CALCULATION OF AGRONOMIC RATES FOR LANDSCAPE IRRIGATION OF RECYCLED WATER AT LA CONTENTA GOLF COURSE

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ATTACHMENTS

CALCULATION OF AGRONOMIC RATES FOR LANDSCAPE IRRIGATION OF RECYCLED WATER AT LA CONTENTA GOLF COURSE

1.0 INTRODUCTION

Condor Earth Technologies, Inc (Condor) prepared this Calculation of Agronomic Rates for Landscape Irrigation of Recycled Water (Report) at the request of Bill Perley, Director of Utility Services and Engineering of Calaveras County Water District (CCWD). This Report includes background information, a description of calculation methodology, and tables of monthly irrigation loading rates for recycled water.

2.0 BACKGROUND

The La Contenta Golf Course (Golf Course) is regulated as a land application area for wastewater treatment plant (WWTP) discharges under Waste Discharge Requirements (WDR) Order No. R5-2002-0222. Upgrades in facilities allow CCWD to increase treatment capacity, with resulting increases in discharge of tertiary treated (Title 22) water. To accommodate increased discharges, CCWD is submitting a Notice of Intent to comply with the *General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water* (General Permit) from the State Water Resources Control Board Order No. 2009-0006-DWQ. The General Permit requires Producers and Distributors of recycled water to apply recycled water at agronomic rates[1].

3.0 PREVIOUS WORK

In preparation of this report Condor reviewed the following reports:

1. *Final Calaveras County Water District La Contenta Golf Course Irrigation Water Use Study* (Irrigation Water Use Study), August 6, 2007, prepared by Blankinship & Associates, Inc.
2. *Evaluation of Agronomic Practices at La Contenta Golf Course* (Evaluation of Agronomic Practices), November 21, 2008, prepared by Michael McDermott, Golf Map Services.
3. *Water Balance (Revised) – 100-year and Average Year Storm Event – Future Flows* (Water Balance), 2011, prepared by HDR Engineering.

3.1 IRRIGATION WATER USE STUDY

The Irrigation Water Use Study was prepared to evaluate potential scenarios to increase recycled water irrigation. Water quality data on recycled water and supplemental irrigation water were gathered from CCWD and the Golf Course staff. Data on local climate, reference evapotranspiration (ETo), and crop factors were gathered from public sources. Infiltration rates were measured and water and soil samples were collected over several months and analyzed by a Registered Engineer. Grass species are described as bentgrass and annual blue grass on greens and fairways whereas tees are mostly rye grass. Bentgrass and annual blue grass are cited as very sensitive to moderately sensitive to soil salinity. Irrigation practices are described in relation to parts of the course:

- Greens, green surrounds, and other sensitive areas (7 acres) receive 100 percent New Hogan water.

[1] Agronomic Rate: The rate of application of recycled water to plants that is necessary to satisfy the plants' watering and nutritional requirements, considering supplemental water (e.g., precipitation) and supplemental nutrients (e.g., fertilizers), while preventing or strictly minimizing the amount of nutrients that pass beyond the plants' root zone. General Permit ORDER NO. 2009-0006-DWQ, Attachment A, item b.

- Tees (4 acres) receive a range of 40:60 to 60:40 blend of New Hogan to recycled water from March to May and a 50:50 blend from June to October.
- Fairways and roughs (55 acres) receive a 60:40 blend of New Hogan to recycled water from March to April, a 30:70 blend from June to September, and a 40:60 blend in May and October.

Included is a description of a typical 4-hour irrigation cycle at fairways in which New Hogan water is used to flush soil for the first 30 minutes prior to use of recycled water.

Findings include tabulated data summaries of water quantity and quality, and soil quality. The recycled water is of inferior quality with respect to salinity than the New Hogan water used for supplemental irrigation. The author states that salt build-up in soil is undesirable for plant vigor and retards soil permeability. Data showing salt reduction in the soil profile during winter rainfall flushing is presented.

The Irrigation Water Use Study concludes that the course manager's selective use of recycled water for irrigation appears based on well understood concepts of effluent water use on turf, and that the historic volumes and rates of recycled water use do not appear to have resulted in any obvious detrimental impact to soil or turf conditions. Table 11 in the Irrigation Water Use Study shows the ratio of recycled water to turf acreage at the Golf Course is about half the average rate from four other comparable courses. The Irrigation Water Use Study concludes that additional recycled water can be accommodated on the course and provides a plan for increasing use of recycled water from 120 acre feet per year (af/yr) to 175 af/yr over a 3-year period.

3.2 EVALUATION OF AGRONOMIC PRACTICES

The Evaluation of Agronomic Practices in 2008 provided an overall analysis of the water use requirement for the year and calculated the total water requirement for 70 acres of turf at 287 af/yr, and 59 acres (fairways, roughs, and tees) at 242 af/yr. The author made 11 specific recommendations for modifying irrigation equipment or practices to expand the use of recycled water.

3.3 WATER BALANCE

HDR Engineers provided a water balance table showing anticipated recycled water volumes following plant upgrades. HDR employed historical records showing total Golf Course irrigation demand of 305 af/yr. Data provided by CCWD for the years 2003 through 2011 show total irrigation water use averaging 269 af/yr of which 147 af was recycled water (53 percent). The water balance table in an average rainfall year projects future deliveries of 233 af/yr of recycled water (76 percent of total demand).

4.0 LA CONTENTA IRRIGATION PLAN

The La Contenta Irrigation Management Plan (Plan) is provided in Table 1. The Plan takes into account the climate, turf evapotranspiration, and nutrients in recycled water. Table 1 shows values for climatic and water quality parameters used to estimate agronomic hydraulic and nutrient loading. In this Plan, the total agronomic irrigation volume is 283 af, of which 233 af (82 percent) is recycled water.

The Monitoring and Reporting Program for the General Permit specifically requires calculation of nitrogen and salt loading, shown in the last two columns of Table 1. The monthly nutrient loading of a blend of 82 percent recycled water and 18 percent supplemental irrigation water was based on the water quality data shown in the sub table to the lower left of Table 1. Average recycled water quality data from 2 years of monthly effluent sampling, shown on Table 2, were used. TDS loading in the Plan may be overstated. The TDS concentration of recycled water in the future will likely be lower than data used for this Plan because new UV (ultraviolet) tertiary treatment will not require the addition of chemicals. Water quality data of supplemental irrigation water used for the blending calculation for TDS was taken from the Irrigation Water Use Study. Lacking total nitrogen data, a value of 5 mg/L was used to characterize New Hogan water. Actual nitrogen concentration of surface water is likely less and nitrogen loading may be overstated.

Table 1 shows that total nitrogen loading from irrigation is 207 pounds per acre per year (lb/ac/yr), which is below loading recommended for many crops[2]. It is likely that nitrogen fertilizer amendments will be recommended by the turf managers. To avoid nitrogen application exceeding agronomic rates, any additional fertilization should account for the dissolved nutrient loading shown in Table 1.

Total TDS loading is 4,479 lb/ac/yr. If only New Hogan water were used for irrigation, TDS loading would be 3,556 lb/ac/yr. The additional TDS loading from recycled water is 918 lb/ac/yr. TDS loading affects the agronomy of turf if salinity builds up in the root zone. To avoid plant stress, a leaching requirement of 10 percent was used in Table 1 as part of the agronomic requirement.

5.0 QUALIFICATIONS OF PREPARER

This Report was prepared under the supervision of John H. Kramer, a California Certified Hydrogeologist with experience in agronomic calculations for waste discharges to land. Dr. Kramer received training in soil hydrology at the University of California Santa Barbara where he obtained a PhD in soil moisture measurements in 1994. Since then he has worked on numerous agronomic discharge projects for Public Owned Treatment Works throughout California. These California Department of Corrections and Rehabilitation at Susanville, Blythe, Jamestown, and Ione. Dr. Kramer has calculated site-specific water budgets and agronomic loading rates for complete Reports of Waste Discharge and for compliance reporting at many locations in the Central Valley, including Lathrop, Moncrief, Livingston, Waterford, Angels Camp, and Chinese Camp.

6.0 LIMITATIONS AND SIGNATURE

Condor developed the interpretations and conclusions of this work in accordance with generally accepted principles and practice at the time the work was performed. Condor has endeavored to determine as much as practical about the site using conventional practices given our scope of services, which was to provide an irrigation plan reflecting the seasonal hydraulic requirements of the use area.

This Report is specifically limited to estimating agronomic hydraulic and nutrient loading rates at the Golf Course resulting from irrigation of turf by recycled water from the CCWD La Contenta WWTP. The hydraulic and nutrient loading rates calculated in this report are intended to demonstrate the feasibility of irrigation by recycled water. Actual hydraulic loading rates will differ from year to year, depending on climatic conditions that cannot be predicted. The Plan should be implemented in conjunction with a comprehensive operations and maintenance plan that allows for subjective decisions by the distributor to maintain the course in a playable condition. Local “hot spots” may require additional irrigations or treatments beyond those generalized in Table 1.

The results were based on historic irrigation rates and water quality information provided by CCWD. The data appeared to be within an expected range of variability based on our experience, but Condor performed no sampling, flow monitoring, or chemical analysis. Condor is not responsible for the accuracy and completeness of information collected and developed by others. If any changes are made or errors found in the information used for this Report, the interpretations and conclusions contained herein shall not be considered valid unless the changes or errors are reviewed by Condor and either appropriately modified or re-approved in writing.

[2] California Fertilizer Association. 1995. Western Fertilizer Handbook. Interstate Publishers, Danville, IL, 337pp.

This Report was prepared by Condor under the direct supervision of a Registered Geologist in the State of California. This Report was prepared for CCWD at the request of Bill Perley. It is for the sole use of CCWD. The contents of this Report may not be used or relied upon by any other person(s) without the express written consent and authorization of CCWD and Condor. Any unauthorized use or reliance on this Report by a third party is at such party's sole risk. Any questions regarding the content of this document should be addressed to Mr. Bill Perley at 209.754.3543.

Respectfully submitted,

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TABLES

Table 1. La Contenta Irrigation Management Plan - Agronomic Loading Rates

Month		Precip	Eff. Rainfall	ETo	ETt	IN	IN/IE	LR	Total Irrig	Area	Tot Irrig	Nutrient Loading	
		in/month	in/month	in/month	in/month	in/month	in/month	in/month	in/month	acres	af/month	lbs/ac/month	
	Days	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Nitrogen	TDS
Oct	31	1.2	0.6	3.1	2.7	2.0	2.7	0.3	3.0	70	17.4	12.3	266
Nov	30	2.6	1.5	1.4	1.2	0.0	0.0	0.0	0.0	70	0.0	0.0	0
Dec	31	3.5	2.3	0.8	0.7	0.0	0.0	0.0	0.0	70	0.0	0.0	0
Jan	31	4.0	2.8	0.8	0.7	0.0	0.0	0.0	0.0	70	0.0	0.0	0
Feb	28	3.6	2.3	1.7	1.5	0.0	0.0	0.0	0.0	70	0.0	0.0	0
Mar	31	3.4	0.9	3.2	2.8	1.9	2.5	0.3	2.8	70	16.1	11.3	246
Apr	30	1.9	0.0	4.2	3.6	3.6	4.8	0.5	5.3	70	30.9	21.8	472
May	31	0.9	0.0	6.2	5.3	5.3	7.1	0.7	7.8	70	45.6	32.1	697
Jun	30	0.3	0.0	6.7	5.8	5.8	7.7	0.8	8.5	70	49.3	34.7	753
Jul	31	0.0	0.0	7.2	6.2	6.2	8.3	0.8	9.1	70	53.0	37.3	809
Aug	31	0.1	0.0	6.3	5.4	5.4	7.2	0.7	7.9	70	46.4	32.6	708
Sep	30	0.3	0.0	4.7	4.0	4.0	5.4	0.5	5.9	70	34.6	24.4	528
Totals/yr	**365**	**21.5**	**10.4**	**46.3**	**39.8**	**34.3**	**45.7**	**4.6**	**50.3**	**70**	**283**	**207**	**4,479**

