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Golf courses in Southern Nevada will significantly impact the water management efforts by using recycled water rather than potable water to irrigate their turf

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**Golf Courses in Southern Nevada will Significantly Impact the Water Management
Efforts by Using Recycled Water rather than Potable Water to Irrigate their Turf**

A Thesis submitted in partial satisfaction
Of the requirement for the degree of
Bachelor of Arts
In

Environmental Studies
University of Nevada
Las Vegas

By
Sean D. Ainsworth

Spring 1999

Thesis Advisor: Darlene Cartier
Program Coordinator

ABSTRACT

As the number of people continually move to the Las Vegas Valley and take up residence, the possibility of "running out of water" can become a reality. Having large water users (i.e. golf courses) irrigate their turf with recycled water, they will significantly impact the water management efforts in the Las Vegas Valley. When each course is irrigating their turf with recycled water, this will help ease the drinking water demand in the valley, especially during the peak demand season (summer).

ACKNOWLEDGMENTS

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INTRODUCTION

Las Vegas, Nevada is a city where water seems to be everywhere, an oasis in the desert. Hotels abound with all sorts of water features. Residential communities are built around man made lakes, which glitter in the sunlight. Situated in the middle of the Mojave Desert, Las Vegas averages around 4.13 inches of rain annually. To the average citizen, Las Vegas may seem to have a plentiful supply of water. Southern Nevada receives approximately 300,000 acre feet a year (an acre foot equals will fill one acre w/one foot of water, or roughly 326,000 gallons) from the Colorado River.

At current estimates, Las Vegas welcomes 5,000 people a month. This record pace has been happening for the past decade. This growth has made Southern Nevada the fastest growing region in the U.S. for the past ten years. With the population explosion happening in this city, what is to become of the future supply of water needed to quench the thirst of the thousands of more people venturing towards this city? The solution may lie in the use of recycled water.

The industry term for reused water is “recycled water*”, also known as wastewater or effluent water. To maximize the water available in Southern Nevada, recycled water could be used for areas where the need for water is high, yet full human contact (children running through sprinklers, rolling around on the grass, etc.) with water is low. If golf courses use recycled water, they can significantly impact water management efforts in Las Vegas thereby decreasing our demand on the drinking water supply.

*Note: Recycled and effluent water will be used interchangeably throughout this thesis. However, the word “effluent” will be when appropriate.

Stages of Recycled Water Treatment

There are three stages of treatment in the processing of recycled water: primary, secondary, and tertiary treatment.

Primary Treatment

The objective during primary treatment of water is to remove all settleable organic and inorganic solids by sedimentation (suspended and dissolved solids), and the removal, by skimming, of materials that will float (Asano et.al, 1985). Approximately 25 to 50 percent of the biochemical oxygen demand (BOD), 35 to 50 percent of the chemical oxygen demand (COD), 50 to 70 percent of the total suspended solids (SS), and 65 percent of the oil and grease are removed during primary sedimentation. During sedimentation in primary treatment, some organic nitrogen, phosphorus, and some heavy metals are also removed. Primary treated water will have no large debris, can have a bad odor, and can contain some pathogens. In some states, primary treatment is the minimum treatment required for irrigation. If primary treated water is used, it is only for irrigation for crops, orchards and vineyards, and areas not meant for human consumption. Primary treated water for golf course irrigation, is not allowed in the United States (Asano et al.1985).

Secondary Treatment

Secondary treatment follows primary treatment, but now involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. In this treatment process, aerobic microorganisms (principally bacteria)

metabolize the organic matter in the effluent water, thereby producing more microorganisms, and less toxic inorganic end-products (carbon dioxide, ammonium, water). The microorganisms are then separated from the treated effluent water to get the secondary effluent. The sedimentation process is now repeated, similar to the processes involved in primary treatment. Secondary effluent will have a slight odor, and more than 90 percent of the solids are removed (Asano et al. 1985). Although, water treated to the secondary stage is not meant for human consumption; if ingested, the risk of becoming seriously ill is low.

Tertiary Treatment

Tertiary treatment is used when specific wastewater constituents must be removed, that cannot be removed in the secondary treatment process. Advanced treatment is necessary to further remove nitrogen, phosphorus, additional suspended solids, heavy metals, and additional dissolved solids. The primary function of tertiary treatment is to reduce the risk of human exposure to harmful bacteria and viruses. To ensure that the water is free from any detectable bacteria or viruses, disinfection is the final stage in this treatment process. The disinfection process involves the injection of a chlorine solution into a chlorine contact basin. The effectiveness of the disinfection process is measured in terms of the concentration of indicator organisms (total coliform or fecal coliform bacteria) remaining at the end of the chlorine basin (Asano et.al, 1985). These indicator organisms represent the most probable number of organisms per 100 mL of water sample (Crook, 1985). Table 1 shows the coliform limits on the different types of irrigation established by the EPA (Crook, 1985). Also, see the Nevada Administrative

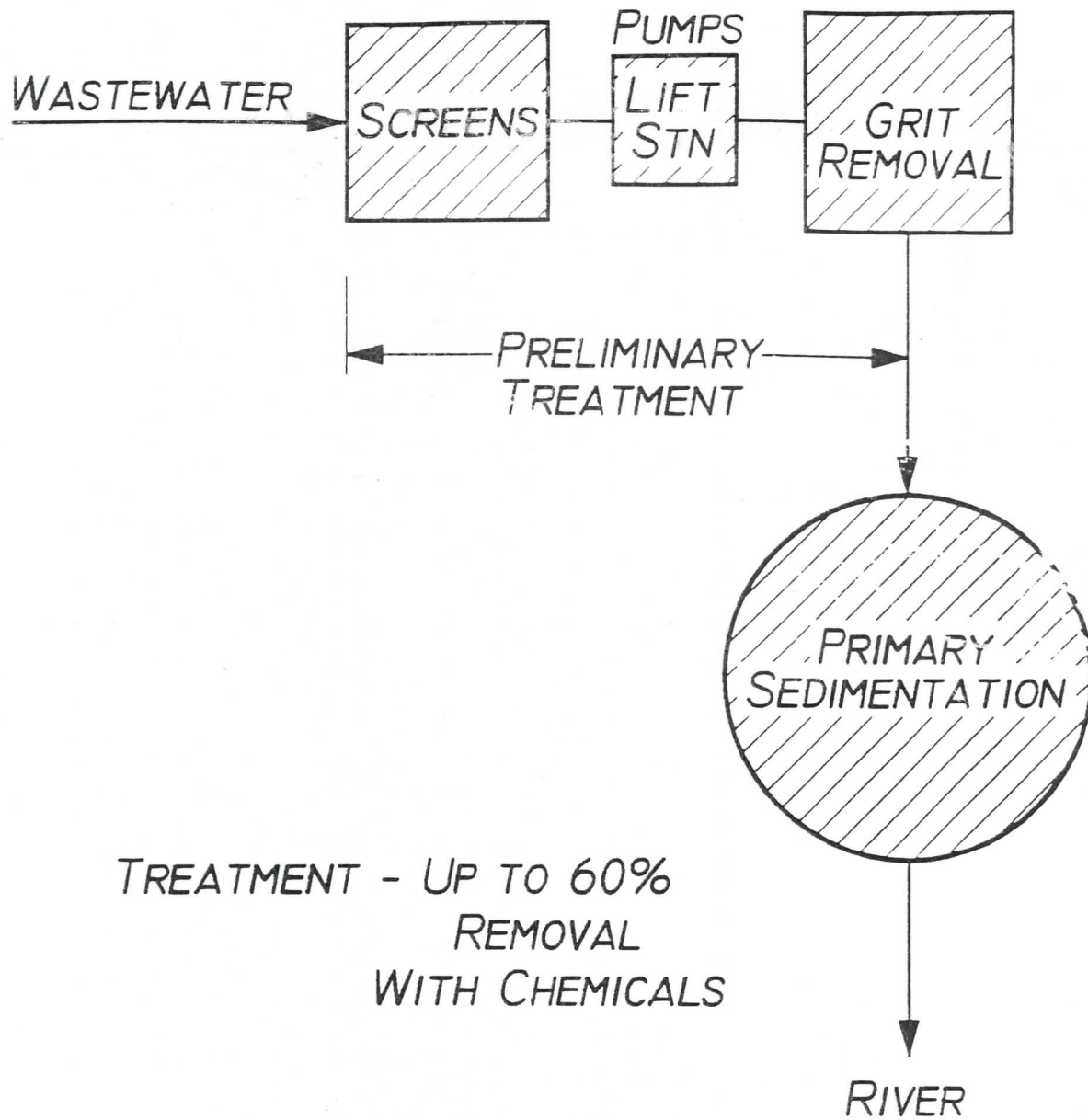
Code, "Use of Treated Effluent for Irrigation" in Appendix A. Figures 1, 2, and 3, on the following pages show examples of the treatment process.

Treatment level	Coliform limits	Type of Use Allowed
Primary		Surface irrigation of orchards and vineyards, fodder, fiber, and seed crops.
Secondary	<23/100 mL	Pasture for milking animals Landscape impoundments Landscape irrigation (golf courses, cemeteries, etc.
Tertiary	<2.2/100 mL	Surface irrigation of food crops (no contact between water and edible portion of crop)
Tertiary w/disinfection	<2.2/100 mL	Spray irrigation of food crops Landscape irrigation (parks, playgrounds, etc.

