

WASTEWATER RECYCLING ALONG TRANSPORTATION CORRIDORS

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This paper discusses the desirability and feasibility of irrigating green spaces within and along transportation corridors with highly treated wastewater. The wastewater recycling technology is based on the 0-discharge, total-recycling wastewater system of the city of Saint Petersburg, Florida, which was recently approved by the U.S. Environmental Protection Agency. This system produces a virus-free wastewater effluent that retains the valuable nutrients essential to plant growth. Properly treated wastewater is proposed to be distributed, where feasible, along and within transportation corridors to preserve water and fertilizer and protect the integrity of the affected green spaces. Streets, highways, and airports are viewed in relation to their use as rights-of-way for the wastewater distributors and as recipients of the treated wastewater. It is demonstrated that policies of the American Association of State Highway and Transportation Officials and federal and state governments have established at least a permissive attitude on this matter. It also is demonstrated that the substitution of treated wastewater for the public water supply in irrigation systems is both desirable and necessary to conserve and preserve the dwindling potable water supply of the United States. Research is recommended on utility-accommodation policies and practices and the feasibility, applications, and limitations of wastewater recycling along and within transportation corridors.

●TRANSPORTATION corridors are truly the windows through which we view the nation. Whatever the mode of transportation, some of the most memorable features along the way are the green areas and surface waters within and along these corridors. Massive amounts of water and fertilizer are required to maintain these natural features. As water and fertilizer shortages become more prominent in the United States, we enjoy fewer green areas and permit surface water levels to recede. This paper discusses treated wastewater recycling along transportation corridors. Streets, highways, and airports are viewed in relation to their use as rights-of-way for the treated wastewater distributors as well as recipients of the treated wastewater for certain beneficial uses.

TREATED-WASTEWATER DISTRIBUTION SYSTEMS

The coordination of transportation and other rural and urban utilities is a prime concern of the Committee on Utilities of the Transportation Research Board. Treated-wastewater distribution systems are of common concern to transportation and other utility officials in the following areas:

1. Conservation of water, energy, and natural resources;
2. Maintenance and beautification of streets, highways, and airports;
3. Accommodation of utilities on street, highway, and airport rights-of-way;
4. Multiple use of street and highway rights-of-way; and
5. Coordinated land use, transportation, and utilities planning.

This paper will take a cursory look at wastewater recycling within and along transportation corridors and will lay the groundwork for the future research needed to integrate and coordinate this new utility.

NEED FOR WATER CONSERVATION AND RECYCLING

The following is taken from a statement adopted by the Board of Directors of the American Water Works Association on June 18, 1971:

The Association believes that the full potential of reclaimed water as a resource should be exploited as rapidly as scientific knowledge and technology will allow, to the maximum degree consistent with the overriding imperative of full protection to the health of the public and the assurance of wholesome and potable water supplied for domestic use. Such research and development is considered to be of greater national need than that now being directed to desalination.

The federal water-pollution-control law provides for 75 percent federal aid to local governments to achieve best practicable waste-treatment technology, which includes treatment and reuse, and land-application techniques.

Technology is now available to treat wastewater to a degree that permits its safe reuse for all but direct introduction into potable water supply systems. Such reuse can conserve much drinking water and massive amounts of energy and other natural resources. Exactly how critical is the need for conserving the domestic water supply? A 1974 report of the Florida Division of State Planning concludes that 90 percent of the water used in the state is derived from the Floridan aquifer, and with a weekly increase of 6,000 new residents, Florida will use up all readily available water by 1985. Severe water quality and quantity problems can be cited in every state. Urban areas are most critical and they must reach out farther each year to satisfy their needs. Treated wastewater can serve as a satisfactory substitute for potable water for many urban uses such as lawn sprinkling, make-up water for low-energy air-conditioning and heating systems, maintaining pond and lake levels, and industrial and power-plant applications.