Irrigation Water Quality (mg/L)			
	New Hogan (11)	WWTP (12)	Blend (13)
TN	5	21	18
TDS	313	412	394

Historic and Projected Use (af)				
	New Hogan	WWTP	Total	Data source
Pre 2011	129	148	276	CCWD water use data table
Projected	63	233	305	Water Balance HDR, 2011
Projected	50	233	283	Agronomic Rates

Notes

(1) Camp Pardee California Data 1926-2012 Monthly Averages

(2) Effective rainfall is precipitation available to plants (subtracts, runoff, evaporation and deep percolation water) monthly effective rainfall factors from NMP at Waterford, California

(3) ETo= reference evapotranspiration, modified from CIMIS Sation 166(Lodi) after Blankinship & Associates, Inc., 2007

(4) ETt= Turf Water Requirement, ETt = ETo x Kc; where Kc 0.86 (Kc value for California from *U of A Extension, Turf Irrig. Mgt. Series No.2, Table 1)*

(5) IN = Irrigation need for plant transpiration = ETt-Eff. Rainfall

(6) IN/IE = IN adjusted for irrigation efficiency, IE, where IE = 75% ; IN not adjusted when no irrigation used

(7) LR = leaching requirement = 10% of adjusted IN

(8) Total irrig = Total irrigation demand, IN/IE+LR

(9) Total landscped acreage includes greens, surrounds, tees, fairways, roughs, and irrigated landscape

(10) Total irrigation volume at agronomic application rate

(11) Avg. TDS from Blankinship, 2007, Table 6, TN assumed at 5

(12) Avg of 2010-2011 monthly effluent data (CCWD) TDS of future water could be less due to UV disinfection

(13) Blend based on projected volume of applied WWTP recycled water / Total irrigation water = 82%

af= acre feet

mg/L= milligrams per liter

lbs/mgxL/af= 2.71 Conversion factor

TN= total nitrogen

TDS= total dissolved solids

Table 2. La Contenta WWTP Effluent Nutrients and TDS

2010	Sodium	Chloride	Nitrate as Nitrogen	TKN	TN	TDS
Jan	54	52	22	<1	22	411
Feb	48	46	17	<1	17	383
Mar	44	42	13	<1	13	372
Apr	47	44	16	<1	16	397
May	52	44	20	<1	20	392
Jun	51	44	18	<1	18	416
Jul	55	52	20	<1	20	424
Aug	56	50	24	<1	24	393
Sep	39	58	22	1.4	23.4	391
Oct	57	87	30	1	31	390
Nov	67	90	26	1.4	27.4	509
Dec	58	52	20	<1	20	456
Average	52	55	21	<1	21	411
Std Dev	7	16	5		5	38
CV	14%	30%	22%		24%	9%
2011						
Jan	46	40	10	<1	10	337
Feb	49	41	16	<1	16	366
Mar	47	44	17	1.1	18.1	380
Apr	48	40	19	<1	19	387
May	54	42	19	<1	19	380
Jun	54	46	23	<1	23	457
Jul	62	55	30	<1	30	461
Aug	58	48	24	<1	24	455
Sep	64	50	22	<1	22	399
Oct	63	56	19	2	21	442
Nov	63	46	28	<1	28	411
Dec	82	60	22	<1	22	469
Average	58	47	21	<1	21	412
Std Dev	10	7	5	1	5	44
CV	18%	14%	26%		25%	11%
Overall Avg	55	51	21	<1	21	412

Data from Bill Perley CCWD March 2012

ATTACHMENT 1

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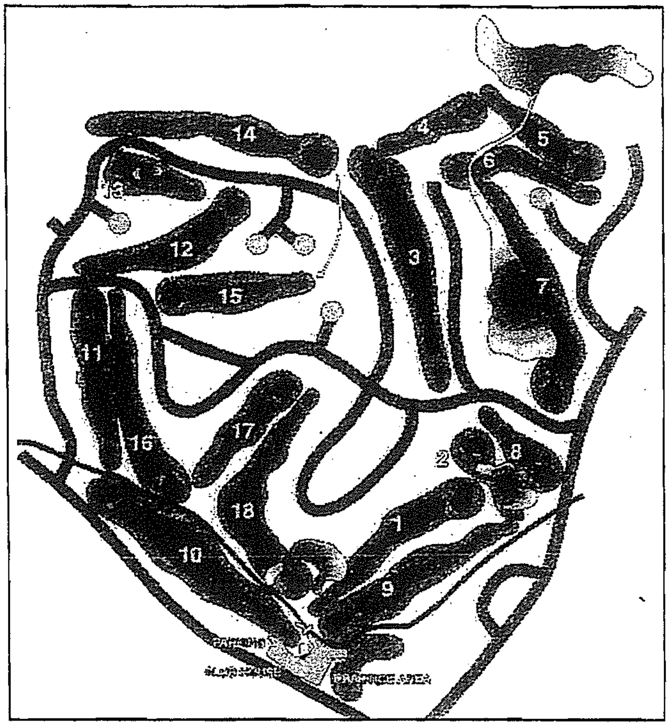

FINAL
Calaveras County Water District
La Contenta Golf Course

Irrigation Water Use Study

August 6, 2007

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FINAL
Calaveras County Water District
La Contenta Golf Course

Irrigation Water Use Study

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1.0 Background

The Calaveras County Water District ("District") includes all of Calaveras County in the Central Sierra Nevada foothills in the northeastern portion of the State. The District boundaries encompass approximately 640,000 acres of land ranging from the San Joaquin Valley to the Sierra Nevada Mountains. The District currently provides water service to approximately 10,000 municipal and residential / commercial customers in four improvement districts located throughout the County, including La Contenta Golf Course. Refer to **Figure 1**.

La Contenta Golf Course ("course") is an 18-hole public golf course with approximately 70 acres of irrigated turf located in Valley Springs, CA. The course opened for play in 1974 and is currently operated and managed by Empire Golf. Grasses on greens and fairways are bentgrass and annual bluegrass, whereas tees consist mostly of ryegrass. Small creeks and ponds are located throughout the course. The course is irrigated by a combination of reclaimed water that is delivered to the course by the District and water drawn from an irrigation pond that is filled with water from New Hogan Reservoir. Refer to **Figure 2**.

The District and the Course are jointly named by the Central Valley Regional Water Quality Control Board (RWQCB) on Waste Discharge Requirement #R5-2002-0222.

The source of reclaimed water is the La Contenta Sewer Treatment Plant ("Plant") which uses a Bio-lac activated sludge pond and a tiled drying facility. Influent liquid is filtered and then chlorinated. Effluent is stored in District storage ponds for use by the course. Current effluent delivery capacity is approximately 900 gallons per minute (gpm) and an auxiliary pump to increase capacity up to 1500 gpm is being installed. During the March to October irrigation season, a typical irrigation cycle lasts approximately 4 hours depending evapotranspiration (Eto) requirements and takes place in the early morning. The first 30 minutes of the irrigation cycle uses irrigation pond water to irrigate greens and the remaining time uses reclaimed water to irrigate the rest of the course.

Because of potential new development in the area, the course may need to develop additional capacity to take reclaimed water (Tanner 2006). Although only conceptual at this time, additional capacity may take the form of additional surface storage such as ponds and/or wetlands placed on the course. Once designed and permitted, these ponds and/or wetlands may discharge to Cosgrove Creek. Ponds and/or wetlands have the advantage of not only providing storage, but also provide for intentional water loss through evaporation and emergent aquatic plant evapotranspiration.

2.0 Objective

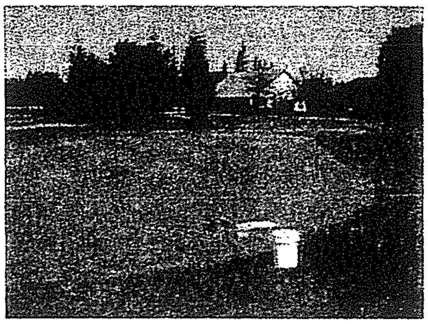
The objective of this report is to assess the irrigation needs of the golf course relative to water sources available and to evaluate potential scenarios to increase Plant water use. Analysis of both water quality and quantity was done resulting in irrigation recommendations necessary to sustain favorable golf course turf. This report provides an initial analysis.

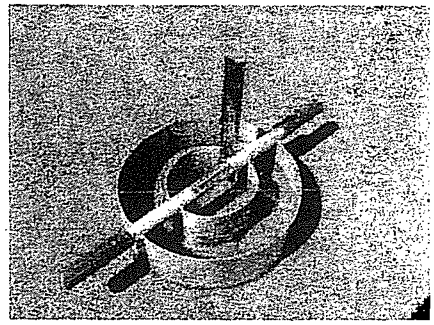
3.0 Approach

On April 5, 2007, data was gathered from District and Course staff and a site reconnaissance of the course and the Plant was performed. Existing data was gathered on course layout and construction, local climate and Eto rate, grass type(s), turf quality, soils, drainage, historic irrigation water and historic water quality data. Water quality data gathered included: pH, electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), major cations and anions and metals.

On April 10, 2007, additional data was gathered and water samples were collected from the Plant effluent line spigot located on the course upstream of the irrigation system wet well located behind the golf course maintenance facility. Additionally, water was collected from Course's irrigation pond near the 7th hole. The water source for this irrigation pond and the other irrigation pond on the Course is New Hogan Reservoir.

Last, preliminary percolation testing was done with a ring infiltrometer at several greens and fairways on the course. An example percolation measurement and the ring infiltrometer are shown below.





4.0 Data Used

Water quantity data are tabulated and summarized in **Tables 1, 2** and **12**. Various sources for this data exist and are noted on each table.

Water quality data from plant effluent and the Course irrigation pond, and soils data from various locations on the course were obtained from the District (Fred Burnett) and the Course (Cliff Rourke). These data are summarized in **Tables 3-7.**

Water quality data generated by the District's contract laboratory (Sierra Foothill Labs) did not in all cases agree with data generated by the Course's contract laboratory (A&L Labs). As a result, three-way split samples were collected on April 10, 2007 from the effluent line and the 7th hole irrigation pond. Samples were sent to both Sierra Foothill and A&L in an effort to evaluate differences. The third sample was analyzed by Blankinship & Associates staff using in-house instrumentation. Data from these analyses is presented in **Table 6.**

5.0 Findings

5.1 Water Quantity

A summary of historic water quantity data is presented in **Table 1, 2** and **12**. Several sources of data were used as noted. The percent of irrigation season (May-October) total course irrigation water that is Plant effluent ranges from 36% to 52% with an average of 42%.

The course's current use of irrigation water is weather dependent, seasonal, and specific to certain locations on the course. For example:

- Greens (3 Ac), green surrounds (2 Ac) and other sensitive areas (2 Ac) of the course get 100% New Hogan water
- Tees (4 Ac) get a range of 40:60 to 60:40 blend of New Hogan:Plant water from March to May and get a 50:50 blend from June to October
- Fairways (27 Ac) and roughs (28 Ac) get a 60:40 blend of New Hogan:Plant water from March to April; 40:60 in May and October; and 30:70 June to September

The nearest complete meteorological data set is California Irrigation Management Information System (CIMIS) station #166 located approximately 20 miles to the west in Lodi. This station reports an estimated annual rainfall of 14 inches and an annual Eto of 46 inches. Refer to **Table 2**. As shown in **Table 2**, using an annual blue grass (poa annua) crop coefficient (Kc) value as representative of the course and a 75 % irrigation efficiency, the values for total water use are within approximately 8% of the values shown in **Table 1**.

Table 11 presents a comparison of the use of reclaimed water for irrigation at several area golf courses. It should be noted that this data is presented for general comparative purposes only and does not imply that all courses can or should use the same amount of reclaimed water. For example, no data on soils, grass type, topography or other related characteristics were obtained from each course in order to normalize irrigation water use data and accordingly, comparisons between courses should be done with caution.