Table 1 Wastewater Treatment and Quality Criteria for Irrigation

Reproduced from (Crook, 1985)

PRIMARY TREATMENT



SECONDARY TREATMENT

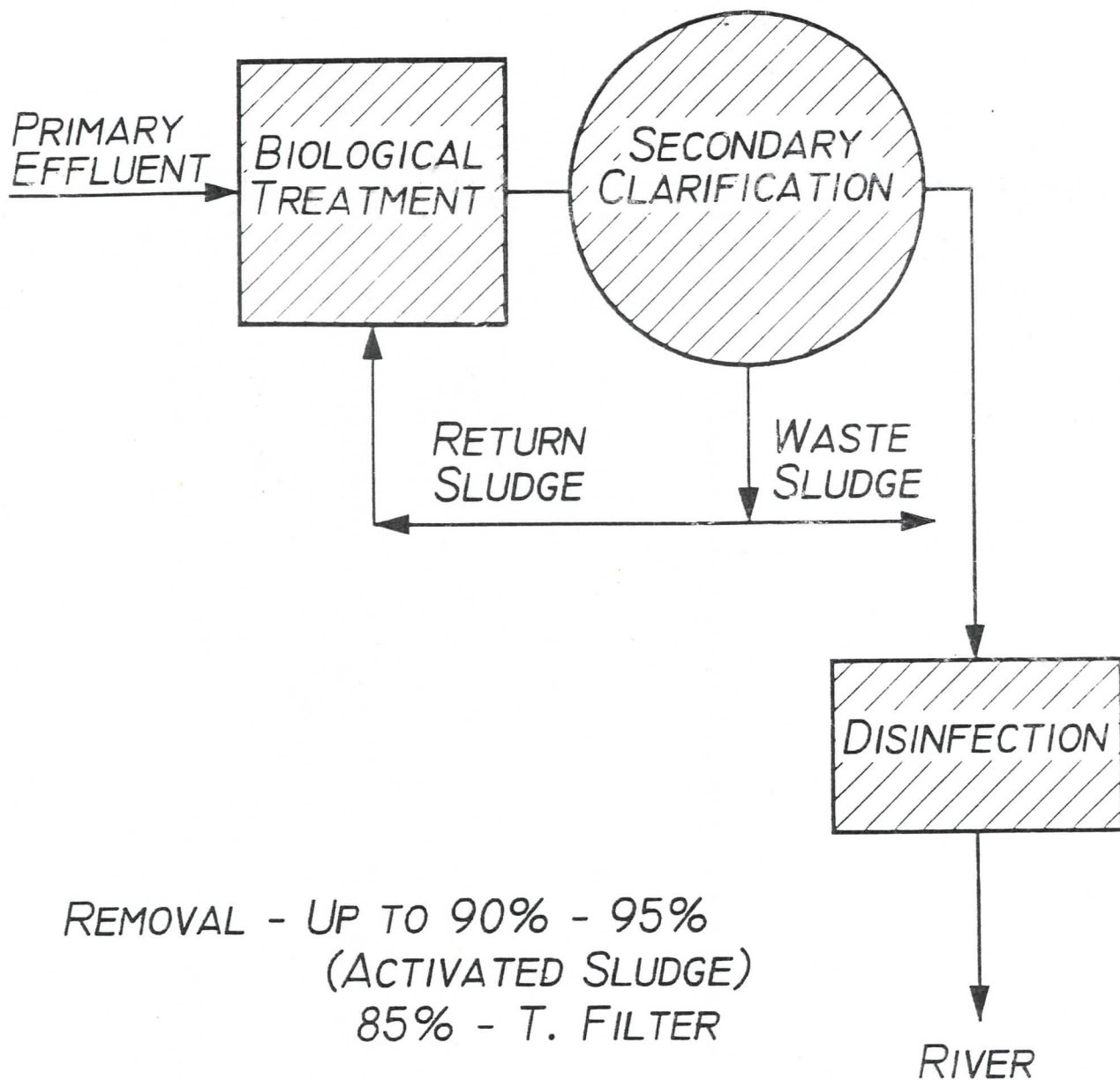
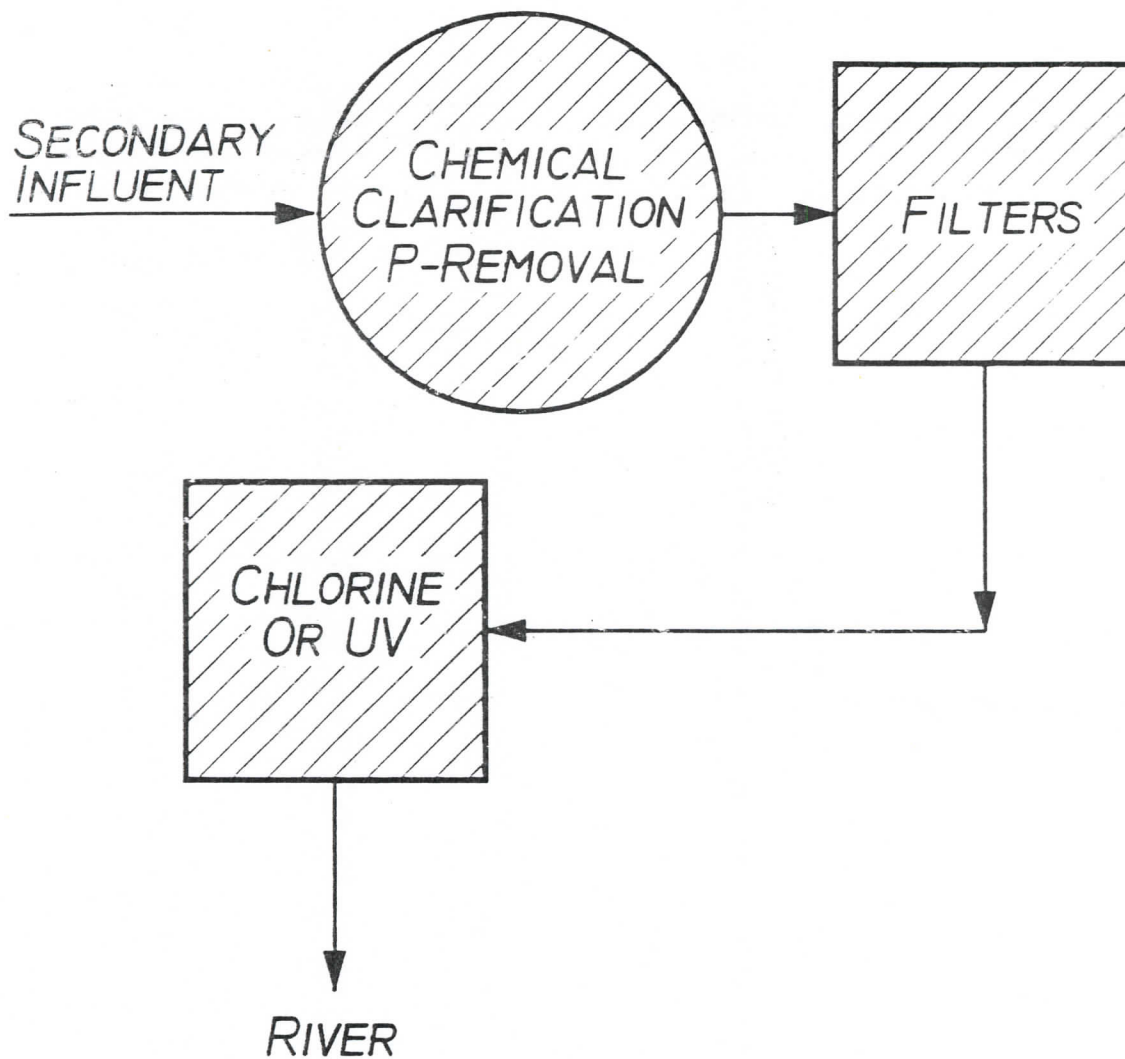


Figure 2

TERTIARY TREATMENT



REMOVAL - > 95% - 99%

Use of Recycled Water for Turf Irrigation

Municipal effluent is ideally suited for turf irrigation, particularly in arid climates such as Las Vegas, where water conservation is crucial. There are several reasons why the use of recycled water can be beneficial for irrigating turf. First, the high shoot and root density of turf grasses have the potential for removing heavy metals from large volumes of recycled water. Large volumes of water are necessary for the growth and maintenance of turf on large surface areas, further increasing the volume of effluent which can be "cleansed". Second, plant nutrients, common in effluent water (Nitrogen, Phosphorus, Potassium) reduce the need for commercial fertilization on a respective turf plot. Finally, most expanses of irrigated turf are located adjacent to, within cities where water is treated, thereby minimizing effluent delivery costs (Mancino and Pepper 1994).

Advantages for Turf grass and Landscape Plants

The quality (overall health, color, growth) of both turf grass and landscape plants irrigated with recycled water may be the same or even better than using potable water and fertilizing with nitrogen, phosphorus and potassium at certain times of the year (Mancino and Pepper, 1994). "Wastewater Reuse for Golf Course Irrigation" (Hayes et al., 1990), showed that effluent irrigation during the spring months developed a better quality turf grass than potable water irrigated/fertilized turf grass. In the other seasons, however, using potable water and a fertilization program was the same. The reason being that during the growing months the amount of water and nitrogen needed is very high. Since recycled water contains a very high percentage of Nitrogen, this fulfills the turf grass need,

reducing the need to add nitrogen fertilizer. In the winter months the water and nitrogen need is lower (Mancino and Pepper, 1994).

Disadvantages for Turf grass and Landscape Plants

Salinity plays a major role in damaging turf grass. Salt concentration in recycled water is high compared to that of drinking water. The practical way to address this problem through leaching. That is, to apply a sufficient amount of water to the turf, and let the water carry the accumulated salts below the root zone (Feil et al. 1997).

When applying recycled water to turf grass and landscape plants, the main constituents of concern are the ions: chloride, sodium, and boron. According to the American Water Works Association (1997), damage to plant life from these ions can occur in several ways:

- Chloride toxicity is the most common, with symptoms appearing first as leaf burn or drying of leaf tissue (usually appearing at the extreme leaf tip) and then developing into leaf drop or defoliation.
- Typical sodium toxicity symptoms are leaf burn, scorch, and dead tissue along the outside edges of leaves.
- Boron toxicity normally appears first as a yellowing, spotting, or drying of leaf tissue on older leaves at the tips and edges, and then progresses toward the center.