WASTEWATER TREATMENT AND REUSE TECHNOLOGY

The reuse of treated wastewater by land application has been practiced in the United States since late in the nineteenth century. The recent concern for 0 discharge of pollutants has created new interest in land applications and greater emphasis on improved technology. A survey in 1964 disclosed 2,192 land-disposal systems in the United States including 1,278 industrial systems and 914 municipal systems. Land-application approaches can be classified as irrigation, overland flow or spray runoff, and infiltration percolation. Primary, secondary, and tertiary-quality municipal effluents have been applied to the land. Most existing systems have not employed acceptable technology, monitoring, and management and have been potentially harmful to people and their environment. Primarily because of pressure and financial support from state and federal regulatory agencies, the most recent wastewater-recycling systems are establishing high standards that will ensure public acceptance of this needed concept. This is essential especially for those urban areas where exposure of the treated wastewater to the public is a prime factor.

The Saint Petersburg, Florida, wastewater-recycling system is an excellent example of modern urban land-application systems. Saint Petersburg is constructing one of the first regional wastewater systems to achieve total recycling and 0 discharge to surface waters. Research started in 1971, and the construction of the first system began in January 1975 and should be completed by 1977. In-plant bacteria and virus inactivation

and controlled natural usage of nutrients are key factors in the design of the system. Flora Mae Wellings of the State Epidemiology Research Center conducted the critical virus studies for the city. She concluded: "One would anticipate a virus free effluent as a finished product if turbidity can be held to 0.5 JTU [Jackson turbidity unit] followed by a breakpoint chlorination of 0.5 ppm for at least 60 minutes."

Rodney Cherry of the U.S. Geological Survey conducted the effluent-irrigation research program. He demonstrated the feasibility of local spray irrigation rates of 2 to 4 in. (5.08 to 10.16 cm)/week with high use of wastewater nutrients by native grasses.

Black, Crow and Eidsness, Inc., designed the wastewater facilities based on findings of the research program. It was demonstrated that a clean wastewater effluent can be produced from a domestic influent treated with a complete mix, activated-sludge secondary-treatment process, followed by chlorination before and after multimedia filtration. Only the valuable nutrients remain. Final quality control is achieved in a retention lake before entry of the treated effluent into a wastewater distribution system. Wastewater production that exceeds demand or does not meet water quality standards is pumped to deep injection wells for storage and possible later reuse; this ensures a fail-safe system from the standpoint of public health. The treated wastewater will be sold to golf courses and other vital green areas along the route of the 14-mile (22.53-km) distribution system. A new section of I-275 is being considered for irrigation. The wastewater also will serve as condensing water for low-energy air-conditioning systems along the route of the distribution pipelines. Digested sludge will be used for a city sod farm and nursery, truck spraying of selected green areas, and in commercial fertilizer. Obviously, each urban environment will be different, and the technology must take this into account. The key consideration is that technology is available and a full-scale demonstration project is being constructed.

WASTEWATER RECYCLING APPLICATIONS WITHIN AND ALONG TRANSPORTATION CORRIDORS

The urban area holds the greatest potential for wastewater recycling. This is where most wastewater is produced and treated and can be distributed most economically. Agricultural use may be equally valuable in rural areas that are short of water.

The wastewater treatment process can be adapted to meet any indirect recycling application. If the intended end use is to grow grass or other flora, the nutrients should be retained in the treated-wastewater effluent. For maintaining surface water levels in lakes or ponds, the nutrients should be reduced to a point that avoids eutrophication. In various commercial or industrial applications, complete nutrient removal may be required. In some applications, such as power-plant cooling water, demineralization of the treated effluent may be necessary. In all cases, the reduction or inactivation of bacteria and viruses for public health considerations is of paramount importance.

The irrigation and fertilization of green spaces should hold greatest interest for transportation officials. Grass and other plants are functional as well as beautiful in transportation facilities. Healthy plants protect the integrity of the ground surfaces they cover and the structural features they abut. Green spaces are critical to proper drainage, noise control, air quality, and aesthetics.

