Effluent water—New hope for greener turf

by Harold LeSieur

In drought-stricken California, a method to save water by irrigating golf courses less expensively has to attract attention. The worst drought in California's history has forced attention on a relatively obscure method of water conservation — the recycling and reuse of sewage effluents. Now everybody stands to win as a result: a safe method of waste disposal for sanitary engineers, a sound means for recharging dwindling ground water supplies for the conservationist and hydrologist, and a new source of less expensive water and fertilizer for the golf course superintendent.

Water shortages spur development

Now in its second year, the longest dry spell in California's history is giving strong impetus to waste water reuse. A concentrated campaign is underway to conserve this scarce resource, now critically short from inadequate snowfall in the eastern Sierra Nevada watershed.

Yet the problem is more basic than two years of drought in this populous state, or prolonged dryness throughout the Far West. "We are constantly using more water than is going back into the ground table", observes Dr. Ian Pepper of the University of Arizona Turfgrass Research Center. He points to "enormous interest" by golf course superintendents from all over the country in the work of his institution. Research results will be made public within one year, showing how far beyond consumptive use levels irrigation with sewage effluent may safely be carried on turfgrass-soil systems.

Researchers at the University of Arizona check turfgrass plots installed in a lysimeter to determine the efficiency of turfgrass-soil systems in removing nitrogen under high effluent loads.

Primary and secondary sewage treatment (Figure 1) produce a disinfected, relatively clear effluent suitable for irrigation use. Tertiary, or advanced water treatment, is comparatively rare and limited generally to recovery of potable drinking water. Now, however, a form of tertiary treatment is seen to be possible using turfgrass-soil systems to "polish" sewage effluents while accepting irrigation water and fertilizer ingredients in the bargain. Until recently, this waste water effluent has been largely reserved for crop production, at irrigation levels only. Now, however, treatment by soil-turfgrass systems, to recharge underground water supplies at capacities far above simple irrigation needs, is the prize being sought.

Combining the promises of conserving a scarce natural resource, at a savings to potential users, with by-product fertilizer as an added bonus and in a manner promising to be non-polluting to the environment — this method has attracted attention for good reasons indeed.

In some cases this waste water is not merely attractive but a necessity. At Rossmore Leisure World, in Southern California's Laguna Hills, a local water company must supply irrigation water to huge Irvine Ranch, to famed "Lion Country" and to the Laguna Hills golf course as well. No outflow to the Pacific Ocean is permitted, so that all waste water must either be utilized or evaporated.

It was not until 1974 that the American Water Works Association, guardian of high quality standards in public drinking water, went on record urging waterworks officials to plan reuse of wastewater. Acknowledging that "pristine waters are rare, and diminishing," AWWA past president Henry Graeser observes that "It is only a matter of time until all water utilities will have to consider the question of waste water reclamation and reuse, at least to some degree." To this Graeser adds, "In the southwestern and western U.S. it is not a matter of time. These areas are living with the problems."

One of the most promising reuse methods, from a cost-effectiveness standpoint, tertiary treatment of golf course turfgrass has a champion in Dr. Victor B. Younger of University of California, Riverside. His summary points to the basic need for this technology: "Water is a valuable resource, particularly in the West. This will continue to be true from here on out."

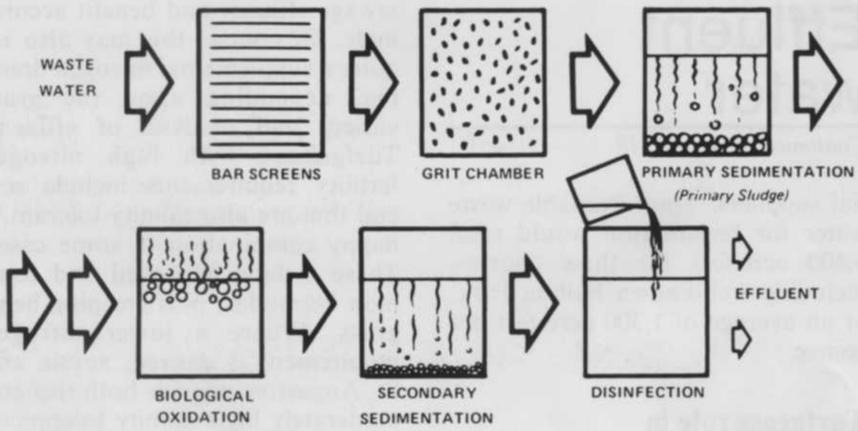

Figure 1 — *Flow diagram of primary and secondary sewage treatment.*

California mecca for reclamation

California is prolific in providing examples of existing and planned uses of sewage effluent for golf course irrigation. Arizona and Michigan also boast several courses using this technique, as do some other eastern states.