Table 2 on the next page explains more detailed effects of effluent water on turf grass/landscape plants.

WATER QUALITY EFFECTS ON LANDSCAPE PLANTS

Parameter (symbol)	Visual Appearance		Growth Characteristics			Method of Irrigation	
	Color	Burn	Root	Stem	Foliage	Foliar	Soil
Calcium (Ca) ¹
Magnesium (Mg) ²
Sodium (Na) ³
Carbonate (CO ₃) ⁴
Bicarbonate (HCO ₃) ⁵
Chloride (Cl) ⁶
Sulfate (SO ₄) ⁷
Nitrate (NO ₃) ⁸
Ammonium (NH ₄) ⁹
Phosphate (PO ₄) ¹⁰
Potassium (K) ¹¹
Boron (B) ¹²
Acidity/Basicity (pH) ¹³
Sodium Adsorption Ratio - adjusted (SAR adj) ¹⁴

- 1 Calcium is a structural nutrient absorbed by plants and is also essential for healthy leaf, bud, and root growth. In too high concentrations it can leave deposits on leaves via spray irrigation.
- 2 Magnesium is essential for photosynthesis and plant growth.
- 3 Sodium toxicity can result in leaf burn, scorch, and even dead tissue along outside edge of leaf. These effects can occur through both soil applied and foliar applied irrigation methods.
- 4 Carbonate toxicity can restrict plant growth.
- 5 Bicarbonate toxicity can restrict plant growth and precipitate on leaf surface leaving an unsightly white deposit.
- 6 Chloride toxicity can result in leaf burn, drying of leaf tissue, early leaf drop, or defoliation. Toxicity occurs through both soil applied and foliar applied irrigation methods.
- 7 Sulfate is essential for proper growth and maturity, but in excess can combine with calcium to form unsightly deposits on leaves.
- 8 Nitrate excess can cause problems such as overabundance of vegetative growth or lodging.
- 9 Ammonium acts much the same as nitrate.
- 10 Phosphate is an essential requirement for early growth and root formation.
- 11 Potassium is essential for plant and root growth, disease resistance, and efficient water use.
- 12 Boron toxicity appears on older leaf tips and edges as a yellowing, spotting, and/or drying of leaf tissue.
- 13 pH affects the uptake of nutrients and water.
- 14 SAR adj values over 9 can severely limit or in some cases stop plant growth.

References: FAO. Irrigation and Drainage paper. 29 Rev. 1. Water Quality for Agriculture, 1985
 Western Fertilizer Handbook - Horticulture Edition. California Fertilizer Association, Interstate Publishers, Inc., 1990
 Irrigation with Reclaimed Municipal Wastewater - A Guidance Manual. G. Stuart Pettygrove/Takashi Asano, Lewis Publishers, Inc., 1984

Table 22

California-Nevada American Water Works Association (1997)

Regulations Affecting the Use of Recycled Water on Golf Courses

For turf irrigation the golf course superintendents must consider public health protection. The EPA provides guidelines for water reuse by golf courses (EPA, 1992).

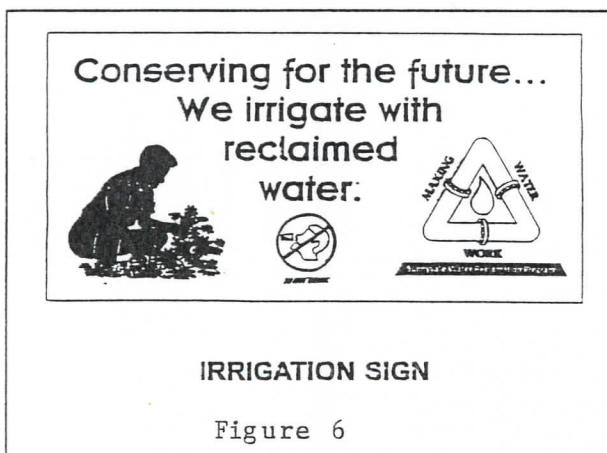
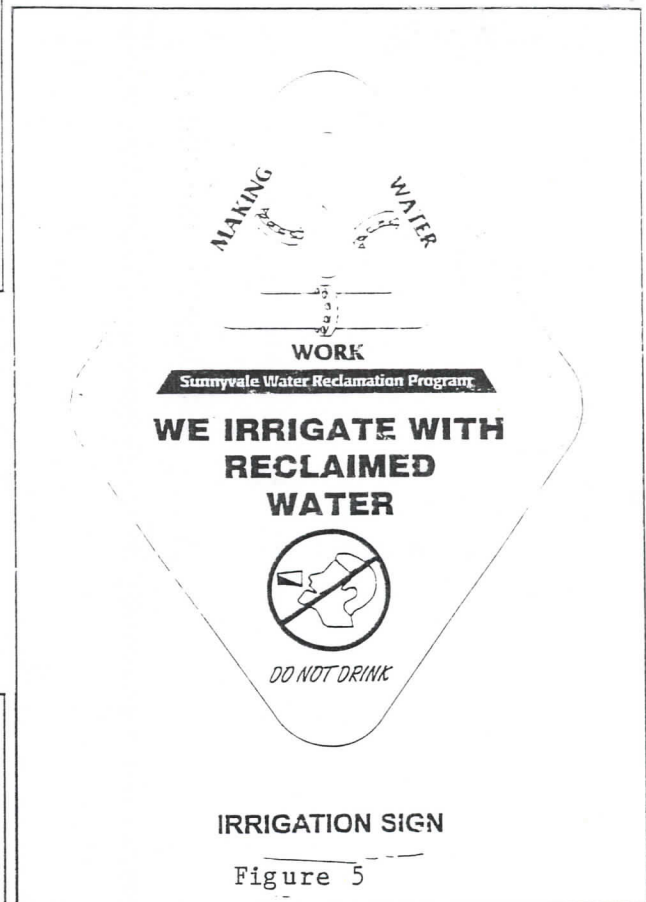
These guidelines include:

- At controlled-access irrigation sites where design and operational measures significantly reduce the potential of public contact with reclaimed water (also known as treated effluent), a lower level of treatment, e.g., secondary treatment and disinfection to achieve <14 fecal coli/100 mL, may be appropriate.
- Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations.
- The reclaimed water should not contain measurable levels of pathogens.
- A higher chlorine residual and/or a longer contact time (amount effluent is in contact w/chlorine) may be necessary to assure viruses and parasites are inactivated or destroyed.
- A chlorine residual of 0.5 mg/L or greater in the distribution system is recommended to reduce odors, slime, and bacterial regrowth.

The likelihood of human disease occurring as a result of the use of secondary or tertiary treated effluent water on turf is low (Mancino et al. 1994). However, since there are a large number of viruses/parasites in raw sewage, there is the potential for some organisms to survive the treatment process, and come into direct human contact. The golf course superintendent must monitor the water supplied from the treatment plant, and require virtually all the irrigation to occur at night (Moore, 1994).

After irrigation of the golf course, the superintendent must take into consideration the players whom the course is catering to. Figures 4, 5, and 6 show examples of signs that the course must post by state law. This will let the players know that the course is being

irrigated with treated effluent. These signs are usually posted near water features such as ponds, lakes, streams or fountains.



Figures 4, 5, and 6
California-Nevada American Water Works Association (1997)

Other Concerns Affecting the Use of Recycled Water on Golf Courses

Smell

All water, including drinking water, has some sort of odor. The fact that it is used for irrigation, doesn't affect the odor. Effluent storage lakes on golf courses (complete with fish, ducks, algae, etc.) often lend a strong odor to the irrigation water (Moore, 1994). The odor is usually strongest early in the irrigation cycle, perhaps due to small accumulations of gases in the air pockets of the irrigation system. However, when the irrigation system is operating, golfers are not usually present, due to the irrigation taking place at night (Moore, 1994).

Appearance

Recycled water is no more unattractive than regular potable water when properly stored, in storage ponds/lakes (Moore, 1994). Nutrients in effluent water encourage algal blooms, making the pond less appealing to look at. The blooms usually make the water turbid, green, and creates a filamentous growth obvious to the observer. Appearance problems are exacerbated when effluent-filled ponds are too shallow, inadequately aerated, choked with algae, and contaminated with silt and other debris from runoff.

Concerns for Animal Life

There has been no evidence showing that recycled water can or will harm wildlife who consume or bathe in recycled water.

Water Management Practices Using Recycled Water

There are forty-three golf courses currently in operation in Southern Nevada. These golf courses collectively use roughly over 36,000 acre feet a year or 12% of the valley's allotment yearly from the Colorado River. Twenty of the forty-three use drinking water to irrigate their turf, eight courses own their own wells, and fifteen courses use recycled water to irrigate their turf. If the twenty courses who use potable convert to recycled water, it would significantly reduce the amount of potable water being used for irrigation. Table 3 on the next page, shows all the golf courses in the valley as of April, 1999, and which water source they use.

Benefits of Recycled Water

In a drought, or during a mandatory watering restriction, effluent water users will not be affected (Feil et al. 1997). When golf courses hook up to the recycled water pipeline, they will experience a decrease in their rates. According to the Las Vegas Valley Water District "Service Rules", "The non-potable water irrigation rate will be at or below the annual average potable water rate." The potential savings for a potable water using course can be tremendous. When a golf course is in operation, water takes up most of the budget. When rates for potable water increases, the recycled using golf courses rates will remain the same.