Maintenance and Beautification of Transportation Corridors

The most cost effective routing of the treated-wastewater distribution lines is often along existing transportation corridors to major users within the urban area. The placement of these lines within the corridor provides a readily available supply of treated wastewater with nutrients for the maintenance and beautification of grass and plant life. Green spaces along urban transportation corridors are designed to protect the integrity of both the paved and unpaved surfaces. Lack of watering and fertiliza-

tion renders them ineffective for much of the year. Many cities have made showplaces of major thoroughfares through decorative plantings and lush lawns nourished by irrigation systems and fertilizer applications. This practice can be greatly expanded within and along the route of the treated-wastewater distribution lines.

Maintenance of Surface Water Levels

The state of Ohio has 211 Interstate Highway borrow-pit ponds (exclusive of I-90) that represent 1 percent of the state's standing water. These are located near urban centers. This is typical of the thousands of borrow-pit ponds constructed across the nation as part of the highway improvement programs of the last few decades. These ponds often are neglected and appear as scars on the landscape. These and other surface waters in urban areas can be maintained at attractive levels by using treated wastewater for replenishment.

Airport Beautification

Major airports require large amounts of water and fertilizer to maintain their green spaces. Treated wastewater can be used as an economical replacement for both. How great is the impact of airports on existing water supplies? Assuming a spray irrigation rate of 2 in. (5.08 cm)/week on 1,000 acres (404.7 hm^2) of airport green space, this will require about 8 million gallons water/day (30.28 million dm^3/day). This is a major drain on available water, whether it is withdrawn from city water mains or directly from the ground.

Golf Courses

The nation's population is turning to the sport of golf in unbelievable numbers. For example, the Grand Strand Region surrounding Myrtle Beach, South Carolina, experienced an 800 percent increase in paid rounds of golf from 1962 to 1971. Sixty thousand rounds were recorded in 1962, and the figure increased to 477,000 rounds in 1971. It is estimated that 12 billion gallons (45.42 billion liters) of water and \$250,000 worth of fertilizer are required per year to keep the 23 Grand Strand championship golf courses green. Multiply this by the ever-increasing number of golf courses across the nation and the impact is monumental. Most of the nation's golf courses are within easy reach of wastewater-treatment plants by means of distribution lines constructed along transportation corridors.

Public Parks

The environmental concern of the last decade has resulted in the acquisition of massive land areas for urban and suburban parks. The multiple-use concept for highway improvements also has created numerous park areas along highway corridors. These additions plus the existing parklands constitute a major demand for water and fertilizer. Treated wastewater can efficiently and effectively satisfy this need.

Agriculture

We stated earlier that urban uses have primary value for treated-wastewater recycling because this is normally where the wastewater is treated and, therefore, distribution costs would be minimized. It should be recognized, however, that worsening agricultural water and fertilizer shortages are making it feasible to transport treated wastewater and its by-product, digested sludge, to the rural areas. The Chicago Metro-

politan Sanitary District uses 8 barges to transport digested sludge to a 7,000-acre (2832.9-hm²) farm in Fulton County, Illinois. In 1971, the city of Phoenix contracted with the Buckeye Water Company to provide treated effluent for irrigation of agricultural land 30 miles (48.27 km) west of the city. Florida's citrus industry imports about 80,000 tons (72 624 Mg) of dried sludge annually, mostly from Chicago and Houston.

Groundwater Recharge

Los Angeles County, California, is treating about 15 million gallons/day (56.78 million dm³/day) of municipal wastewater and recharging the groundwater for reuse by the city of Whittier Narrows. This concept is being widely explored in many areas of the country. In most cases the aquifers, or groundwater supplies, are separated by several miles (kilometers) from the densely populated urban areas. This constitutes another demand for rights-of-way for treated-wastewater distributors between the metropolitan high-use areas and the recharge areas.

The foregoing discussions describe wastewater recycling needs, technology, and progress. The nation is recognizing the need and benefits of wastewater recycling, and treated-wastewater distribution lines along transportation corridors are now a matter of vital concern to transportation and other utility officials.

TRANSPORTATION CONSIDERATIONS

The concept of wastewater recycling applies to all types of transportation rights-of-way. Highway rights-of-way are of primary concern, however, because they afford the greatest opportunity for application and have the most compatible routing with the wastewater distribution pipelines.