Table 12 presents a summary of estimated existing water use on the course and provides a potential transition scenario to the use of Plant water than is currently used. This transition scenario occurs over 3 years and allows for the blending of New Hogan water with Plant water and also provides for 2 "flush" events per irrigation season where New Hogan water is used to push accumulated salts potentially present from the use of Plant water out of the rootzone and through the soil profile.

During and after the 3rd and final year of the transition, there is a net increase of approximately 9% (30 AF) in the total amount of water used on the course which may require certain areas of the course that are typically out of play to be irrigated more frequently.

5.2 Water Quality

In order to attempt to get a broad representation of irrigation water quality used on the course, several sources were used and are summarized in **Tables 3-6**. As discussed previously, sampling by Blankinship & Associates on April 10, 2007 is presented in **Table 6**. In order to evaluate these different data groups relative to irrigation water quality standards, a comparison of data from **Tables 3-5** to Irrigation Standards in presented in **Table 7** (Harivandi 1999).

As indicated by **Tables 3-6**, there appears to be general agreement in the approximate range of concentrations for important analytes such as total dissolved solids (TDS), sodium, chloride, calcium, magnesium and Sodium Adsorption Ratio (SAR).

Under the current irrigation scenario, approximately 2,200 lbs/ac of solids is being deposited on the course per year by use of Plant effluent. Refer to **Table 3**. The impact of salt present in these solids is in part mitigated by a blending of Plant effluent and New Hogan water which aids in leaching salts from the soil. Further soil salinity accumulation is mitigated by flushing achieved by winter rains.

As expected and reported in **Table 6**, the quality of New Hogan water is significantly better from an irrigation water quality perspective as a result of lower total dissolved solids (TDS), chloride, and sodium as compared to Plant effluent. However, there appears to be significant (> ~20%) differences in reported values of TDS and chloride depending on the analytical laboratory used. Based upon a preliminary comparison of laboratory data to TDS data generated from Blankinship & Associates instrumentation, TDS data from Sierra Foothills Labs is more accurate. The comparative accuracy for other inter-laboratory analysis is not known.

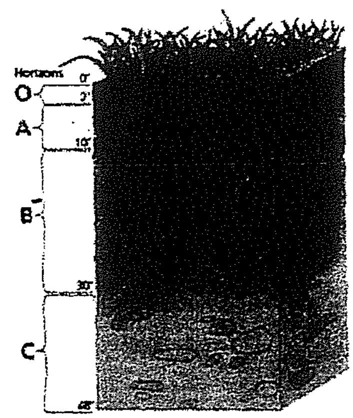
As shown in **Table 7**, the concentrations of electrical conductivity (EC), TDS, sodium and chloride in Plant effluent are characterized as creating slight to moderate impact to turf. Plant effluent Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) is characterized as creating a slight to moderate impact to turf when compared to irrigation water quality standards.

5.3 Soil Quality

According to the District staff, the annual amounts of reclaimed and New Hogan water use are shown in **Tables 1 and 2**. In addition to use data, **Table 1** also presents rainfall at the East Bay Municipal Utility District (EBMUD) Camp Pardee Weather Station NCDC #1428 located approximately 4 miles from the course. As **Table 1** shows, the amount of rain as a % of the total irrigation water and reclaimed water use is 8.7% and 28 % respectively. The amount of rainfall as a % of reclaimed water is above the recommendation of Evapotranspiration (Eto) plus 15% (Harivandi 1997; Crites 2000) and appear to adequately flush the soil of salts and dissolved solids at the end of every irrigation season. Although delayed to the end of the irrigation season, this scenario appears to work well under irrigation approach and the current ratio of reclaimed water to New Hogan water.

Tables 8 through 10 show data from the analysis of soils from various greens and fairways on the Course from 2001 to 2003. As shown in **Table 8**, significant differences exist in key soil parameters (chloride, sodium and other soluble salts) useful in assessing impact from irrigation with Plant water on greens.

In particular, significant change (expressed as a % change from summer season to winter season) occurs in virtually all tabulated parameters. The significance of this change is that it shows summer build up and subsequent winter flushing of soluble salts from the soil profile sampled. As mentioned above, this suggests that on average, winter (December through February) rains are effective at flushing salts from the soil profile and/or root zone (horizons O, A, and B in the figure to the right) resulting in an improvement in overall soil conditions and as a result improvement in turf health.



Adopted from Univ of MI, Soil Quality Institute (Units in cm)

As expected, there is an inverse relationship between salt-related analytes in fairway soil as shown in **Table 8** and rainfall as a percent of total water applied as shown in the **Table 1**. In other words, the less rainfall, the less leaching of salts occurs. This phenomenon is not observed in greens, likely due to the regular use of New Hogan water as an irrigation source.

More specific detail on greens #7, #9, and #15 are shown in **Table 9** and associated figures. Although irrigated with New Hogan water, these tables and associated figures illustrate the summer salt buildup and winter flushing that takes place on the Course.

The Course's greens are planted with bentgrass and have transitioned in varying degrees to annual bluegrass (poa annua). Bentgrass and annual bluegrass are listed as very sensitive to moderately sensitive to soil salinity (Harivandi 1999; Carrow 1998). Although regularly flushed by winter rain and irrigated with New Hogan water, the importance of salt management on greens soils is critical given the type of grass currently present on the Course.

Table 10 and associated figures show the same phenomenon of salt build up and subsequent flushing in fairways. The magnitude of residual salt concentration buildup detected in fairway soils is significantly greater than that found in greens. This suggests that these soils are not as able to drain as greens soils and is consistent with the use of Plant effluent on fairways and not on greens. The long term impact of this transient salt accumulation is not known.

Using a ring infiltrometer, water percolation on the course ranged from approximately 1-2 inches/hour.

6.0 Conclusions

The Course's current selective use of Plant effluent water for irrigation purposes appear to be based on generally well understood concepts of effluent water use on turf (Carrow 1998; Crites 2000; Harivandi 1997; USGA 1994; Wu 1996). If, however, soils and irrigation practices are not properly managed, the use of irrigation water that contains a combination of salt and/or TDS may adversely influence plant health and vigor and negatively impact soil percolation and drainage. Allowing conditions such as these to develop run contrary to the use of an integrated golf course management approach that endeavors to establish and maintain healthy and vigorous turf that requires minimal irrigation, fertilizer and pesticide input while maintaining an acceptable playing surface.

Areas of the course that receive the most foot traffic, are damaged the most by golf activity, and where grass is under the most stress as a result of low heights of cut are the greens, green surrounds, and tees. As a result, these areas are the most susceptible to potential impacts from irrigation with effluent water. Additionally, because these areas are populated with high percentages of annual blue grass (poa annua), they are sensitive to soil salinity and additional care must be taken when using reclaimed water for irrigation. Consistent with the course's current approach, irrigation of the greens and green surrounds are most appropriately done with New Hogan water. However, tees are irrigated with a combination of Plant effluent and New Hogan water. Similar to greens, tees encounter similarly high traffic and wear and are mowed to low heights of cut.

The historic volumes and rates of Plant effluent use do not appear to have resulted in an obvious detrimental impact to soil or turf conditions on the course as observed during site reconnaissance in April. This may be due in part to the existing rate of soil infiltration. The use of New Hogan water on greens and winter flushing of the course appear to maintain salt levels in the turf grass rootzone at generally acceptable concentrations. Data indicate that salt concentration in fairway soils is greater than that in greens soils in mid to late summer. However, based on a preliminary review of course conditions in April, fairway grass does not appear to have been adversely impacted by the transient presence of salts at the concentrations and durations encountered.

7.0 Recommendations

Based on the data presented above, we make the following recommendations:

1.) Given the SAR, sodium and chloride concentrations in Plant effluent, irrigation with the current ratio of Plant effluent to New Hogan water, if changed, should only be done so gradually to evaluate the impact, if any to agronomic conditions.

2.) Treatment plant effluent averages approximately 42% of the total irrigation water use and equates to approximately 1.5 AF of reclaimed water per acre per year. Given the apparent ability of soils on the course to percolate and leach salt, the percent of irrigation water that is reclaimed water can be increased. This can be accomplished several ways, including the potential transition scenario presented in **Table 12**. During any transition, the following should be done:

   a. Handheld monitors should be used and/or buried wireless remote sensors should be installed at representative locations on the course. These will provide real-time and historical data on soil moisture and EC to the superintendent and allow for corrective action as necessary.

   b. If soil salt accumulation is indicated, or turf health/vigor or percolation rate declines, higher % of New Hogan water should be used in amounts needed to flush salts to springtime or similar conditions. For example, flushing of soil with New Hogan water may be needed several times per summer depending on weather, soil conditions, etc.

3.) Tees should be irrigated in a manner similar to greens and green surrounds to prevent salt accumulation in these high traffic areas.

4.) No area of the course should be irrigated beyond its estimated Eto.

5.) Select one analytical laboratory to be used by both the District and the Course so that comparable data is generated.

6.) Continue to regularly monitor Plant effluent, New Hogan water and soil to assess the magnitude and extent of salt presence and impacts to percolation and drainage. Suggested analyses include: soil and irrigation water EC, sodium, and chloride; irrigation water Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC); soil exchangeable sodium percentage (ESP), cation exchange capacity (CEC), and hydraulic conductivity; and plant chloride.

7.) Depending on the results of soil testing, soil amendments such as gypsum (calcium sulfate) may be necessary to displace sodium in the soil profile.

8.) Continue providing the Course with copies of the RWQCB quarterly WDR reports.

9.) Consider limiting or prohibiting cart traffic on fairways to prevent compaction that may exacerbate soil percolation problems created by the use of reclaimed water.

10.) Consider requesting that District customers who have water softeners switch from sodium chloride to calcium chloride.

11.) Landscape plants are generally more sensitive to reclaimed water and irrigation of these areas should be done accordingly.

12.) As a result of the deposition of reclaimed water solids to the course's soil, aerification and topdressing should be done as needed in order to prevent a reduction in percolation.

8.0 Limitations

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No warranty, express or implied, is made. This report is solely for the use of the District and Course. Any reliance on this report by any other third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in agronomic or irrigation practices, environmental standards practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