Golf Courses in the Las Vegas Valley

Golf Course	Water Supply	Water Source	Number of holes
Angle Park	LVVWD	♣	45
Anthem County Club*	Henderson	Treated Effluent	18
Badlands - Pecole Ranch	LVVWD/Well	♣	18
Black Mountain	Henderson	Treated Effluent	18
Boulder City	Boulder City		18
Callaway Golf Center	LVVWD		18
Canyon Gate CC	LVVWD	♣	18
Craig Ranch	Wells		18
Desert Inn	Wells		18
Desert Pines	LVVWD	♣	18
Desert Rose	CCSD/CLV	Treated Effluent	18
Desert Willow	Henderson	Treated Effluent	18
Desert Willow Golf Club	Henderson	Treated Effluent	18
Eagle Crest - Sun City	LVVWD	♣	18
Highland Falls - Sun City	LVVWD	♣	18
Las Vegas County Club	Wells		18
Las Vegas Golf Club	Wells		18
Las Vegas National County Club	Wells		18
Las Vegas Paiute Resort	Wells		36
Legacy Golf Club	Henderson	Treated Effluent	18
Los Prados	LVVWD		18
MGM Grand Hotel*	Boulder City	Raw Lake Water	36
Mount Charleston Golf Resort	Wells		18
North Las Vegas - Brooks	N. Las Vegas		9
Outlaw - Pecolle Ranch	LVVWD	♣	18
Painted Desert	LVVWD		18
Palm Valley - Sun City	LVVWD	♣	18
Red Rock CC *	LVVWD	♣	18
Reflection Bay Golf Club	Henderson		18
Revere at Anthem	Henderson	Treated Effluent	18
Rhodes Ranch Golf Club	LVVWD	♣	18
Rio Secco	Henderson	Treated Effluent	18
Royal Links	CLV	Treated Effluent	18
Shadow Creek	N. Las Vegas		18
Sienna CC*	LVVWD	♣	18
South Shore - Lakes of Las Vegas	Henderson		18
Southern Highlands*	LVVWD		18
Spanish Trail	LVVWD	♣	27
Stallion Mountain CC	CCSD/CLV	Treated Effluent	54
Sunrise Vista - NAFB	Wells - SNWA		18
TPC at Summerlin	LVVWD	♣	18
TPC at the Canyons	LVVWD	♣	18
Wildhorse CC	Henderson	Treated Effluent	18
* Under Construction		♣ To convert to Recycled Water	

Table 3

Source: Las Vegas Valley Water District

METHODS

To test my hypothesis that moving golf courses from potable water lines to recycled water lines, will decrease the demand on the Las Vegas Valley's drinking water supply and significantly impact water management efforts, I selected two courses in Las Vegas: Stallion Mountain Country Club and Canyon Gate Country Club. Stallion Mountain, a forty-five hole course is already irrigating with recycled water, and Canyon Gate, an eighteen hole course will be receiving recycled water by 2001. I selected these two courses, due to the similar acreage of turf between both eighteen hole courses. I did my comparison of these courses by using only one of the eighteen hole courses at Stallion Mountain. Next, I interviewed each superintendent with a survey of questions (see Appendix D). After each interview, I did a visual survey and took photos. I compared and analyzed the 1998 wateruse of both Stallion Mountain and Canyon Gate. The goal of my research is to compare and analyze the historical water use of the recycled water using course, and compare and analyze the potable water using course. I will quantify the amount of water "conserved" by using recycled water for irrigation. Furthermore, how much water could be used by all other potable-water irrigating courses in the Las Vegas Valley.

RESULTS

Stallion Mountain

Site Descriptions



Figure 7: Stallion Mountain Country Club in East Las Vegas.

Stallion Mountain is a forty-five hole, private facility with over 400 acres of turf, and twenty-five surface acres of water features. The course is located near Flamingo and Nellis Blvd., on the east side of the Las Vegas Valley. Stallion Mountain resides between the Clark County Sanitation District and the City of Las Vegas Water Pollution Control Facility. Currently, Stallion Mountain receives its water from the City of Las Vegas Water Pollution Control Facility.

Water Usage

<i>M o n t h</i>	<i>M i l l i o n s / G a l l o n s</i>	<i>A c r e F e e t</i>
J a n u a r y	9 , 9 7 0 , 0 0 0	3 1
F e b r u a r y	9 , 7 0 0 , 0 0 0	3 0
M a r c h	1 8 , 8 1 0 , 0 0 0	5 8
A p r i l	2 9 , 6 2 0 , 0 0 0	9 1
M a y	4 0 , 4 4 0 , 0 0 0	1 2 4
J u n e	3 9 , 3 4 0 , 0 0 0	1 2 1
J u l y	4 5 , 1 5 0 , 0 0 0	1 3 8
A u g u s t	3 7 , 1 6 0 , 0 0 0	1 1 4
S e p t e m b e r	2 8 , 9 9 0 , 0 0 0	8 9
O c t o b e r	2 1 , 9 1 0 , 0 0 0	6 7
N o v e m b e r	7 , 8 3 0 , 0 0 0	2 4
D e c e m b e r	8 , 4 8 0 , 0 0 0	2 6
T o t a l s	2 9 7 , 4 0 0 , 0 0 0	9 1 2
<i>A c r e f t . / a c r e / y r . = 6 . 7</i>		

Table 4: Stallion Mountain Wateruse for 1998. (Courtesy of Stallion Mountain)

From the table above, 912 acre feet of water is reused. This reuse is beneficial for the facility and the environment, since there is less water being discharged back into the Las Vegas Wash. The less water that empties in to the Wash the less erosion there is.

Stallion Mountain receives Stage Three tertiary treated water, disinfected with chlorine. When the water is received by Stallion Mountain, a slow steady flow of chlorine is added at the temporary storage basin, seen below. Here the water is disinfected before reaching the irrigation system. Figures 8 and 9 show the process.

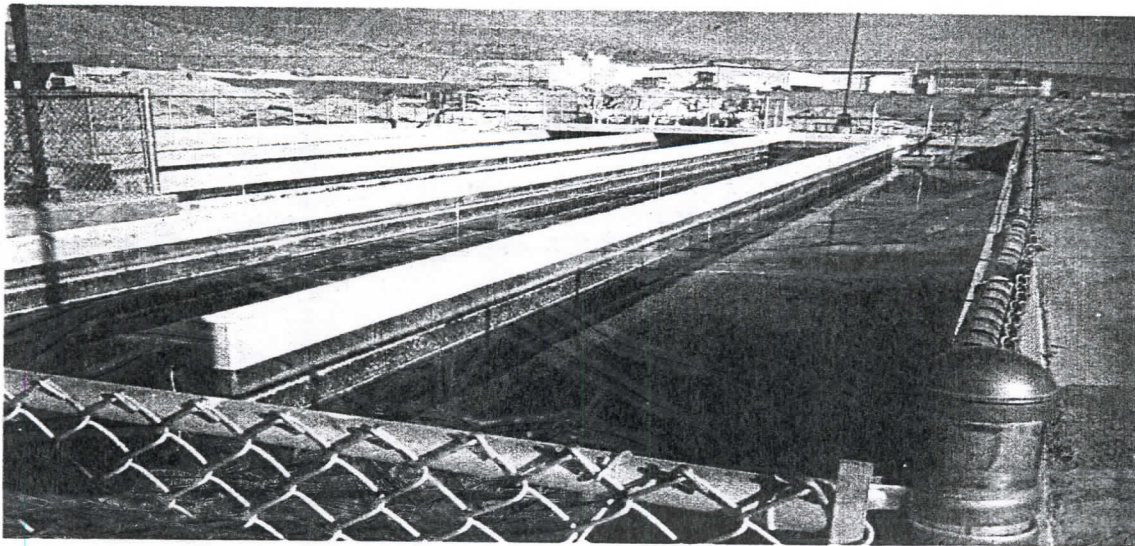


Figure 8: Stallion Mountain Chlorine Contact Basin.



Figure 9: Sign posted at Stallion Mountain, showing chlorination is taking place.

I asked some of the maintenance staff if they had any problem working with recycled water. All agreed they had no problem, just as long the water was being tested. Workers have been known to take a few swigs from the sprinkler head if its running, on a hot day. According to one of the maintenance staff, he explained, "He would have to drink over 1,000 gallons in a very short period, to get ill." In Figure 10 on the next page, a sign is posted near an effluent stream. Although human contact is unlikely, Stallion

Mountain posts signs throughout the course to inform patrons against contact as a precaution.



Figure 10: Stallion Mountain posts signs around the course to inform patrons to avoid contact.

Advantages at Stallion Mountain

Turf, it seems does not have much, if any problem, from being irrigated with recycled water and actually can be beneficial. According to Bill Rohret, Superintendent of Stallion Mountain, "the best filter is turfgrass," meaning that the turf will filter out all of the impurities. During the spring, from February to May, Nitrogen fertilizer is not used (which can reduce the cost for fertilizer), due to the accumulation of Nitrogen from the recycled water. From June to January, there just is not enough Nitrogen in the water to keep up the demand of the turf.

The biggest benefit for using recycled water at Stallion Mountain is the savings. The average cost for recycled water is \$0.25 per 1,000 gallons of water, compared to the average cost of \$1.97 per 1,000 gallons for potable water. Due to Stallion Mountain's

very close proximity to the treatment plant (less than ½ mile), the delivery costs are virtually zero. Stallion Mountain used 297,400,000 gallons in 1998. Barring any other costs, Stallion Mountain roughly paid \$74,350 for their irrigation. If they irrigated their turf w/potable water, they would have paid \$585,878 for irrigation. This is a savings of \$511,528. This savings makes recycled water a very cost effective way to irrigate turf.

Disadvantages at Stallion Mountain

According to Bill Rohret the superintendent of Stallion Mountain, the pump stations and well casings from the constant contact with recycled water will rust and rot over time. But, most everything is stainless steel, to circumvent some of this damage.

When irrigating with recycled water, the biggest concern is salts, and salt build up in the soil. The salts can rust equipment, adding up the costs. But, when managing Stallion Mountain, the goal is to provide the players, and members of the course a refreshing game of golf. Complete with all the landscape features. Irrigating with recycled water has it draw backs though. When irrigation takes place, misting from the rotary heads can cause leaf burn, especially to deciduous trees. In Figure 11, on the next page, a close up view of the leaf shows significant burn. Also in Figure 12, the photo shows how the direct spray contact can hurt the tree.