One of the earliest in California to treat its turfgrass in this fashion is the Corona National golf course, near Riverside, since the early 1950's. Corona's John Bell and Jim Noble are described as "veteran users", by Professor Younger of U.C. Riverside. In the "early days" of their project, Corona's staff consulted with Younger on an algae and chlorosis problem associated with sewage ponding.

A more publicized California recovery project, described as "one of the most successful demonstrations of the use of reclaimed water", is the Santee Country Water District near San Diego. Since the early 1960's, reclaimed sewage has been used to irrigate the Carlton Oaks golf course, plus a tree farm and even to provide a popular lake for recreational swimming.

Less publicized is the Marine Corps Air Station at Twenty Nine Palms, California, which has utilized reclaimed effluent for over 10 years. At Furnace Creek golf course in famed Death Valley and at Whittier Narrows recreation area, both in Southern California, this economic method of irrigating is practiced.

As many examples again can be mentioned. According to Mike Yamada, a sanitary engineer with the Los Angeles City Bureau of Sanitation, the City of San Clemente has been doing this since 1957. Ventura City, he says, has 10 years experience in waste water use, and the La Cañada Country Club (near Glendale) can point to over 8 years actual trial of the technique. In his list, Yamada also includes the Moulten Niguel and Rossmore Leisure World courses, both in the Laguna Hills, plus the San Joaquin course in the huge Irvine Ranch.

Two courses in Hollywood's rambling Griffith Park are presently in the feasibility study stage, with estimated installation of waste water irrigation within a possible 6 months. Griffith Park will receive reclaimed water from the City of Los Angeles' Glendale plant.

According to the California State Department of Water Resources, San Diego courses are a good bet, with 5 different water treatment plants serving as poten-

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tial suppliers. Total available waste water for reclamation would total 6,400 acre-feet for these courses, including well-known Balboa Park, or an average of 1,300 acre-feet per course.

Turfgrass role in "polishing" sewage

All types of plants are not equally well suited to irrigation with reclaimed sewage effluent. Fortunately, turfgrasses are among the best in this respect. They take up large amounts of the nitrogen, phosphorus and potash found in such waters. Generally, they can also be exposed to large amounts of boron without showing toxicity symptoms. However, all turfgrasses are not the same, and some are better than others. Salinity tolerance, for example, is highest for improved and common bermudas, creeping bentgrass, zoysia, St. Augustine and tall fescue.

Ornamentals, on the other hand, have a low tolerance to both salinity and boron. If such plants are to be used, a separate irrigation system using better water is recommended by Professor Younger.

In order for turfgrass-soil systems to function efficiently in waste water "polishing", they must perform a number of functions. In addition to taking up soluble fertilizer ingredients — nitrogen, phosphorus and potash — they must maintain satisfactory infiltration rates while effectively screening sedimentts. An equally important quality of turfgrass-soil systems has been demonstrated recently; namely, denitrification by microorganisms and bacteria. Thus, any nitrogen which is not utilized directly in feeding turf may be further eliminated by bacteria in the carbon content of grass debris and roots.

Naturally, a turfgrass variety with high nitrogen fertility requirement will remove most effectively this fertilizer ingredient from a given sewage effluent and benefit accordingly. Of course, this may also require a supplemental nitrogen dressing, depending upon the grass variety and analysis of effluent. Turfgrasses with high nitrogen fertility requirements include several that are also salinity tolerant, a happy combination in some cases. These include improved and common bermudas, plus creeping bentgrass. Where a lower nitrogen requirement is desired, zoysia and St. Augustine provide both this and moderately high salinity tolerance.

To illustrate the nitrogen uptake possible, bermudagrass is reported to require 8 to 16 pounds per 1,000 square feet during a 12-month growing season. Annual ryegrass needs approximately one pound of nitrogen per 1,000 square feet per month during the winter season. These grass species, which are common to the Southwest, have a high nutrient demand and may be used effectively year-round for sewage effluent purification.