9.0 References

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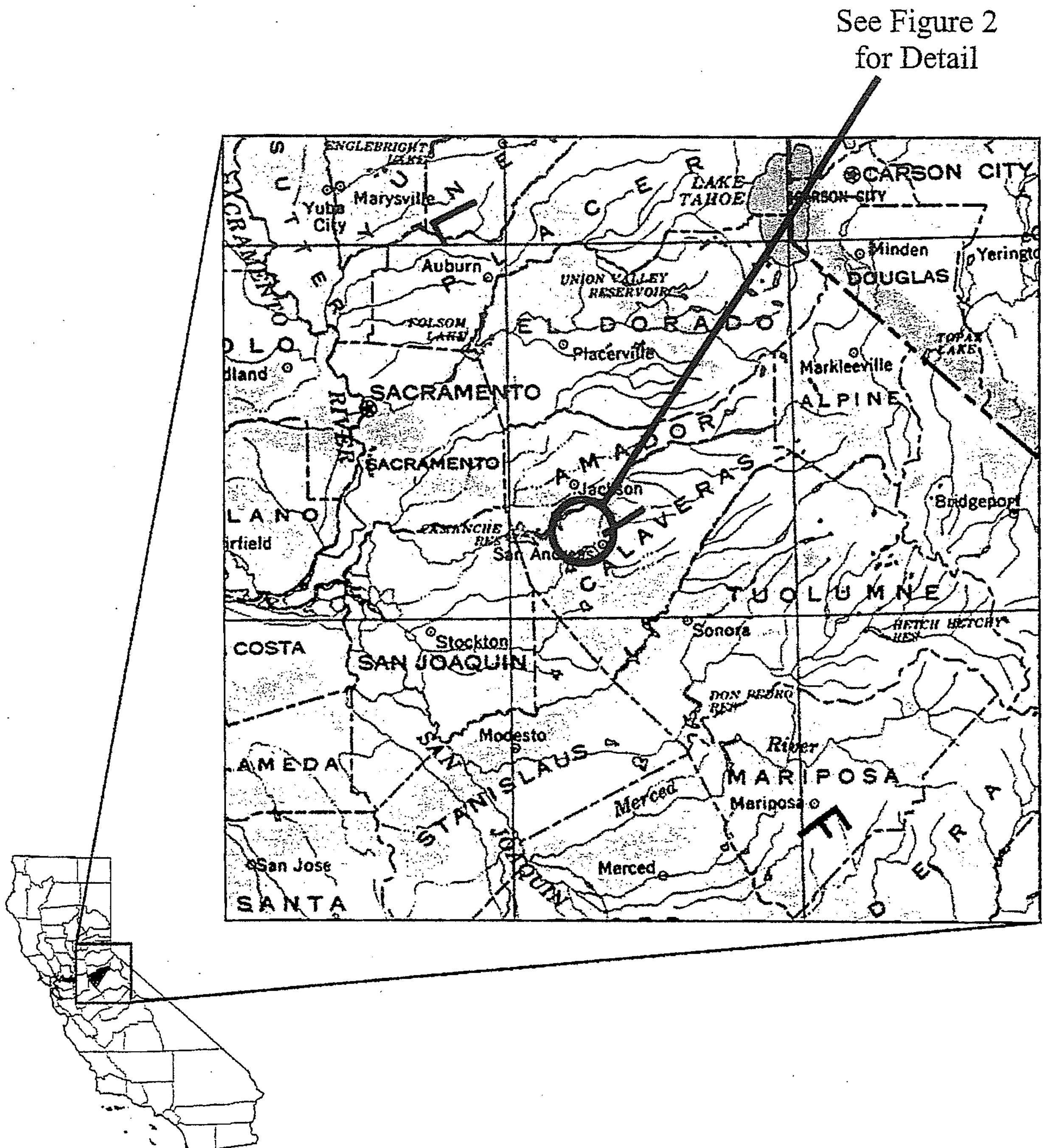

Legend

Calaveras County

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La Contenta
Project Location
Valley Springs, California

Project	Figure
Calaveras Co. Water District	1
Date 15 March 2007	

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La Contenta Golf Course and Calaveras
County Sewer Treatment Plant

Valley Springs, California

Project	Figure
Calaveras Co. Water District	2
Date 21 March 2007	

Table 1: La Contenta Golf Course Water Quantity Usage Analysis

	CCWD Data Average (A.F.)			"Projected" On-Course Data (A.F.) (3)			L.C.G.C. Measured Data (A.F.)			Average		
Month	New Hogan (1)	WWTP (2)	Total	New Hogan	WWTP	Total	New Hogan (4)	WWTP (5)	Total (NH+WWTP)	New Hogan	WWTP	Total
January	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
March	1.4	1.1	2.5	4.8	2.4	7.2	0.7	1.1	1.8	2.3	1.5	3.8
April	7.9	6.2	14.1	13.9	7.1	21.0	4.7	6.2	10.8	8.8	6.5	15.3
May	17.5	11.5	29.0	14.5	14.8	29.3	18.9	11.5	30.4	17.0	12.6	29.6
June	29.1	19.5	48.6	15.9	21.9	37.8	30.5	19.5	50.0	25.2	20.3	45.5
July	40.2	19.2	59.4	17.8	24.5	42.3	43.1	19.2	62.3	33.7	20.9	54.7
August	35.9	16.5	52.3	16.5	22.6	39.1	39.1	16.5	55.5	30.5	18.5	49.0
September	18.9	14.3	33.2	12.6	17.3	29.9	21.8	14.3	36.1	17.8	15.3	33.1
October	6.6	7.7	14.3	9.8	9.8	19.5	8.9	7.7	16.6	8.4	8.4	16.8
November	0.0	0.3	0.3	4.8	0.0	4.8	0.0	0.3	0.3	1.6	0.2	1.8
December	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	158	96	254	111	120	231	168	96	264	145	104	250
	% of Total:	38%		% of Total:	52%		% of Total:	36%		% of Total:	42%	

Notes:
(1): Average 2004-2006 La Contenta GC Usage from Fred Burnett (5/16/07)
(2): Average 2001-2006 L.C.G.C. Usage from Fred Burnett (5/16/07)
(3): L.C.G.C. Projected 30 Year Water Use from Cliff Rourke
(4): Average 2001-2006 L.C.G.C. Water Usage From Hogan from Cliff Rourke
(5): 2001-2006 L.C.G.C. Metered Effluent Thru the Pump Station from Cliff Rourke

Year	Hogan AF (1)	Effluent AF (1)	Total AF (1)
2001	178	38	216
2002	193	51	244
2003	161	114	275
2004	208	118	326
2005	154	108	262
2006	109	144	253
Average	167	96	263

Rainfall Total (in) (2)	Rain as a % of Total	Rain as a % of Reclaimed
20.5	9%	54%
17.4	7%	34%
17.8	6%	16%
19.8	6%	17%
29.4	11%	27%
29.2	12%	20%
22%	8.7%	28.0%

Notes:
(1) Source: Fred Burnett CCWD
(2) Source: E. Bay Municipal Utility District Camp Pardee Weather Station NCDC #1428.

Table 2. LaContenta Golf Course Summary of 5 Year Average Weather Data and Resulting Water Requirements

	5Yr Ave Monthly Eto (in/mo) (1)	90% Eto x Kc (2)	Eto adj for IE (3)	5Yr Ave Precip	Diff (in) (4)	Area (Ac)	Vol (AF)	
Dec	0.8	0.6	0.8	3.5	-2.6	70	15.3	
Jan	0.8	0.7	0.9	2.2	-1.3	70	7.8	
Feb	1.7	1.3	1.8	1.8	0.0	70	0.2	
							23.3	**Excess**
Mar	3.2	2.5	3.4	2.2	1.2	70	7.0	
Apr	4.2	3.4	4.5	1.6	2.9	70	16.7	
May	6.2	5.0	6.6	0.5	6.2	70	36.0	
Jun	6.7	5.4	7.2	0.1	7.1	70	41.3	
Jul	7.2	5.8	7.7	0.0	7.7	70	44.8	
Au	6.3	5.0	6.7	0.1	6.6	70	38.7	
Sep	4.7	3.8	5.1	0.1	5.0	70	29.2	
Oct	3.1	2.4	3.3	0.6	2.6	70	15.3	
Nov	1.4	1.1	1.5	1.4	0.1	70	0.6	
Totals	46.3	37.0	49.4	14.0	35.4	840.0	**229.7**	**Required**

Winter Rain "flush" as a % of total: 10.1%

Notes:

(1) Eto Source: Ca Dept of Water Resources Reference Eto Map (Zone 11) and CIMIS Station 166 (Lodi).
(2) Crop Coefficient (Kc) Source: Poa Annua. http://ucrturf.ucr.edu , R. Green, 2005. Trends in GC Water Use & Regulation in CA
Irrigation Season is from Mar to Nov. Crop Coefficient (Kc): 0.8
(3) Irrigation Efficiency (IE) %: 75%
(4) Negative value means rainfall exceeds crop requirement

Table 3. La Contenta Golf Course Effluent Water Quality

Analytical Lab	Year	adj SAR	bicarbonate	carbonate	RSC	Ca	Mg	B	Na	Cl	SO4	NO3	PO4	TDS
Harris	Jun-04	6.37	140.3						101.0	108.0	56.0	8.4	6.0	
Harris	Sep-04	7.03	159.2	31	1.2	25	12	0.6	99.0	132.0	59.0	4.7	3.0	
A&L	Aug-05	3.56	331	0	1	51	50	0.63	102.0	87.5	39.0	**1.0**	0.0	636.0
A&L	Jul-06	2.69	150	0	-1	40	16	0.5	77.9	75.8	35.0	**1.0**	2.8	404.0
A&L	Sep-06	3.56	225	31	1.4	40	17	0.6	95.9	125.1	50.0	**1.0**	1.3	601.0
Ave A&L:(1)		3.3	235.3	10.3	0.5	43.7	27.7	0.6	91.9	96.1	41.3	1.0	1.4	547.0
Ave Harris:(2)		6.7	149.8	31.0	1.2	25.0	12.0	0.6	100.0	120.0	57.5	6.5	4.5	
Ave All:		4.6	201.1	15.5	0.7	39.0	23.8	0.6	95.2	105.7	43.7	2.7	3.2	547.0

Notes:

All Values mg/L unless otherwise noted
Bold - Analyte not detected, value is one half the analyte-specific detection limit.
Source: LCGC Lab Data Sheets supplied by C. Rourke. Lab source as indicated above.
RSC= Residual Sodium Carbonate
SAR = Sodium Adsorption Ratio
(1): A&L data from 2005 and 2006
(2): Harris data from 2004

Estimated Average Annual Course Solids Loading:

Effluent Vol (AF)	Acres	Lbs/Ac
104	70	2215

Table 4. CCWD 2005 and 2006 Treatment Plant Effluent Water Quality Data

Sample Date		Feb 05
Alkalinity		
	Total	93
	Bicarbonate	93
	Carbonate	<5
	Hydroxide	<5
Calcium		32
Chloride		94
Hardness		146
Magnesium		16
pH		
Sodium		80
Sulfate		59
SAR		2.9
RSC		-1.22

Sample Date		Dec 06
Alkalinity		
	Total	125
	Bicarbonate	125
	Carbonate	<5.0
	Hydroxide	<5.0
Calcium		26
Chloride		81
Hardness		106
Magnesium		10
pH		
Sodium		78
Sulfate		36
SAR		3.3
RSC		0.10

Notes:
All values in mg/L unless otherwise noted
Source: CCWD F. Burnett. Data from Sierra Foothills Lab
SAR = Sodium Adsorption Ratio
RSC = Residual Sodium Carbonate

Table 5. CCWD 2006 Treatment Plant Effluent Water Quality Data

Date	TDS	EC (est)	Turbidity	CL2	Sodium	Chloride	NO3 as N	TKN
4/28/2006	460.0	0.7	1.9	25.0	84.0	84.0	11.0	1.0
5/12/2006	499.0	0.8	1.5	34.0	97.3	99.0	0.3	7.8
6/19/2006	435.0	0.7	1.5	5.0	98.2	114.0	0.3	17.0
7/19/2006	386.0	0.6	0.5	11.0	78.0	86.0	0.1	15.0
8/8/2006	362.0	0.6	1.5	18.0	75.9	75.0	0.4	8.8
9/8/2006	391.0	0.6	0.5	17.0	85.0	98.0	0.1	
10/6/2006	373.0	0.6	0.8	12.0	88.0	95.0	0.2	2.3
Ave (Apr-Oct)	415.1	0.6	1.2	17.4	86.6	93.0	1.8	8.7

Notes:
All units mg/L; EC mmhos/cm; turbidity NTUs
nd-No data available
Source: CCWD Plant Sampling data supplied by F. Burnett. Data from Sierra Foothills Laboratory

Table 6. Summary of Comparative Laboratory Analysis

CCWD Treatment Plant Effluent Water (4)

Analyte	BA Field (1)	A&L Labs	Sierra Foothill	% Difference
TDS	**326.4**	547	438	19.9%
Calcium		43.08	35	18.8%
Potassium		11.2	12	-7.1%
Sodium		88.97	88	1.1%
Chloride		75.83	96	-26.6%
Magnesium (2)		16.04	15	6.5%
E.C. (mmho/cm) (1)	510	710	**684.4**	3.6%
SAR (adj.)		3.4	3.1 (3)	
RSC		1.0		

New Hogan Water (5)

Analyte	BA Field (1)	A&L Labs	Sierra Foothill	% Difference
TDS	**182.3**	359	267	25.6%
Calcium		45.09	38	15.7%
Potassium		2.2	2.3	-4.5%
Sodium		26.90	25	7.1%
Chloride		25.16	30	-19.2%
Magnesium (2)		19.93	17	14.7%
E.C. (mmho/cm) (1)	284.8	410	**417.2**	-1.8%
SAR		0.93	0.85 (3)	

Notes:
All values are in mg/L except for EC in us/cm
TDS: Total Dissolved Solids
EC: Electrical Conductivity
Bold Values Estimated using 0.640 us/cm = 1 mg/L TDS
Water collected at LCGC wet well.
(1) E.C. analysis under B&A done with a YSI 85 in field
(2) Sierra Foothill Labs reports Mg via hardness
(3) Calculated standard, not adjusted
(4) Samples collected 4/10/07 from the Plant effluent line spigot located on the course upstream of the irrigation system wet well behind the golf course maintenance facility.
(5) Samples collected 4/10/07 from Course's irrigation pond near the 7th hole. Pond is filled with New Hogan water.