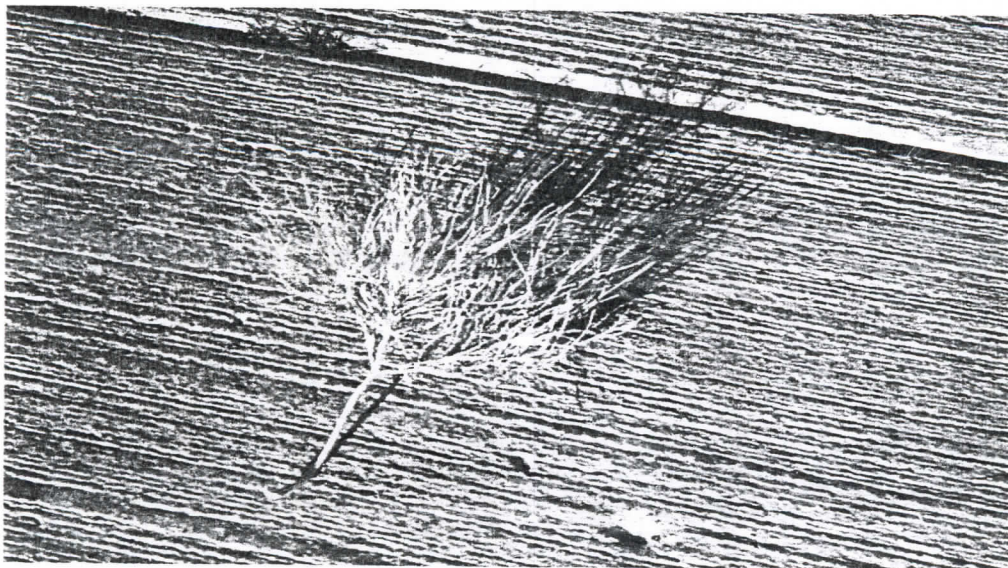


Figure 11: Stallion Mountain - Leaf Burn on the Mondell Pine from the recycled water.



Figure 12: Stallion Mountain - Stone Pines can only tolerate the recycled water.

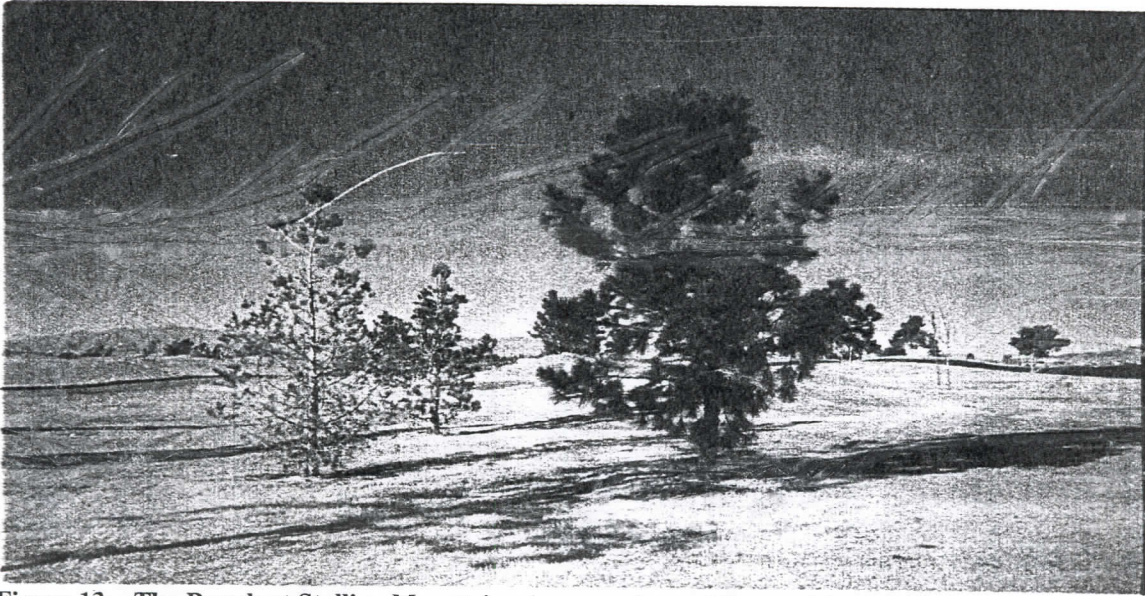


Figure 13: The Rough at Stallion Mountain. A comparison of the two Mondell Pines. Each pine is roughly the same age. Although the pine on the right, was irrigated w/potable water.

In figure 13, according to Mr. Rohret, both of the pines came from the same company, and were roughly the same height, when the pine on the left was planted where it stands, and the pine on the right was planted at the clubhouse, which is using potable water. The maintenance crew had just transplanted the pine on the right a few weeks before the photo. Pines can only tolerate recycled water. As seen above, recycled water can impact the leaves and growth of the trees. This is one disadvantage of recycled water.

Another disadvantage of recycled water is salt build up around the course. In Figures 14 and 15 illustrates the salt build up, and what it can do to the surrounding turf.



Figure 14: Salt at Stallion Mountain that has yet to be flushed or filtered from the turf.

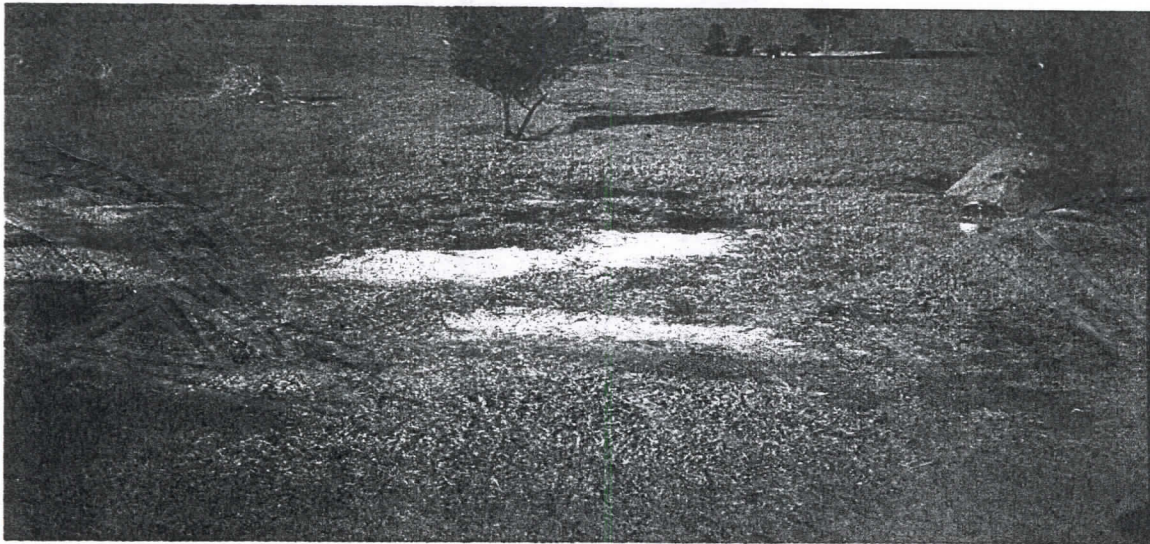


Figure 15: Accumulation of salt at Stallion Mountain from irrigation w/recycled water. (Stallion Mountain)

From an aesthetical standpoint, annual flowers cannot be on the course where recycled water may be present. Due to the high salt content, those types of flowers must be planted where potable water reach them. Also, shrubs and/or trees that require drip irrigation cannot be on the course either. Due to the high TDS from the water, the emitters stand good chance to clog. Once the emitters clog, the system must be replaced.

Figure 16 shows the entrance to clubhouse, all of the turf, flowers, shrubs and trees are on potable water. For ornamental vegetation/flowers, recycled water is too salty for the plants, potable water is then used to irrigate the foliage.

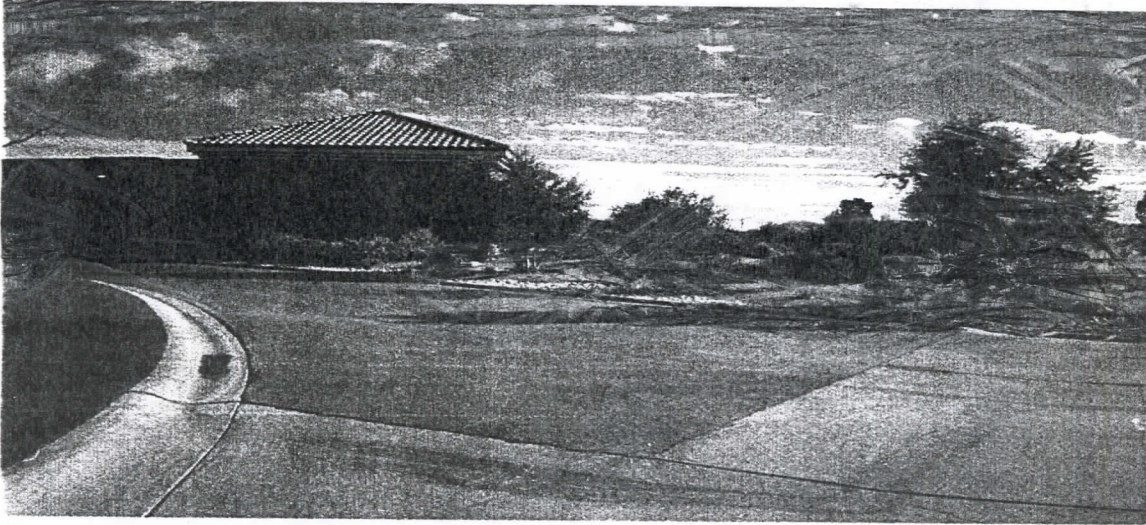


Figure 16: Around the clubhouse at Stallion Mountain, the desert landscape requires drip irrigation, so recycled water is not used.