Potential users of renovated water for golf course irrigation can feel added confidence from the reassurance of Professor Younger. "If a golf course has available sewage effluent water," "it should strongly consider using it for irrigation. From 95 percent to 99 percent of all domestic effluents which have undergone secondary treatment are satisfactory for this purpose." To this he adds, "We have been researching this for years, and don't need more research. We know the method can be used effectively." Of course, Younger is the first to recommend a preliminary test of soil and effluent water source, before selecting proper irrigation rates and deciding upon a suitable maintenance program.

Does this literally mean that further research on this problem is unneeded? Not at all. Even Younger would like to see more data on variations in effluent waters and on salt tolerances of various turfgrasses and ornamentals. However, the technique of using turfgrass-soil systems for tertiary treatment of sewage effluents is a matter of agricultural engineering application — no longer one of basic research. Even so, work underway at several universities does show promise of broadening knowledge in this socially-valuable field.

One of the more significant programs underway in the U.S. is that of the Turfgrass Research Center at the University of Arizona. As early as 1972, R. C. Sidle and G. V. Johnson of the University's Soils, Water and Engineering Department demonstrated that turfgrass can be irrigated with sewage effluent at rates in excess of plant water requirements and 95 percent purification efficiency, yet without hazard of ground water pollution from nitrogen.

Currently, a team comprising Professors William R. Kneebone, Ian Pepper (a soil biochemist from Great Britain) and the same Gordon Johnson is being funded by the State of Arizona. Specific objectives of this study effort, using turfgrass plots installed in a lysimeter is to determine the efficiency of turfgrass-soil systems in removing nitrogen under high effluent loads. Also, to determine which turfgrass species and cultivars are most efficient in filtering effluent and utilizing nitrogen. Treatments up to four times consumptive use will be evaluated. At the moment, Arizona's researchers are trying common bermuda, overseeded with rye grass during winter, and will monitor this over an entire year to determine variations between seasons.

The use of sewage effluent for irrigation has been well documented for production of food and fiber crops, and this work has served as a valuable back-drop to golf course application of this methodology. Researchers at Pennsylvania State University, University of Pennsylvania, Michigan State and the University of Arizona have demonstrated feasibility of utilizing sewage effluents for irrigating forage and small grain crops, or the safety of simple disposal in forest lands. A joint project at Michigan State University is currently demonstrating use of waste water to grow grass for cattle feeding.

At University of California, Los Angeles, Dr. Wade Berry is reported investigating the use of waste water for irrigation of both vegetables and ornamentals.

Of course, the six years of work

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on greenbelt irrigation using sewage effluent performed by Younger of UC Riverside (in collaboration with the U.S. Forest Service), is among the most basic research projects yet accomplished. This investigation, in the famed Lake Arrowhead region of California, demonstrated no evidence of degradation or contamination of surface or ground waters, after 5 years of monitoring. The implications for golf course irrigation are encouraging, and more specific research on turfgrasses will doubtless benefit from this cornerstone work. Figure 3 illustrates a student withdrawing a ground water sample in this Lake Arrowhead project.

Economics of waste water reuse is a subject of secondary importance to most researchers, yet necessarily concerns the average golf course superintendent contemplating use. A more definitive answer may be the result of a new research grant to Younger of UC Riverside from the Office of Water Research & Technology, Department of Interior. Commencing this Fall, two graduate students under Younger's direction will compare costs of processing, piping and discharging effluent using this technique, with the costs of disposing by alternate means (as, to the ocean) and the economic value of water recovered.

In considering the economics of waste water effluent, even on a shirt cuff basis, some credit should be given to the fertilizer ingredients which accompany it when used in irrigation. Thus, as characterized by Dr. Wade L. Berry of UCLA's Department of Nuclear Medicine, a typical urban effluent can add 4 lb. of nitrogen, 2.7 lb. of phosphorus and 2.3 lb. of potassium, for each acre-inch applied. In the Southern California area, where approximately 40 acre-inches of water are needed to replace evapotranspiration losses, this level of use would add 160 lb. of nitrogen, 108 lb. of phosphorus and 92 lb. of potassium each year.

"In most instances," he concludes, "this would supply more phosphorus and potassium than presently used and also most of the nitrogen for low use turf, although additional nitrogen would be needed, especially for high use turf." At today's fertilizer prices, this deduction can be very helpful.