Table 7. La Contenta Golf Course Comparison of Effluent Water Quality with Standards

Parameter	No Impact[1]	Slight to Moderate Impact[1]	Severe[1]	Data Sources (1)	(2)	(3)	(4)	(5)	(6)
Salinity									
EC (mmhos/cm)	< 700	700 to 3000	>3000	600			**710**	685	600
TDS	450	450-2000	>2000	409	**547**		**547**	438	415
Infiltration									
Calcium						26	43	35	
Magnesium						10	16	15	
SAR = 0-3, & EC =	>700	700-200	<200						
SAR = 3-6, & EC =	>1200	1200-300	<300		**4.6**	**2.9 to 3.3**	**3.4**	**3.1**	
SAR = 6-12 & EC =	>1900	1900-500	<500						
SAR = 12-20 & EC =	>2900	2900-1300	<1300						
Bicarbonate	< 90	90 to 500			114				
pH (Std Units)	Normal Range (6.5- 8.4)								
Hardness						106			
Sodium (foliar absorption)	< 70	> 70	-	**86.7**	**92**	**78**	**89**	**88**	**86.6**
Chloride Root Absorption	< 70	70 to 355		**92.8**	**96**	**81**	**76**	**96**	**93**
Chloride Foliar Absorption	< 100	> 100		**92.8**	**96**	**81**	**76**	**96**	**93**
RSC (meq/L)	< 1.25	1.25 - 2.5	> 2.5		**-1 to 1.4**	-1.2 to .1	1		
Boron	< 1	1 to 2	> 2		0.6				
Nutrients									
Nitrate as N				2.4					1.8
TKN				7.6					8.7
Sulfate					41				
Phosphate					1.4				

Notes:
All values in mg/L unless otherwise stated.
Values in **Bold** are above values that may cause slight to moderate impact to turf.
1-UC Cooperative Extension, California Turgrass Culture, Volume 49,#1-4, 1999. Interpreting Turfgrass Irrigation Water Results.
SAR = Sodium Adsorption Ratio
RSC = Residual Sodium Carbonate
Data Sources:
(1): Sierra Foothill Labs (SFL) CCWD Plant Jan-Dec 06
(2): A&L and/or M.D. Harris Labs LCGC Effluent Water Quality (Table 3)
(3): SFL CCWD 2005 and 2006 Treatment Plant Effluent Water Quality Data (Table 4)
(4) A&L Labs April 2007 (Table 6). Adjusted SAR value reported
(5) Sierra Foothills Lab April 2007 (Table 6). Standard SAR value reported
(6) SFL CCWD 2006 Treatment Plant Effluent Water Quality Data (Table 5)

Table 8. La Contenta Golf Course Soil Analysis: Greens and Fairways Summary

Averages - Greens (7,9,10,11,15)

Date	Apr-01	Sep-01	Mar-02	Jul-02	Jun-03	Jul-03	Difference Winter-Summer (1)	% Change (2)
Ca/10	94.4	122.68	105.68	115.66	127.76	113.8	19.9	19.9%
Sol Salts	0.3	0.438	0.186	0.292	0.274	0.24	0.1	28.0%
Na	24.4	71.8	18.8	73.8	34.6	62	39.0	180.3%
PBS Na	1.78	3.84	1.26	4.44	1.94	3.7	2.0	128.9%
CEC	6.02	8.1	6.58	7.26	7.88	7.3	1.3	21.2%
EC		1.31	0.494	0.82	0.696	0.86	0.4	86.5%
HCO3 (meq/L)		4.32	2.84	3.2	2.62	2.4	0.3	10.4%
Cl (meq/L)		1.86	0.9	2.22	1.28	2.9	1.2	129.4%

Averages - Fairways (8,9,11,16)

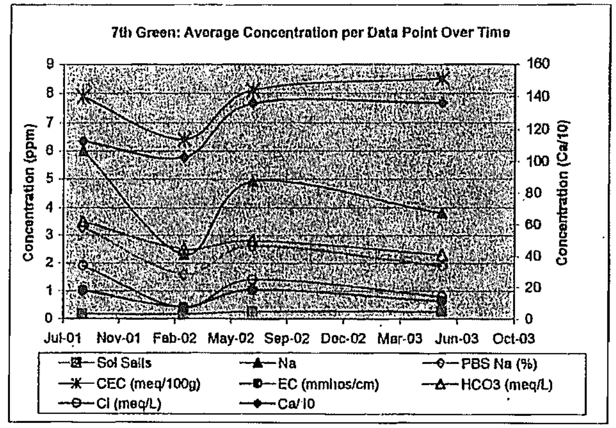
Date	Aug-01	Mar-02	Jul-02	Difference Winter-Summer (1)	% Change (2)
Ca/10	254.2	223.6	292.4	49.7	22.2%
Sol Salts	1.0	0.5	1.4	0.7	155.1%
Na	217.5	115.8	242.3	114.1	98.5%
PBS Na (%)	5.1	3.1	4.7	1.8	56.6%
CEC (meq/100g)	19.3	16.5	21.9	4.1	24.9%
EC (mmhos/cm)	2.6	1.1	3.0	1.7	145.7%
HCO3 (meq/L)	3.9	3.1	3.4	0.5	17.0%
Cl (meq/L)	6.4	3.2	5.0	2.5	78.1%

Notes:
All values in mg/Kg unless otherwise noted
Ca/10: Value of Ca divided by 10
CEC=Cation Exchange Ratio
PBS= % Base Saturation
EC= Electrical Conductivity (mmhos/cm)
(1) Difference Winter Summer: Calculated by subtracting ave. summer (May-Sept) values from ave. winter (Oct-Apr) values
(2) % Difference is value in (1) divided by ave. winter value

Table 9 and Associated Figures.   La Contenta Golf Course Soil Analysis: Greens

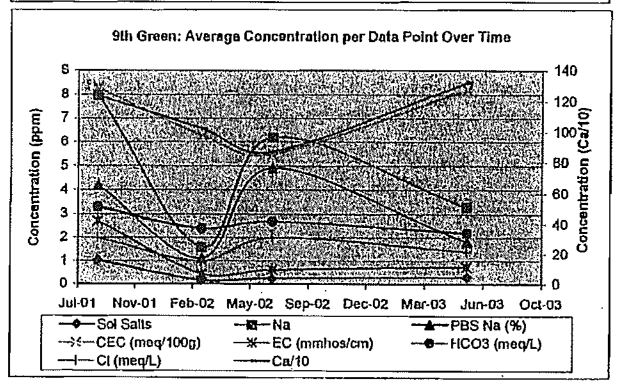
7th Green

Date	Sep-01	Mar-02	Jul-02	Jun-03	Average
Ca/10	112.6	102.6	136.1	136.4	121.93
Sol Salts	0.2	0.18	0.27	0.28	0.23
Na	6	2.3	4.9	3.8	4.25
PBS Na (%)	3.3	1.6	2.6	1.9	2.35
CEC (meq/100g)	7.9	6.4	8.1	8.5	7.73
EC (mmhos/cm)	1.03	0.43	1.03	0.64	0.78
HCO3 (meq/L)	3.5	2.5	2.8	2.3	2.78
Cl (meq/L)	1.9	0.4	1.4	0.8	1.13



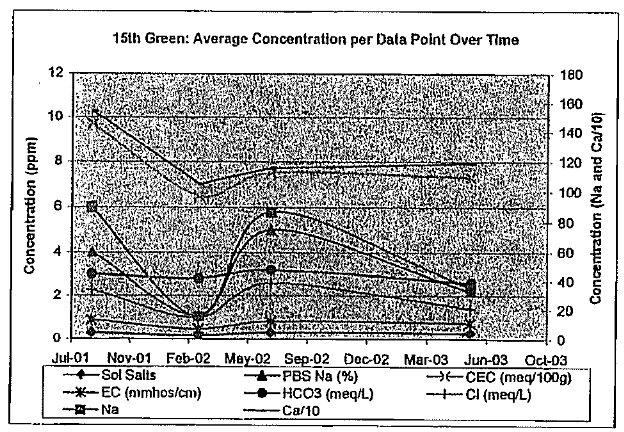
9th Green

Date	Sep-01	Mar-02	Jul-02	Jun-03	Average
Ca/10	123.9	102.2	86.9	132.3	111.33
Sol Salts	1.02	0.17	0.24	0.29	0.43
Na	8	1.6	6.2	3.3	4.78
PBS Na (%)	4.2	1.1	4.9	1.8	3.00
CEC (meq/100g)	8.3	8.3	5.5	8.2	7.08
EC (mmhos/cm)	2.73	0.47	0.63	0.75	1.15
HCO3 (meq/L)	3.3	2.4	2.7	2.2	2.65
Cl (meq/L)	2	1	2	1.4	1.80



15th Green

Date	Sep-01	Mar-02	Jul-02	Jun-03	Average
Ca/10	154.3	105.1	115.7	118.9	12.35
Sol Salts	0.31	0.17	0.32	0.29	0.27
Na	90	16	87	36	57.25
PBS Na (%)	4	1.1	5	2.2	3.08
CEC (meq/100g)	9.7	6.5	7.5	7.3	7.75
EC (mmhos/cm)	0.9	0.47	0.82	0.75	0.74
HCO3 (meq/L)	3	2.8	3.2	2.6	2.90
Cl (meq/L)	2.3	1	2.6	1.4	1.83

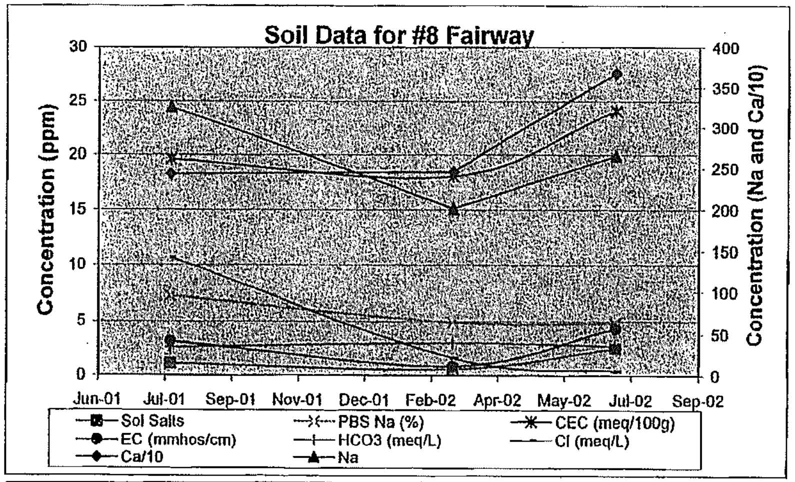


Notes:
All values in mg/Kg unless otherwise noted
Ca/10: Value of Ca divided by 10 to get on scale
CEC=Cation Exchange Ratio
PBS= % Base Saturation
EC= Electrical Conductivity (mmhos/cm)

Table 10 and Associated Figures. La Contenta Golf Course Soil Analysis: Fairways

8th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	242.7	245.7	368.2
Sol Salts	1.1	0.59	2.5
Na	326	201	265
PBS Na (%)	7.2	4.9	4.8
CEC (meq/100g)	19.6	18	24.1
EC (mmhos/cm)	3.13	0.83	4.28
HCO3 (meq/L)	2.6	3	2.7
Cl (meq/L)	10.7	1.6	0.4