As said previously the biggest concern of using recycled water is salt build up from the continuous irrigation of recycled water. Over time, the salts will crust up, and damage the turf around the vicinity of the build up. In order to move the salt along, aerifying the soil is done on a regular basis, to keep the soil open. Also, some excess watering is done to wash the salts away, or filter through the ground. Over-watering is not done as frequently here at Stallion Mountain, due to the good drainage of the area.

Canyon Gate

Site Descriptions



Figure 17: Canyon Gate Country Club, West Las Vegas.

Canyon Gate is a smaller eighteen hole course with 137 acres of turf, and a little above 12 acres of water features. The course lies between Fort Apache and Durango Road, near Sahara Ave on the west side of the Las Vegas Valley. Residential homes are on and near the course.

Water Usage

Canyon Gate has always been irrigated with potable water and currently receives its water from the Las Vegas Valley Water District. Salt build up is relatively low, leaf burn on any of the foliage is uncommon. This water could be used for drinking purposes in our ever growing city. Table 5 shows Canyon Gates water use for 1998.

<i>M o n t h</i>	<i>M i l l i o n s / G a l l o n s</i>	<i>A c r e F e e t</i>
J a n u a r y	9,436,000	29
F e b r u a r y	4,634,000	14
M a r c h	12,895,000	40
A p r i l	29,817,000	91
M a y	38,625,000	118
J u n e	41,735,000	128
J u l y	45,072,000	138
A u g u s t	41,521,000	127
S e p t e m b e r	31,738,000	97
O c t o b e r	23,581,000	72
N o v e m b e r	13,134,000	40
D e c e m b e r	12,992,000	40
T o t a l s	305,180,000	936
<i>A c r e f t./a c r e / y r. = 6.2</i>		

Table 5: Canyon Gate Wateruse for 1998. (Courtesy of L.V.V.W.D)

When golf courses use potable water, the water bill's that add up, take a big percentage out of the budget, which means less profit for the course. When Canyon Gate starts to receive the recycled water they will still pay approximately \$1.97 per 1,000. This is because the course is further away from the plant, which makes delivery costs rise. Also, instead of chlorine being used to disinfect the water, UV rays are being used. The new technology makes the project expensive at first. The benefit will be that if the rates go up for residents and businesses alike around the city, Canyon Gate will still pay around \$1.97 per 1,000 gallons, because they will now have recycled water on their course (LVVWD "Service Rules). Water rates are expected to increase over 70% in the next ten years if Canyon Gate did not receive recycled water, there rates would be roughly \$3.35 per 1,000 gallons. The cost they pay right now would almost double.

Advantages of Using Potable Water at Canyon Gate

Since Canyon Gate uses potable water as of 1999, Tim Dagg, Superintendent of Canyon Gate, rarely has any problems with leaf burn, or anything that would be associated with recycled water. In Figure 18, the trees/shrubbery, show no problems, and look very well.

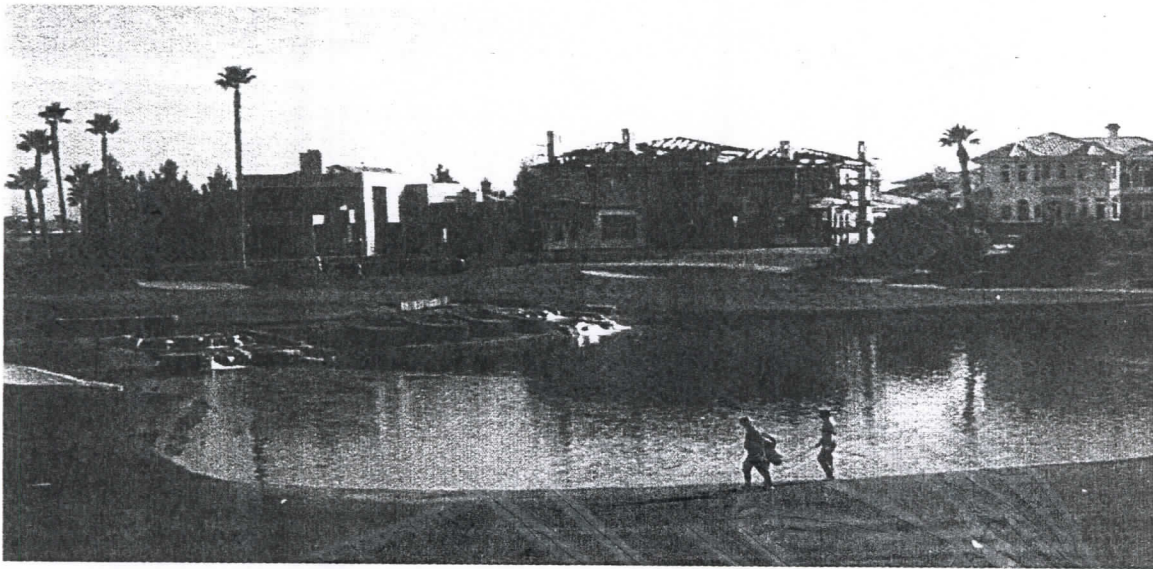


Figure 18: When using potable water at Canyon Gate, plant selection is easy.

DISCUSSION

Overall Advantages of Using Recycled Water

Stallion Mountain and Canyon Gate use about the same amount of water per acre. This surprised me, since I was told that recycled water using golf courses may irrigate a bit more than potable courses since the flushing of salts take place. I feel there will be no significant impact from recycled water the courses that will begin to receive recycled water. Stallion Mountain it seems is the indicator course that shows recycled water can and will work. Considering the amount of water used by Stallion Mountain also, you would figure Stallion Mountain would waste more water, since their water is so cheap. But, from both Tables 4 and 5, that is not so. Actually, Canyon Gate uses a bit more water than Stallion Mountain, since the soil is very rocky, while Stallion Mountain's soil is a bit more sandy. This sandy soil is better for drainage, and a rocky soil makes watering a bit more tedious, since it is hard to push the water in the soil.

The biggest motivator it seems to move towards recycled water is cost. Recycled water requires "cleaned" as far as particle filtration, while potable water goes through reverse osmosis according to Gary Grinnell, Senior Civil Engineer at the Las Vegas Valley Water District. The reverse osmosis process is very expensive, which is a reason why clean water can get expensive. Aside from the cost, the real issue is that the water is used to its full potential also, and not just wasted. Both Bill Rohret and Tim Dagg explained that there is, "a need for recycled water with water scarcity becoming a bigger issue everyday here in Las Vegas." They further go on to say that recycled water, "is meeting societies/economies needs." Once all the golf courses in the Las Vegas Valley

hook on to the recycled water lines, and recycled water is proven to be beneficial in the public's eyes, the next step will be parks and schools.

Overall Disadvantages of Using Effluent

When Canyon Gate starts to receive recycled water in 2001, the course will look a little different than the way it is today. Plants, trees, and equipment must be retrofitted before the first recycled water delivery arrives. Also, the soils at Canyon Gate are rocky, sandy, so it will be rather difficult to flush or filter the salts from the fairways and rough. From my observation, about 25% to 30% of the trees/plants must be taken out before irrigation with recycled water begins. The plant life will not be able to last longer than a year, due to the high salt content of the water. When considering the turf, Canyon Gate will add soil amendments to keep the grass from going into shock. As all the negatives add up though, Mr. Dagg is looking at receiving recycled water as cost effective.

Addressing Disadvantages

Even though recycled water may have some disadvantages when irrigating trees, there are some trees that can thrive with recycled water. The tree that has the least problem, if any problem, would be the different varieties of olive trees. Most olive trees planted in the Las Vegas Valley, have a waxy leaf. This waxy leaf protects the tree from damage that otherwise occurs to other trees, such as the pines. In figure 19, this shows how full/healthy these olive trees are. When these olive trees are planted in bunches, it can give the course some nice green. Also, older ash trees can prosper w/recycled water, but the younger the tree is, the more susceptible it can be to the salt problem.



Figure 19: Olive Trees at Stallion Mountain are a nice touch to courses irrigating w/recycled water.

Future Conversions of Golf Courses

Canyon Gate, and six other courses in the northwest part of Las Vegas, will begin to be irrigated with recycled water. A water recycling plant is now under construction. A pipeline from the City of Las Vegas Water Pollution Control Facility will feed the recycling plant under development. The recycled water plant that is being built in the northwest is going to supply those courses in that area (Table 3). This new facility called a Water Resource Center will use ultra-violet light to disinfect that water. This new technology will require five times more energy than chlorination, but the water will be almost as pure as the potable water we drink right now. Also, another facility will be built in the coming years, to supply the growing numbers of courses in the southwest part of the city (Appendix B). According to Gary Grinnell, the goal is to have, “enviro-friendly golf courses all over the city, and the country.” Golf courses will not be the environment problem the public perceives them to be now and in the future.

CONCLUSION

There are twenty golf courses in Las Vegas, using more than 6,000,000,000 gallons of drinking water. In the future, when these courses begin to use recycled water, more than 18,500 a/f will be used by residents who will need the water. Current estimates put Las Vegas at more than 2,000,000 people in the early part of the 21st century. This water that was previously used to water turf, will now be used to quench our growing residents thirst.

The cost of using recycled water is very cheap compared to the potable as said previously. The cost of treating the water makes it very economic for large water users to tap into the recycled pipeline. Also, the electricity being used will be less, due to simple gravity. In the future, potable water that comes from the water treatment plant on the east side of Las Vegas, that would be destined for a golf course in Summerlin will now come from a water resource center near by. The amount of electricity needed to pump so many millions of gallons of water uphill will no longer be needed. This in fact makes it more cost effective to build more wastewater facilities. Everybody wins with recycled water.

