas. Even with increased recycling efforts, sanitary landfills will still be needed. The "Not in my backyard" syndrome, common among many citizens of the United States, has resulted in the prevention of building many much needed sanitary landfill sites. This syndrome is fueled by the misconceptions that landfills are unattractive and dangerous and, therefore, decrease property values. The case studies discussed illustrate that these ideas may be invalid.

Properly designed and constructed landfills do not appear overly unattractive; with proper maintenance, odor can be contained and short-lived. Water pollution can be avoided with correctly lined and drained fills; methane build-up is kept in check through proper ventilation. Although site specific, the property values adjacent to many landfills did increase after the landfill site was reclaimed. For example, in Edmonton, Alberta, Canada, the property value of land adjacent to a landfill increased by 30% after the site was converted into a recreational area (Naber, 1987). The New York Road landfill in Charlotte, North Carolina, was restored to become the Renaissance Community Park complete with golf, tennis, softball, soccer fields, and a coliseum was built nearby. The once stagnant area realized an increase in land value and economy (Treadway, 1989).

Sanitary landfills are here to stay. With good quality control from the beginning, no problems should occur later. This is sound economics both for the community and waste disposal companies (J. Endress and D. Claibo, Landfill Managers, BFI, pers. comm.). In the near future, all landfills could become an asset to their communities, based on the knowledge that the site will eventually become a valuable land resource. These landfills may even be part of the solution to our future energy problems. Currently, the cost of producing electricity from landfill methane is higher than energy from fossil fuels, but it is lower than the cost of nuclear energy (Logsdon, 1989). Perhaps the renewable energy resource sought for so long is in our own trash cans.

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