Notes:
All values in mg/Kg unless otherwise noted
Ca/10: Value of Ca divided by 10 to get on scale
CEC=Cation Exchange Ratio
PBS= % Base Saturation
EC= Electrical Conductivity (mmhos/cm)

9th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	469.4	293.5	311.5
Sol Salts	0.77	0.56	1.47
Na	204	121	364
PBS Na (%)	3	2.4	5.9
CEC (meq/100g)	29.9	22.1	26.9
EC (mmhos/cm)	2.15	1.39	3.54
HCO3 (meq/L)	6.6	2.9	4.5
Cl (meq/L)	5.8	3.3	8.7

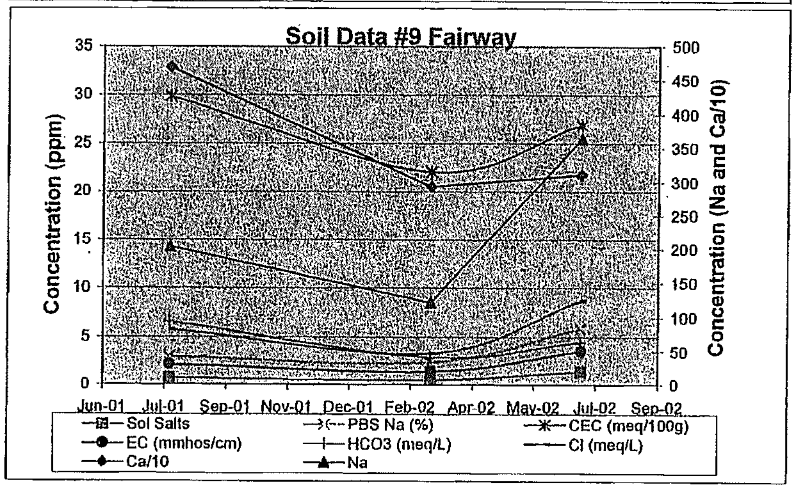
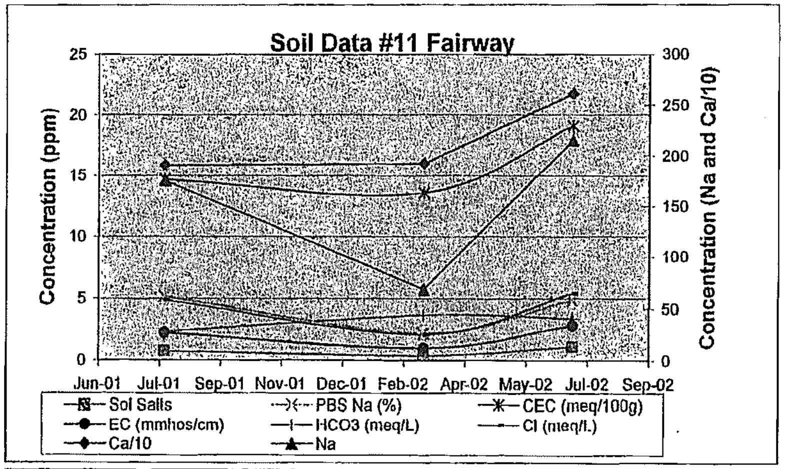


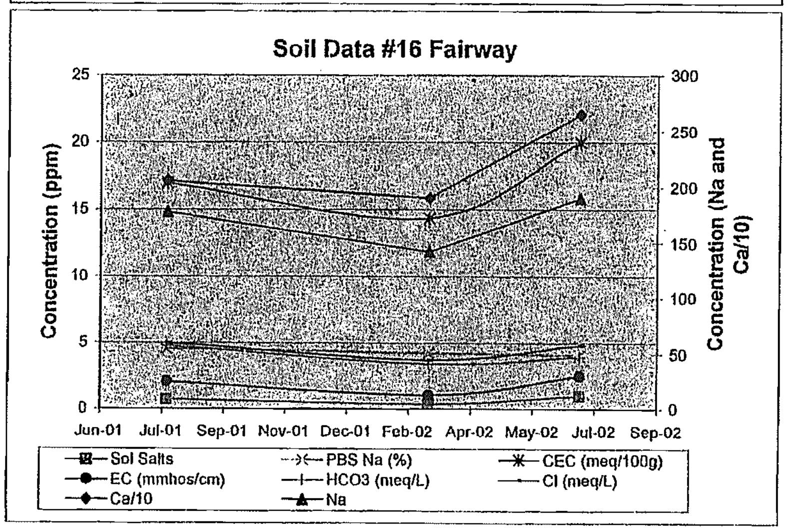
Table 10 and Associated Figures. La Contenta Golf Course Soil Analysis: Fairways

11th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	190.4	192.1	261.2
Sol Salts	0.8	0.4	1.16
Na	175	68	215
PBS Na (%)	5.2	2.2	4.9
CEC (meq/100g)	14.7	13.6	19.1
EC (mmhos/cm)	2.22	1.01	2.81
HCO3 (meq/L)	2.3	3.7	3.4
Cl (meq/L)	4.9	2.1	5.4



Notes:
All values in mg/Kg unless otherwise noted
Ca/10: Value of Ca divided by 10 to get on scale
CEC=Cation Exchange Ratio
PBS= % Base Saturation
EC= Electrical Conductivity (mmhos/cm)



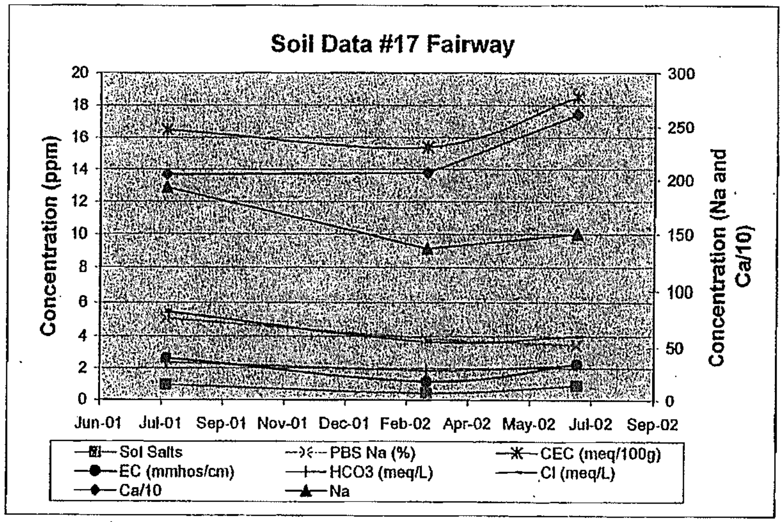
16th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	205.8	190.5	265.2
Sol Salts	0.76	0.43	1.05
Na	178	142	190
PBS Na (%)	4.6	4.3	4.1
CEC (meq/100g)	17	14.4	20
EC (mmhos/cm)	2.12	1.08	2.55
HCO3 (meq/L)	4.8	3.5	4
Cl (meq/L)	5	3.8	4.8

Table 10 and Associated Figures. La Contenta Golf Course Soil Analysis: Fairways

17th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	205.5	206.8	261.7
Sol Salts	0.99	0.47	0.93
Na	193	137	150
PBS Na (%)	5.1	3.9	3.5
CEC (meq/100g)	16.5	15.4	18.5
EC (mmhos/cm)	2.66	1.18	2.26
HCO3 (meq/L)	2.4	1.9	2.2
Cl (meq/L)	5.5	3.7	4



Notes:
All values in mg/Kg unless otherwise noted
Ca/10: Value of Ca divided by 10 to get on scale
CEC=Cation Exchange Ratio
PBS= % Base Saturation
EC= Electrical Conductivity (mmhos/cm)

18th Fairway

	Aug-01	Mar-02	Jul-02
Ca/10	211.2	235	286.8
Sol Salts	1.4	0.43	1.09
Na	229	111	270
PBS Na (%)	5.5	2.9	5.2
CEC (meq/100g)	18.1	16.9	22.7
EC (mmhos/cm)	3.49	1.08	2.64
HCO3 (meq/L)	4.8	3.7	3.8
Cl (meq/L)	6.6	3.1	6.6

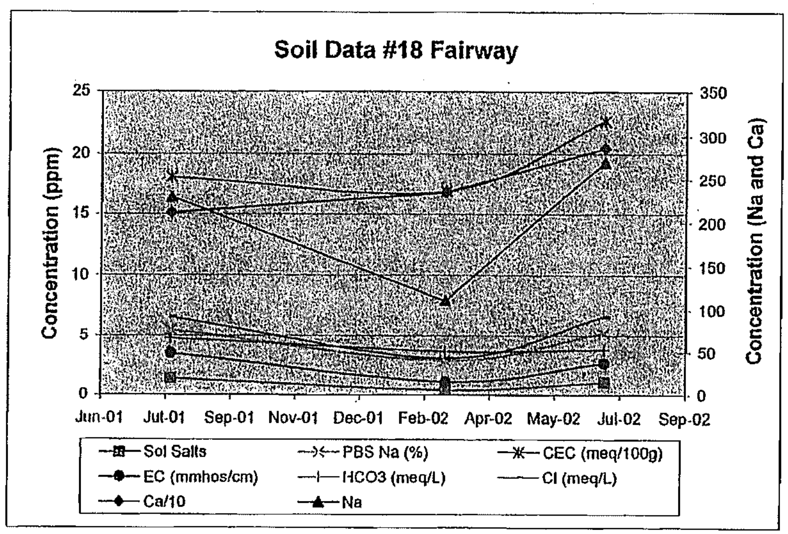


Table 11. La Contenta Golf Course Comparison of Local Golf Course Reclaimed Water Use

Course	Turf Ac	Reclaimed Water Use AF/Yr	AF/A Year
La Contenta GC	70	104	1.5
Rancho Murietta CC North	138	290	2.1
Rancho Murietta CC South	136	290	2.1
Castle Oaks GC Ione	145	557	3.8
Saddle Creek GC Copperopolis	84 126	420	5.0 3.7

Table 12. La Contenta GC
Existing and Potential Water Use Scenario Analysis

Estimated Existing Water Use (1)

Month	FRWAY NH	FRWAY WWTP	ROUGH NH	ROUGH WWTP	TEES NH	TEES WWTP	GRNS NH	GRNS WWTP	SURR NH	SURR WWTP	OTHER NH	OTHER WWTP	Tot NH	Tot WWTP	Grand Totals
Mar	1.7	1.1	1.7	1.2	0.25	0.16	0.3	0	0.6	0	0.2	0	4.75	2.46	7.21
Apr	4.9	3.2	5	3.4	0.7	0.48	0.9	0	1.8	0	0.6	0	13.9	7.08	20.98
May	4.5	6.8	4.7	7	0.67	1	1.3	0	2.5	0	0.8	0	14.47	14.8	29.27
Jun	4.4	10	4.5	10.6	1	1	1.6	0	3.2	0	1	0	15.7	21.6	37.3
Jul	4.9	11.4	5.1	11.8	1.2	1.2	1.8	0	3.6	0	1.2	0	17.8	24.4	42.2
Aug	4.5	10.5	4.7	11	1.1	1.1	1.7	0	3.3	0	1.1	0	16.4	22.6	39
Sep	3.5	8	3.6	8.4	0.86	0.86	1.3	0	2.8	0	0.86	0	12.72	17.26	29.98
Oct	3	4.5	3.1	4.7	0.56	0.56	0.84	0	1.7	0	0.56	0	9.76	9.76	19.52
Nov	1.4	0	1.5	0	0.21	0	0.47	0	0.95	0	0.31	0	4.84	0	4.84
													110.34	119.96	230.3
location total:	32.8	55.5	33.9	58.1	6.55	6.36	10.21	0	20.25	0	6.63	0			230.3
Grand total:	88.3		92		12.91		10.21		20.25		6.63				230.3