In the end, recycled water will help in the water management of the Las Vegas Valley for years to come. Recycled water will help move the large water users off the potable water lines, and on the recycled water lines. In turn, during the very hot summer months, when the water need is at its peak demand, the large water users (i.e. golf courses) will be off the system. This will subsequently ease the demand for water for residents in the Las Vegas Valley. Recycled water in the future may be used on schools and parks all over the valley. We live in a desert, where the future of water could be in

jeopardy. But if water is used to its full potential in the Las Vegas Valley, future generations will continue to flourish.

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Appendix A
Nevada Administrative Code
Use of Treated Effluent for Irrigation

NAC-Nevada Administrative Code Use of Treated Effluent for Irrigation

Spray Irrigation Uses

Fecal Coliform			c.f.u. or mpn/100 ml	
Reuse Category	A	A(1)	B	C
30-day geom mean	No limit	200	23	2.2
Max daily number	No limit	400	240	23
Min Buffer Zone	800 ft.	400 ft.	100 ft.	None
General Uses				
Pasture and Agriculture Not For Human Consumption				
Golf Course Cemetery Highway Median Park Greenbelt Res and Comm Lawns				
Controlled				
Does Not Occur				
Full Body Contact Not reasonably expected				

Total Coliform	c.f.u. or mpn/100 md	Exception	<2.2	<23	None	Cemetery Golf Course Highway Median Greenbelt/Park Playground Res and Comm Lawns	Uncontrolled	Full body contact expected
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NAC - Nevada Administrative Code

445A.272 Termination of applicability of individual permit upon inclusion in general permit. A holder of an individual permit who is excluded from a general permit solely because he holds the individual permit may request that the individual permit be revoked and that he be included in the general permit. The applicability of the individual permit is automatically terminated upon notification by the director that the discharger is included in the general permit.

(Added to NAC by Environmental Comm'n. eff. 3-18-93)--(Substituted in revision for NAC 445.1756)

Use of Treated Effluent for Irrigation

See
445A.277
below

445A.275 General requirements and restrictions.

1. A person shall not use treated effluent for irrigation unless he has:

(a) Submitted to the division and has received the approval of the division of a plan for the management of effluent; and

(b) Obtained a permit pursuant to NAC 445A.228 to 445A.263, inclusive.

2. A person using treated effluent for irrigation by flooding or sprinklers shall use effluent that has received at least secondary treatment. As used in this subsection:

(a) "Secondary treatment" means that the biological oxidization of the sewage to a point where the sewage has a 5-day inhibited biochemical oxygen demand concentration of 30 milligrams per liter or less.

(b) "Five-day inhibited biochemical oxygen demand" means the amount of dissolved oxygen in milligrams per liter required during stabilization of the carbonaceous decomposable organic matter by aerobic bacterial action at 20 degrees centigrade for 5 days.

3. Any person using treated effluent for irrigation shall post a notice at the site of irrigation warning the general public to avoid contact with the treated effluent.

4. Except as otherwise provided in this subsection, a person shall not use treated effluent to irrigate crops for human consumption. A person may use treated effluent for surface irrigation of fruit bearing trees and nut bearing trees.

5. A person using treated effluent to irrigate by sprinklers shall conduct the irrigation in a manner which inhibits the treated effluent from drifting or carrying outside the buffer zone.

6. A person shall not allow treated effluent used in irrigation to run off the site being irrigated.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.176)

Reviser's Note.

The regulation of the state environmental commission filed with the secretary of state on September 13, 1991, the source of NAC 445A.275 to 445A.280, inclusive, became effective on that date and contains the following provisions not included in NAC:

"Notwithstanding the provisions of sections 2 to 8, inclusive, of this regulation, a person who:

1. Is using treated effluent for irrigation on the effective date of this regulation without having obtained a permit pursuant to NAC 445A.228 to 445A.263, inclusive, within 180 days after the effective date of this regulation, may continue to use treated effluent for irrigation without having obtained a permit until the state department of conservation and natural resources takes action upon the application for a permit"

445A.276 Spray irrigation: Requirements for bacteriological quality and buffer zone limitations.

1. Treated effluent being used for spray irrigation must meet the following requirement for bacteriological quality and buffer zone limitations:

NAC - Nevada Administrative Code

	Fecal Coliform			
	c.f.u or mpn/100 ml			
Reuse Permitted	A	A(1)	B	C
30-day geometric mean	No limit	200	23	2.2
Maximum daily number	No limit	400	240	23
Minimum Buffer Zone (Feet)	800	400	100	0

2. As used in this section:

(a) Category "A" means irrigation with treated effluent of land used for:

(1) Pasture; or

(2) Other agricultural purposes except growing crops for human consumption, where public access to the site being irrigated is prohibited. Treated effluent being used for activities falling within category A must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category A or meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category A(1).

(b) Category "B" means irrigation with treated effluent for land used for:

(1) A golf course, cemetery or greenbelt where public access to the site being irrigated is controlled and human contact with the treated effluent does not occur;

(2) An impoundment where all activities are prohibited and human contact with the treated effluent does not occur; or

(3) Any combination of a use listed in paragraph (a) and a use listed in subparagraph (1) or (2) of this paragraph.

Treated effluent being used for activities falling within category B must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category B.

(c) Category "C" means irrigation with treated effluent of land used for:

(1) A cemetery, highway median, greenbelt, park, playground or residential or commercial lawn where public access to the site being irrigated is controlled and human contact with the treated effluent cannot reasonably be expected;

(2) Impoundments where full body contact with the treated effluent cannot reasonably be expected;

(3) Any other purpose not included in category A or B; or

(4) Any combination of an activity listed in paragraph (a) or (b) and an activity listed in subparagraph (1), (2) or (3) of this paragraph.

Treated effluent being used for activities falling within category C must meet the requirements for bacteriological quality and buffer zone limitations identified in subsection 1 as applicable to category C.

(d) "C.f.u. or mpn/100 ml" means colony forming units or most probable number per 100 milliliters of the treated effluent.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--Substituted in revision for NAC 445.1765)

Recycled Water from WRC will meet .277

NAC - Nevada Administrative Code

445A.277 Exceptions to requirements for buffer zone and control of public access. A buffer zone and control of public access is not required where treated effluent is used for irrigation of land used for a cemetery, golf course, greenbelt, impoundment where full body contact can reasonably be expected, park, playground or commercial or residential lawn, if the treated effluent:

1. Has a total coliform concentration of 2.2, or less, per 100 milliliters of the treated effluent as a 30 day geometric mean; and
2. Has a total coliform concentration of 23, or less, per 100 milliliters of the treated effluent as a maximum daily number.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.177)

445A.278 Drip or surface irrigation of landscape: Minimum level of disinfection. The minimum level of disinfection for drip irrigation of landscape and surface irrigation of landscape with treated effluent in areas where public access is controlled is 200 fecal coliform per 100 milliliters of the treated effluent as a 30 day geometric mean and 400 fecal coliform per 100 milliliters of the treated effluent as a maximum daily number.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.1775)

445A.279 Determining quality of effluent: Storage reservoirs excluded from treatment process. For the purpose of determining the quality of effluent, storage do not constitute part of the treatment process.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.178)

445A.280 Waiver or modification of requirements. The director may waive compliance with or modify any requirement of NAC 445A.275 to 445A.280, inclusive, for a specific project of irrigation upon his determination that because of the size, type or location of the project of irrigation, the waiver or modification is consistent with the policy set forth in NRS 445.132.

(Added to NAC by Environmental Comm'n, eff. 9-13-91)--(Substituted in revision for NAC 445.1785)

Appendix B

Planned and Proposed Golf Courses
whom will be receiving Recycled Water

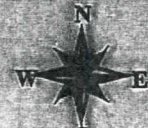
Water Resource Center - RWDS

DRAFT



- LAND USE STATUS**
- Existing
 - Under Construction
 - Proposed
 - Served by Wells
 - No Consumption
 - Pressure Zone
 - Pipeline Alignment

- SERVED BY RECYCLED**
- Golf Course
 - Park
 - School
 - Pond
 - Future WRC, Park & Golf Course
 - Pumping Station