The need of coordination between highway and transportation officials and other utility officials relative to joint use of rights-of-way is a concern that has not been properly addressed at any level of authority. The necessity for a conservation program for water, a most vital resource, is evident. The recycling of treated wastewater has been given the highest priority by water authorities.

As previously indicated, there is a dependency on use of publicly owned transportation rights-of-way as a contributor to the implementation of such a program by providing the space for distribution lines as well as a receiving ground of the recycled water for the irrigation of the grassy and landscaped areas. To entertain such a proposal forces the transportation engineer to deal with the issue of accommodating parallel utilities within and along the transportation rights-of-way.

The transportation engineer must preserve the integrity of such facilities to the maximum extent possible without jeopardizing any safety or operational features for which the facility was originally designed. The transportation engineer also must achieve consensus goals in view of diminishing land and other natural resources and in view of social concerns.

The limited-access freeway, by nature, is more conducive to a compatible relationship of joint occupancy than any other type of highway system. The broad expanse of open right-of-way, limited interference with local street systems, and more direct routes interconnecting high-density metropolitan areas all contribute to this compatible relationship. However, such compatible features are not sufficient in themselves to override existing policies and interpretations of pertinent laws and statutes, which are among the first and main issues to be resolved before such a concept can be applied.

POLICIES ON JOINT OCCUPANCY

In general, the various states have adopted, justifiably, a rather firm policy toward

limiting joint occupancy of utilities within limited-access rights-of-way, for limited-access facilities represent the highest type of all highway systems. Experience has shown operational complications, delays in construction activities, and added costs where utilities have jointly occupied rights-of-way on lower classes of highway systems. Therefore, the typical state utility-accommodation guide limits joint occupation of the limited-access highway facilities.

At the federal level, the regulatory as well as the enforcement agency for transportation rights-of-way is the U.S. Department of Transportation. The Federal Highway Administration is the agency responsible for implementing congressional acts related to the development of federal-aid highway systems as well as for developing the policies and procedures necessary to fulfill such implementation. To this end, several memorandums pertinent to this subject have been written. The following quotations are taken from Policy and Procedure Memorandum 30-4.1 (1).

It is in the public interest for utility facilities to be accommodated on the rights-of-way of a Federal or Federal-aid highway project when such use and occupancy of the highway rights-of-way does not interfere with the free and safe flow of traffic or otherwise impair the highway or its vital quality . . .

Utility facilities or utilities are defined as

all privately, publicly or cooperatively owned lines, facilities and systems for producing, transmitting or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with highway drainage, and other similar commodities.

Federal-aid highway projects are defined as

those projects administered by a State which involves the use of Federal-aid highway funds for the construction or improvement of a Federal-aid highway or related highway facilities or for the acquisition of rights-of-way for such projects, including highway beautification projects . . .

The section on general provisions states that

due to the increasing competition between public transportation and other service facilities for available space, such as for highway, rapid transit, railroad and utility purposes, it is important that rights-of-way be used in the most efficient manner consistent with the overall public interest.

The section on requirements states that

utilities that are to cross or otherwise occupy the rights-of-way of Federal-aid freeways, including Interstate highways, shall meet the requirements of the AASHTO "Policy on the Accommodation of Utilities on Freeway Rights-of-Way" adopted February 15, 1969, and accepted under PPM 40-2. Application of joint development and multiple-use concepts dictates that maximum use of the highways be made for other purposes where such use does not adversely affect the design, construction, integrity, and operation characteristics of the freeway. In the advancement of these concepts and when the State has legal authority to do so, and so requests, approval may be given for installing trunkline or transmission type utility facilities within a utility strip on and along the outer border of existing freeway rights-of-way.