Tot NH: 110.34
Tot WWTP: 119.96
Grand Total: 230.3

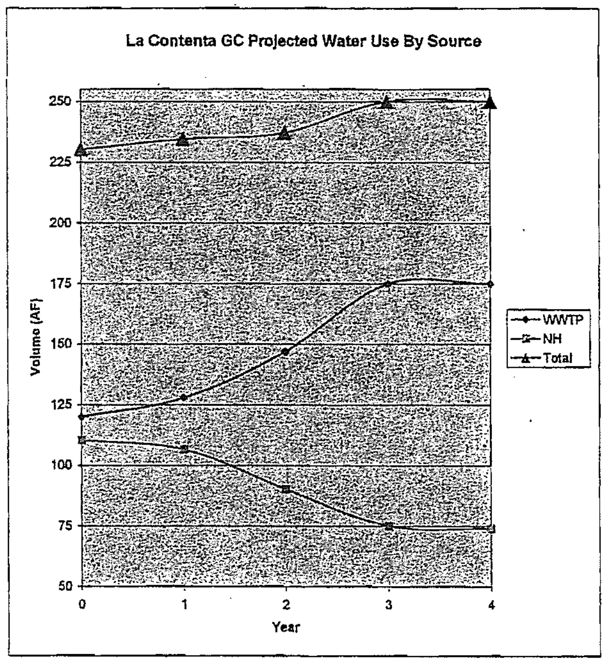
Potential Transition Scenario to Higher % WWTP Effluent Use

Existing (Year"0")	NH	WWTP	Total
G-T-S-O	43.6	6.4	50
F-R	66.7	113.6	180.3
Single Flush Volume	0	0	0
# Flushes	0	0	
Total Used	110.3	120.0	230.3

Year 1	NH	WWTP	Total
G-T-S-O	40.0	8.0	50.4
F-R	45.0	120.0	165.0
GTSO NH Flush %	15.0		
Single Flush Volume	1.2		
# Flushes	2		
Total GTSO NH Flush Volume	2.4		2.4
FR NH Flush %	8.0		
Single Flush Volume	9.6		
# Flushes	2		
Total FR NH Flush Volume	19.2		19.2
Total Used	106.6	128.0	234.6

Year 2	NH	WWTP	Total
G-T-S-O	35.0	12.0	50.6
F-R	30.0	135.0	165.0
GTSO NH Flush %	15.0		
Single Flush Volume (1)	1.8		
# Flushes	2.0		
Total GTSO NH Flush Volume	3.6		3.6
FR NH Flush %	8.0		
Single Flush Volume	10.8		
# Flushes	2		
Total FR NH Flush Volume	21.6		21.6
Total Used	90.2	147.0	237.2

Year 3 and on	NH	WWTP	Total
G-T-S-O	30.0	15.0	49.5
F-R	15.0	160.0	175.0
GTSO NH Flush %	15.0		
Single Flush Volume	2.25		
# Flushes	2.0		
Total GTSO NH Flush Volume	4.5		4.5
FR NH Flush %	8.0		
Single Flush Volume	12.8		
# Flushes	2		
Total FR NH Flush Volume	25.6		25.6
Total Used	75.1	175.0	250.1



Summary of Current to Year 3 Change

Year	NH (AF)	WWTP (AF)	Total (AF)
Existing (Year"0")	110.3	120.0	230.3
Year 3 and on	75.1	175.0	250.1
Change (AF)	-35.2	55.0	19.8
% Change	-32%	46%	9%

Notes: All values in Acre Feet (AF) and are approximate
GTSO: Greens, Tees, Surrounds, and Other Landscape Areas
FR: Fairway and Rough
NH: New Hogan Reservoir source
WWTP: Wastewater Treatment Plant source
NH and WWTP water may be blended in any of the scenarios above
Volume and frequency of WWTP water use are approximate and depend weather and results of regular soil, soil water, +/or plant tissue testing so that adequate growing are established and maintained.
(1) Source: Cliff Rourke, La Contenta GC

ATTACHMENT 2

CONDOR

Evaluation of Agronomic Practices at La Contenta Golf Course

Calaveras County Water District
La Contenta Golf Course
November 21, 2008

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Calaveras County Water District

La Contenta Golf Course

Evaluation of Agronomic Practices at La Contenta Golf Course

Table of Contents

1.0 Summary

Many agronomic practices, such as soil and water management, have an effect on the efficiency with which surface applied irrigation water becomes available to turfgrass plants. The cultural practices, irrigation scheduling, fertilization, aerification etc. have an effect on the amount of water that can be applied over a given time period to meet plant water needs. In an effort to increase effluent water use at La Contenta golf course these practices are the focus of this report.

This is a follow up to the "La Contenta Irrigation Water Use Study dated August 6, 2007-Final Report"("Report"), provided to the Calaveras County Water District ("CCWD"), by Blankinship & Associates Inc. The analysis and the data used to compile that Report will not be duplicated except in case of additional interpretations and updated information provided since the Report was written.

2.0 Background

The La Contenta golf course, located in Valley Springs, California is an 18 hole public facility. Water provided by the District from the La Contenta Wastewater Treatment and Reclamation Facility ("Plant") in combination with raw water drawn from the New Hogan Reservoir ("New Hogan") is used to irrigate the golf course. The two sources of water are used in conjunction to irrigate the Course according to turfgrass type and plant water use requirements. Some areas receive only New Hogan water, while other areas are irrigated with a combination of both New Hogan and effluent water ("Blend").

The Plant distribution system consists of an 8" delivery pipeline from the Lower Storage Reservoir at the Plant, which is gravity feed directly to the irrigation pump station at the Course. Current delivery capacity is approximately 1000 gallons per minute ("gpm"). The District's annual target amount for effluent water use is 245 acre-feet ("AF").

New Hogan Reservoir water is transported via a pump system and a gravity ditch to Skinny Dip Lake, and to the irrigation pond ("# 7 Lake"), 8 and 18. The golf course irrigation pump station draws the raw water directly from #7 Lake.

Blending of the two sources of water, effluent and raw, occurs in the wet well of the irrigation pump station located adjacent to #7 Lake at the maintenance facility.

The Course has approximately 70 acres of irrigated turf, and is typically irrigated between the months of March and November, with an annual evapotraspiration ("ET") rate of approximately 54.86 inches per year, and an annual average precipitation of 12.79 inches.

The Course is irrigated according to turf suitability/sensitivity to the application of effluent water. Greens, green surrounds, tees and landscapes are the most sensitive areas and are primarily watered with New Hogan Reservoir water. These areas only comprise approximately 16% of the total irrigated turf. The remainder of turf areas, roughs and fairways, make up the bulk of the turf areas irrigated with recycled water, approximately 84%.

3.0 Objective
The objective is to increase the amount of effluent water used to irrigate the Course through the use of alternate water management strategies and modified cultural practices. This report is based on the ability of the Course to increase effluent water use, while maintaining turf health, playability.

4.0 Approach
A site visit was conducted in the afternoon (1:30-3: 30pm), on August 14, 2008; data was gathered from the District during a tour of the Course. The condition of the Course was observed and evaluated based on aesthetics of turf and soil appearance. Core samples were used to assess soil moisture levels and visual conditions of turf and soil.

5.0 Data Used
The previous Report was used for technical data and evaluation of both water quality and quantity used to irrigate the Course. Information about the current irrigation system configuration and operating practices were gathered from golf course personnel.

Additional information was received from the District and Course personnel pertaining to water quality and quantity used prior to the site visit. Golf course irrigation central control programming was obtained to evaluate current programming verses optional control strategies. Also on site weather station data and water use history was gathered from the course.

6.0 Findings
Course conditions are representative of the greens fee structure of the facility and the corresponding maintenance budget. Wet and dry turf areas observed during the site inspection are typical conditions during the peak season when the highest annual ET's are encountered and the most water is being applied to meet water use requirements. These conditions were present on steeply sloped areas for the most part. Wet and dry areas adjacent to each other are an indication of runoff due to poor infiltration rates, or low irrigation efficiency.

Since the last Report a gypsum injection system has been installed at the Course next to the irrigation pump station, allowing for direct injection of gypsum to the irrigation system mainline, and distributed to all irrigated areas through the irrigation system sprinkler heads. The injection system has been up and running since mid July 2008.

6.1 Water Quantity
The District controls the delivery of the recycled water to the Course. The timing of the delivery of effluent water is scheduled by the golf course superintendent, and is monitored by the SCADA (supervisory control and data acquisition) system employed by the District. Effluent water delivery currently is approximately 1000 gpm to the irrigation wet well for use by the Course.

The central irrigation computer maximizes the use of golf course irrigation resources. Irrigation system scheduling is based on daily ET calculations received from a weather station located on site. Programs for area/grass type are used to calculate water use requirements. The Course personnel control the irrigation scheduling. The methods of timing and duration currently in use are based on acceptable maintenance practices, experience, and the understanding of the needs of the turf and the expectation of the golfers. The timing of the water cycle is dependent on the time of year, (sunrise-sunset, tee times, and tournament/special events schedule) during the peak season (June, July, and August) and it is generally conducted from the hours of 8:30pm to 6am. Current programming produces a balanced hydraulic distribution of water throughout the Course.

The irrigation pump station maintains pressure in the system according to demand. The central irrigation computer creates the demand by downloading program information to the field controllers. Demand is based on ET, precipitation rate of the sprinklers, soil infiltration rates and water window requirements. Peak demand is reached during the hottest part of the year and ranges from about 1300-1800 gpm depending on water use requirements and the amount of time watering can take place. Peak demand is reached and sustained from approximately 9pm-1am during a typical peak season cycle. The remainder of the cycle is comprised of the completion of the irrigation programs, and is represented as tapering off of the flow, which occurs between 1am and 6am.

6.2 Water Quality

Effluent water quality falls into the category of "slight to moderate impact" on turf quality and increased maintenance practices required to maintain turf health. According to turf type and the amount of blending (ratio) an area receives. The water quality data suggests that the effluent source is manageable with an increase in cultural practices and agronomic procedures during the mid to latter part of the irrigation season. Those areas, which receive higher blend ratios of raw water and or exclusively New Hogan water, have a much lower added maintenance price tag associated with them to maintain healthy conditions.

6.3 Cultural Practices

The golf course is divided up into areas of priority. The highest priorities consist of those areas that affect playability the most. For example, greens universally rank number one for the simple fact that playability of the course is most adversely affected when greens are not up to the expectations of the golfers, and do not present consistent and total turf coverage. Next are areas in close proximity to greens, then tees, fairways and roughs respectively. Also the closer to the intended line of play and landing areas will also require extra attention to help meet expectations and increase maintenance efficiency and productivity.

Cultural practices can also be equated to the height of maintained turf. The lower the height of cut, the more intense the practices that will be necessary to maintain turf health. With greens being cut the lowest this further illustrates the importance that greens play in the golf course

Seeding wore/thin areas is accomplished with salt tolerant ryegrass to help reduce replacement of these areas in the future from the effects of salt build up. The level of salt build up combined with concentrated traffic can have negative effects on turf, Replacing with salt tolerate varieties can help alleviate problem areas.

7.0 Conclusions

7.1 Irrigation Scheduling

Maximizing the current "recycled water discharge" process is the common goal of the Course and the District. Effluent delivery from the Plant to the Course during the irrigation watering cycle is the most critical factor in the "recycled water discharge" process. The ability of the Course to apply the 245 AF of effluent water is in place, with the implementation of the SCADA system and the installation of a booster pump in the effluent delivery pipeline, increasing delivery capacity to 1500 gpm.

The total water use requirement of the Course can be defined through the use of a simple formula. Annual ET ("ETo"), minus annual precipitation, times crop coefficient ("Kc"), times irrigation efficiency ("IE"), times irrigated acreage, equals annual water use requirement.

(ETo – Precipitation) x Kc x IE x Acreage = Water Use Requirement

Assuming a Kc of .8 and an irrigation efficiency of 75% the total water requirement for 70 acres of turf would be 287 AF, and 59 acres would be 242 AF. This is based on an annual ETo for the "irrigation season" from March to November (49.75 inch deficit).