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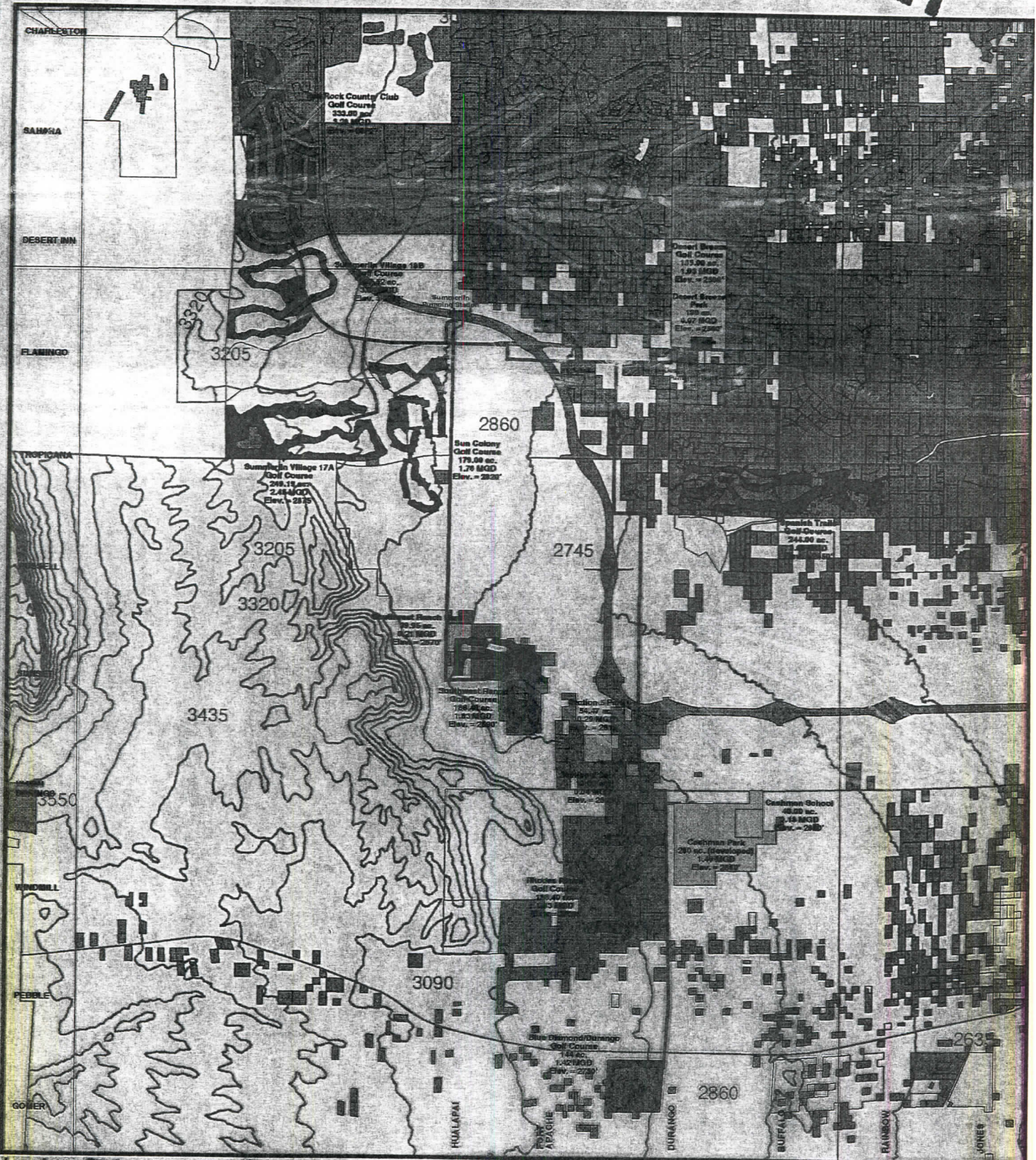
NOTE: THIS MAP IS SUBJECT TO REVISION WITHOUT NOTICE. CONTACT THE LAS VEGAS VALLEY WATER DISTRICT DEPARTMENT OF PLANNING FOR AVAILABILITY OF DISTRICT WATER SERVICE.

THE INFORMATION DEPICTED ON THIS MAP IS BASED ON DATA COLLECTED FROM THE LAS VEGAS VALLEY WATER DISTRICT DEPARTMENT OF PLANNING. THE DISTRICT DEPARTMENT OF PLANNING IS NOT RESPONSIBLE FOR ANY ERRORS OR OMISSIONS. THE DISTRICT DEPARTMENT OF PLANNING IS NOT RESPONSIBLE FOR ANY ERRORS OR OMISSIONS. THE DISTRICT DEPARTMENT OF PLANNING IS NOT RESPONSIBLE FOR ANY ERRORS OR OMISSIONS.



DESERT BREEZE - WRC

DRAFT

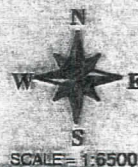


Landuse Status

- Existing
- Under Construction
- Proposed
- Served by Wells
- No Consumption
- Pressure Zones
- Pipeline Alignment

Served by Recycled

- Golf Course
- Park
- School
- Pond
- Lake
- Desert Breeze - WRC



NOTE: THIS MAP IS FOR INFORMATION ONLY. WITHOUT NOTICE, CONTACT THE LAS VEGAS VALLEY WATER DISTRICT DEPARTMENT OF RESOURCES FOR AVAILABILITY OF CURRENT INFORMATION.

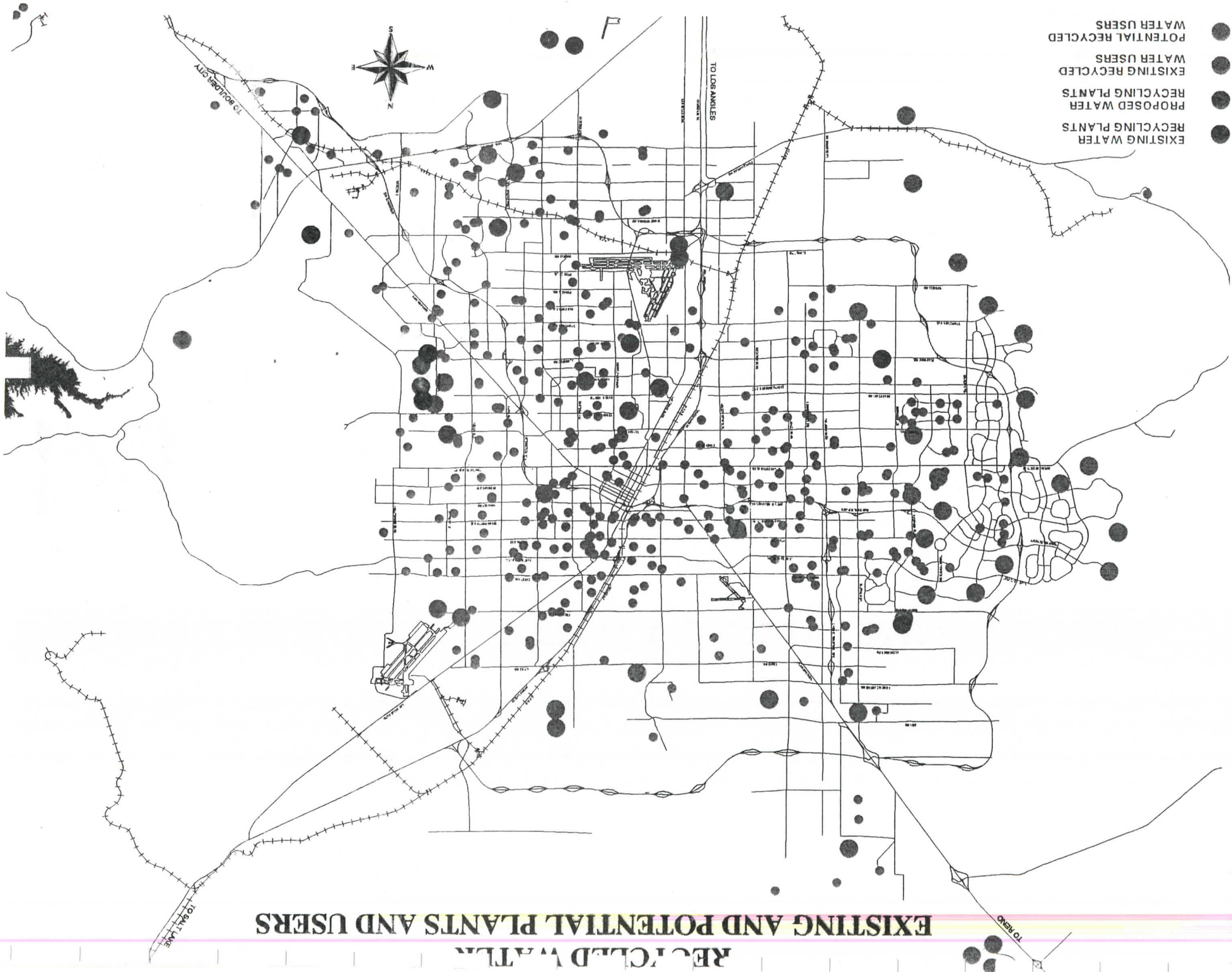
THE INFORMATION ON THIS MAP IS BASED ON DATA COLLECTED FROM VARIOUS SOURCES AND IS NOT GUARANTEED FOR EXACT PLANNING PURPOSES ONLY. THE LAS VEGAS VALLEY WATER DISTRICT DEPARTMENT OF RESOURCES DEPARTMENT OF PLANNING AND ENGINEERING HAS CONDUCTED FIELD SURVEYS TO VERIFY THE DATA ON THIS MAP. THE DATA IS SUBJECT TO CHANGE. THE INFORMATION ON THIS MAP IS NOT GUARANTEED FOR EXACT PLANNING PURPOSES ONLY. THE LAS VEGAS VALLEY WATER DISTRICT DEPARTMENT OF RESOURCES DEPARTMENT OF PLANNING AND ENGINEERING HAS CONDUCTED FIELD SURVEYS TO VERIFY THE DATA ON THIS MAP. THE DATA IS SUBJECT TO CHANGE.



EXISTING AND POTENTIAL PLANTS AND USERS

RECYCLED WATER

- EXISTING WATER RECYCLING PLANTS
- PROPOSED WATER RECYCLING PLANTS
- EXISTING RECYCLED WATER USERS
- POTENTIAL RECYCLED WATER USERS



Appendix C

Questionnaire

Interview for questions for Golf Course Superintendents

1. What level of treatment is the water at when being used on the course?
2. Is there a difference in the total water use of recycled water vs. potable water? If the difference is higher, why?
3. Does recycled water have an effect on the quality of turf and/or plant material on the greens or fairways.
4. Is there a difference in your fertilization program, since using recycled water? What kinds of changes from potable water?
5. Do you think recycled water causes any excessive wear and tear on your equipment?
6. Is there any extra maintenance practices (landscaping/horticultural) implemented when using recycled water?
7. Is there any difference in the maintenance of the irrigation reservoirs?
8. Are there any potential health concerns for players and/or maintenance staff?
9. Any health or safety concerns for migratory birds/waterfowl and wildlife within the area?
10. Do you feel recycled water will have a big future within the industry here in Las Vegas?
11. What do you foresee as the biggest benefit for using recycled water, other than cost?
12. What kind of challenges have you encountered by the use of recycled water? Or challenges in the future?
13. Do you feel there may be a problem with using recycled water in schools/parks.