It is true that irrigation lines, pumps and storage facilities may cost additional dollars because of special needs to filter, chlorinate and contain a more corrosive substance. However, even if this waste effluent must be purchased, this expense may be only an estimated 1/3 of domestic water costs. If a separate filter system is required at the golf course site, Laguna Hills superintendent John Polder estimates a cost of $5,400 for a 1,000 gpm automatic system, or $4,000 for a manual

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back-flush system (plus installation charges).

"When all these things are weighed," concludes Younger of UC Riverside, "you can't help but conclude that it will be economical." A rather unequivocal statement for most scientists! However, Younger has plenty of specific research behind him to back up this conviction. He believes that this is just as true for a governmental agency, which charges for its effluent water, as it is for the golf course user who must pay for it. No doubt, in drought-plagued California, Younger is as impressed with the need to conserve a precious commodity, as with the relatively low costs and economic attractiveness.

Soil preparation key consideration

Needless to say, soil preparation is important where effluent water is to be used. Sandy loams are generally preferable; clay or sands are to be avoided. If greens are constructed according to USGA specifications, clay soils will be avoided and good percolation and drainage will assure less salt accumulation. Internal drainage lines will help this desirable flow.

As a starting point, Professor Younger highly recommends a thorough soil survey. In some cases, a site may be unsuited to effluent usage. Thus, a shallow soil over rock or hardpan may cause inadequately purified water to move horizontally into surface waters or through rock fissures into ground waters. He advises that infiltration rates and hydraulic conductivity of the soil be determined in advance, so that water application rates can be adjusted to avoid surface runoff or ponding.

A special problem is created by a water having a high sodium absorption ratio (SAR), in the presence of a clay soil. Such soils may lose their structure in time and become very poor for plant growth or water purification. Sodium acts to deflocculate soil, which then becomes compact and a poor hydraulic conductor. Gypsum is sometimes successful in correcting this situation, although avoiding this combination is preferable.

To illustrate how much difference is possible in soil readings following effluent irrigations, we may consider the Laguna Hills Golf Course in Southern California. Here, soil test data kept since 1971 show an increase of up to 125 percent in SAR readings, for a clay soil irrigated with effluent water as compared to irrigation with Metropolitan water. Similarly, increases in EC readings up to 100 percent have been noted, particularly after summer irrigation with effluent. However, readings for SAR below 5.0 or EC below 3.5 are considered satisfactory by Laguna Hills maintenance personnel.

In setting up a waste water irrigation program, Younger recom-

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mends not only a soil survey, but a complete water analysis as well. Local test laboratories are available for this purpose. With these data, knowing the rate of soil infiltration and the chemical contents of waste effluent, the golf course superintendent can decide upon a proper precipitation or irrigation rate. This will be less than the rate of infiltration, and low enough (or applied intermittently) so as to prevent runoff. Younger also recommends use of automatic controllers, to regulate flow rate and application time. "There are many on the market," he comments, and mentions Toro Manufacturing, Rain Bird, Royal Coach and Moody Sprinklers as typical California suppliers.

Continuing use of soil, water and plant tissue testing is recommended by Younger, to identify effects of accumulated salts, and to insure proper fertility practices for plant nutrition, color and vigor. Using the "living filter" system, all clippings should be removed, to prevent recycling of impurities from decomposition.

Government regulations slow development

One fly in the ointment of waste water usage in general is the increasingly strict regulation by various governmental agencies. In California, the State Water Resources Board and Department of Public Health set and administer standards (through regional water quality control boards) which some users consider "too tight." This has held up reclamation. Originally scheduled to double from 1974 to 1976 in Southern California, water recovery is today almost unchanged (at only about 6 percent of over 700 M.G.D. discharged to the ocean), according to William Garber of Los Angeles City's Bureau of Sanitation.

"With the present state of knowledge," according to John N. English of EPA's Cincinnati labs, "the greatest potential health hazard appears to be that associated with trace organic materials, and the composition of the organics and their toxicity must be defined. The second most significant problem," he continues, "is that of pathogenic organisms, especially viruses, and heavy metals that contribute to the health hazard." It appears likely that standards applied to potable water recovery may not be strictly applicable or applied to golf course irrigation. □

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