Appendix A in this memorandum is an amplification of the Federal Highway Administration's view of the provision of the American Association of State Highway and Transportation Officials Policy on the Accommodation of Utilities on Freeway Rights-of-Way that sets forth more specifically the requirements for consideration, review, and subsequent approval of a parallel utility accommodation request. It also extracts excerpts from the FHWA Circular Memorandum of October 1, 1969:

This memorandum provides a practical method for applying both the AASHTO Policy (on utilities) and the *Joint development* and *Multiple-use concepts* to freeways and utilities, especially at locations within and approaching metropolitan areas where land is scarce and right-of-way is expensive.

It would appear, then, that the provisions of AASHTO, federal, and state policies have established at least a permissive attitude on proposals for parallel utility accommodations provided that specified criteria are met.

If the criteria are met, there is sufficient justification that the best interests of the public are being served, and the state highway agency has the statutory authority, then the issue resolves itself into matters of philosophy or interpretation of applicable policy and procedure memorandums at the various state and federal decision-making levels.

It is our intent neither to ignore previously mentioned inherent drawbacks associated with the parallel utility concept nor to say that the benefits to be derived from the irrigation of publicly owned rights-of-way or adjacent green spaces would justify, in all cases, the application of this concept. There are many ramifications that any transportation administrator must consider before accepting or promoting wastewater distribution lines within or along transportation corridors or allowing these rights-of-way to be used as wastewater recycling areas. Before accepting or promoting wastewater distribution lines, administrators must consider many items related to the preservation of the integrity for which the transportation facility was originally designed and built. Before allowing rights-of-way to be used, administrators should give serious consideration to 3 items:

1. Health and safety;
2. Sociological and psychological impact; and
3. Additional maintenance requirements.

For health and safety, the effect of spray drift to such features as the highway or airport runway needs to be considered. The recycled water must have no deleterious effect on human, animal, or plant life when inadvertent exposure occurs. Impact of high moisture levels on embankments within the recovery area of a vehicle out of control must be studied. Under sociological and psychological impact, acceptance or nonacceptance of such a concept by both the transportation user and adjacent property owners must be ascertained. The maintenance and operational expense for the irrigation system and additional mowing requirements resulting from higher moisture and nutrient levels must be determined. Any special chemical treatments that might be required to overcome an imbalance of nutrients or adverse pH factors, and the effect of the recycled water on roadside and airport objects, such as fences, sign posts, and guardrails, also must be considered.

Water reuse is increasing. This increase is not, however, keeping pace with the demands for domestic or industrial water requirements. It is estimated that the 16 billion gallons/day (60.57 billion dm³/day) required for domestic use in 1970 will double by the year 2000.

Philosophies, attitudes, and the value system of our society are constantly changing with increasing demands on all segments of public works. Society expects public and private institutions to be equally responsible in evaluating the cost effectiveness of alternatives. If those in the transportation profession fail to respond to these public

expectations, a credibility gap will result. If, on the other hand, objective evaluations are made and trade-offs are justified as being in the best interest of the public, then those in the transportation profession will make a positive contribution to the development of society.

In conclusion, we recommend that the Transportation Research Board seriously consider the following research programs:

1. An analysis of state and federal utility accommodation policies and practices, with special emphasis on wastewater recycling and
2. An analysis of the feasibility, applications, and limitations of wastewater recycling along and within transportation corridors.

REFERENCES

1. Accommodation of Utilities. Federal Highway Administration, Policy and Procedure Memorandum 30-4.1, Nov. 29, 1972.
2. The River of Life. U.S. Department of the Interior, Conservation Yearbook Series, Vol. 6.
3. R. Cherry et al. Hydro-Biochemical Effects of Spraying Waste-Treatment Effluent in St. Petersburg, Florida. U.S. Geological Survey, Tallahassee, Fla., 1973.
4. Wastewater Quality Management Plan for St. Petersburg Wastewater Districts. Black, Crow and Eidsness, Inc., Clearwater, Fla., June 1973.
5. Sludge Treatment and Disposal. In EPA Technology Transfer Manual, Black, Crow and Eidsness, Inc., Gainesville, Fla., Oct. 1974.
6. L. A. Dove. Recycling Allows Zero Wastewater Discharge. Civil Engineering, Feb. 1975.