This calculation does not include for leaching requirements, which is the amount of extra water that is needed during irrigation to move salts below the plant root zone. Leaching requirement calculations are based on electrical conductivity values of irrigation water and approximate soil salinity tolerance of turfgrasses. Additional water usage could be achieved through leaching. Leaching can be a executed either as scheduled events or as additional irrigation daily.

The use of the gypsum injection system may allow the use of effluent water on areas previously watered exclusively watered with New Hogan water, or an increase in the ratio of effluent to New Hogan water throughout the irrigation season.

The delivery of effluent water from the Plant must match the flow of the irrigation pump station in order to achieve maximum efficiency in applying recycled water to the Course. Not only does the volume of demand need to meet Course irrigation demand, but also the timing of the delivery must be in sync with the irrigation water window to allow for maximum discharge of effluent by the Course irrigation system.

The Reprogramming of the irrigation computer to implement a program cycle regime could allow at least the same amount of water to be applied to the Course more efficiently, minimizing runoff on steeply sloped terrain and areas of poor infiltration. Also the addition of programming for wet and dry areas ("Hot Spots") in separate programs could allow for specific areas to receive more or less water according to the site-specific situation. The addition of Hot Spots would also allow for the assignment of specific heads to be placed in multiple programs to run in conjunction with other currently running programs, allowing additional water to be applied while maintaining the current water window.

Malfunctioning irrigation components, improper irrigation sprinkler head spacing, out of tolerance precipitation rates due to wore components are all considerations that need to be monitored in areas displaying less than desirable results.

Cultural practices can have varying cumulative effects on the agronomic conditions of the course. These practices come with a price and not all can be implemented on a scale equal to the quality of the effluent water impact on all grass types. The fee structure of the Course is probably not inline with an increase in the maintenance budget needed to accommodate the increased cost associated with the best management practices necessary to properly manage the use of recycled water in areas not already receiving effluent irrigation. The following is a list of beneficial practices that may or may not be economical or practical given the business plan of the facility and its ability to remain a viable business entity.

7.2 Soil and Water Testing

Routine soil and water testing should be monitored to determine the present conditions and any agronomic trends requiring adjustment.

A general rule of thumb for testing would include a minimum of two soil and four water tests per year. The use of aerial photography can be a very useful tool in assessing weak turf areas and excessive runoff situations. Once again greens fall in to the highest level of maintenance required, and should warrant careful consideration before recycled water is applied to these areas and other high traffic areas.

7.3 Water Treatment

With the installation of the gypsum injection system and positive results monitored over time, the possibility exists that areas presently not receiving recycled water may be manageable in the future with the use of the gypsum injection system, but this will require time to monitor the effects on the areas presently irrigated with effluent to determine if the management of other areas are feasible before proceeding with the conversion. Gypsum amendments can be beneficial in helping to modify soil structure, i.e. increase infiltration rate, and make previously unavailable nutrients available to the turfgrass but the effects take time and are dependent on the amount applied.

7.4 Leaching to Control Soluble Salts

As a result of the increased application of higher levels of total dissolved solids, sodium, particularly bicarbonates, the application of extra water over and above normal irrigation requirements ("Leaching") is required to preserve turf health through the summer season when the highest levels of irrigation are applied to the fairways and rough permitting the movement of salt build up in the root zone. These practices are very subjective and require constant observation to assess the conditions of the playability of the course and expectations of the golfers.

7.5 Aerification, Drainage, and Topdressing

These cultural practices can provide many beneficial effects on soil and plant conditions. The increased infiltration of water, the exchange of oxygen with the root zone and the release of undesirable gases in the soil profile, and provide the removal of surface runoff can all benefit the agronomic health of the Course. Implementing additional procedures above and beyond those already in use may be desirable, but the increased cost associated with these procedures may be prohibitive.

7.6 Fertility and Soil Amendments

The type and quantity of fertilizer and amendments should be based on routine soil and water quality tests. Adjust fertilizer programs in accordance with soil and water test results. Avoid fertilizing low-lying areas and other areas of lush growth. The application of soil wetting agents may be a practical solution for the correction of dry areas with poor infiltration rates.

8.0 Recommendations

1. Increase efficiency of the coordination of the delivery of effluent water between the Course and the Plant. Recycled water delivery must closely match golf course irrigation pump station flow demands to maximize recycled water use. This is to include volume and timing of delivery of effluent during the entire water cycle window when blending is desired.

2. Reprogramming of central irrigation computer to allow the cycling of programs to effectively reduce the runoff and increase water penetration in wet and dry areas.

3. Consider extending the irrigation water window if effluent delivery can't match high golf course irrigation flows, and if course activities allow.

4. Implement flushing cycle/factor to anticipate build-up of salts, coinciding with soil testing to alleviate poor infiltration rates and excessive runoff.

5. Institute a monitoring program of soil and water analysis to include a minimum of bi-annual soil tests, quarterly water test and field monitoring of problematic areas through the grow season to identify problematic areas.

6. Begin the permitting process for additional storage and discharging of effluent to allow overflows to cosgrove creek and increase evaporation in ponds, and, infiltration in wetlands by allowing additional storage and circulation of effluent water.

7. Continue operation of pond aerification and recirculation systems on a regular basis.

8. Monitor the effects of the gypsum applications to determine if positive results are quantifiable, and if the increase/decrease of chemical or fertilizer applications can be adjusted to benefit the condition of the turf.

9. Invest in irrigation central computer upgrades, such as Toro TMap to increase irrigation programming efficiency, along with annual tracking of problem areas using aerial photography.

10. Conduct an irrigation audit to determine the irrigation efficiency of the current irrigation system to help better calculate water use requirements.

11. Investigate proper operation of irrigation components and create a prioritized project list of irrigation modifications to increase irrigation efficiency.

Limitations
The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No warranty, express or implied, is made. This report is solely for the use of the District and Course. Any reliance on this report by any other third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the purposes, locations time frames, and project parameters indicated. We are not responsible for the impacts of any changes in agronomic or irrigation practices, environmental standards practices or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portion of this report

11.0 References
Gross, Patrick, J. 2008, USGA Greens Section Record. March/April 46 (2): 1-8

Harivandi A. 1999 Publication 8009 – Interpreting Turfgrass Irrigation Water Test Results. University of California Division of Agriculture and Natural Resources.

Blankenship, Michael, S. 2007 Report – La Contenta Golf Course Irrigation Study.

ATTACHMENT 3

CONDOR

Water Balance (Revised) - 100 Year and Average Year Storm Event - Future Flows

ADWF (gpd)
200,000

LOWER EFFLUENT STORAGE POND	LESP	UESP
Average Year Volume (ac-ft)	172.0	49.0
Catchment Area (ac)	17.9	5.0
Max Water Surface Area (ac)	14.5	4.3

STORM YEAR STORAGE	
UESP Volume (ac-ft)	30.3
Additional LESP Volume (ac-ft)	49.0
Total	79.3

GOLF COURSE IRRIGATION POND #7	
Volume (ac-ft)	25.8
Catchment Area (ac)	255.0
Max Water Surface Area	4.5

k (cm/s)	K ft/s	ft/mo
1.30E-06	4.27E-08	0.11

LA CONTENTA GOLF COURSE IRRIGATION	
Area (ac)	70
Maximum Application Rate (in/ac-yr)	52.2

	Month		EFFLUENT PRODUCTION					HISTORIC WEATHER DATA			STORAGE - LOWER EFFLUENT STORAGE POND (LESP)							
			Average Dry Weather Flow (ADWF)					Precipitation		ET	Inflow (ac-ft)		Outflow (ac-ft)			Storage Volume (ac-ft)		
			gpd	gallon/month	ac-ft/month	I/I (ac-ft/month)	Total Effluent (ac-ft)	% of Total	in/month	in/month	Effluent	Precipitation	Evaporation	Percolation	Recycled Water to Pond #7	Change	Stored Volume	Excess Water Stored in UESP or LESP
	(1)	Days			(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
100-yr Precipitation	Oct	31	200,000	6,200,000	19.0	0.4	19.4	5.4	2.2	5.1	19.4	1.9	0.6	0.3	0.0	20.4	20.4	0.0
	Nov	30	200,000	6,000,000	18.4	1.6	20.0	11.7	4.8	2.1	20.0	5.5	0.2	0.3	0.0	25.0	45.4	0.0
	Dec	31	200,000	6,200,000	19.0	2.1	21.1	15.8	6.5	1.3	21.1	7.9	0.3	0.6	0.0	28.1	73.5	0.0
	Jan	31	200,000	6,200,000	19.0	10.5	29.5	18.4	7.5	1.4	29.5	9.4	0.5	0.9	0.0	37.5	111.0	0.0
	Feb	28	200,000	5,600,000	17.2	16.3	33.5	16.7	6.8	1.8	33.5	8.5	0.8	1.3	0.0	39.9	150.9	0.0
	Mar	31	200,000	6,200,000	19.0	5.3	24.4	15.9	6.5	3.5	24.4	8.0	1.9	1.5	0.0	28.9	179.8	0.0
	Apr	30	200,000	6,000,000	18.4	5.5	23.9	9.0	3.7	5.4	23.9	3.9	3.2	1.6	0.0	23.1	202.8	0.0
	May	31	200,000	6,200,000	19.0	4.6	23.6	3.9	1.6	8.2	23.6	1.2	6.9	1.6	36.0	-19.8	183.1	0.0
	Jun	30	200,000	6,000,000	18.4	1.5	19.9	1.2	0.5	10.1	19.9	0.1	8.5	1.6	53.8	-44.0	139.1	0.0
	Jul	31	200,000	6,200,000	19.0	0.0	19.0	0.2	0.1	12.2	19.0	0.1	9.3	1.4	68.6	-60.2	78.9	0.0
	Aug	31	200,000	6,200,000	19.0	0.0	19.0	0.3	0.1	11.0	19.0	0.1	5.7	1.0	58.4	-45.9	33.0	0.0
	Sep	30	200,000	6,000,000	18.4	0.4	18.8	1.4	0.6	8.2	18.8	0.1	2.0	0.5	16.7	-0.3	0.0	32.8
	Subtotal				224.0	48.1	272.1	100.0	40.8	70.3	272.1	46.7	40.0	12.5	233.4	32.8		32.8
Average Precipitation	Oct	31	200,000	6,200,000	19.0	0.2	19.2	5.4	1.1	5.1	19.2	0.6	0.0	0.0	0.0	19.8	19.8	0.0
	Nov	30	200,000	6,000,000	18.4	0.8	19.2	11.7	2.5	2.1	19.2	2.3	0.2	0.3	0.0	21.0	40.9	0.0
	Dec	31	200,000	6,200,000	19.0	1.1	20.1	15.8	3.4	1.3	20.1	3.5	0.3	0.6	0.0	22.8	63.6	0.0
	Jan	31	200,000	6,200,000	19.0	5.5	24.5	18.4	3.9	1.4	24.5	4.2	0.4	0.8	0.0	27.5	91.1	0.0
	Feb	28	200,000	5,600,000	17.2	8.5	25.7	16.7	3.6	1.8	25.7	3.8	0.7	1.1	0.0	27.6	118.8	0.0
	Mar	31	200,000	6,200,000	19.0	2.8	21.8	15.9	3.4	3.5	21.8	3.5	1.7	1.3	0.0	22.3	141.1	0.0
	Apr	30	200,000	6,000,000	18.4	2.9	21.3	9.0	1.9	5.4	21.3	1.5	2.9	1.4	21.0	-2.5	138.6	0.0
	May	31	200,000	6,200,000	19.0	2.4	21.4	3.9	0.8	8.2	21.4	0.3	6.2	1.4	40.2	-26.2	112.5	0.0
	Jun	30	200,000	6,000,000	18.4	0.8	19.2	1.2	0.2	10.1	19.2	0.0	6.8	1.3	53.4	-42.2	70.3	0.0
	Jul	31	200,000	6,200,000	19.0	0.0	19.0	0.2	0.0	12.2	19.0	0.0	5.7	0.9	66.4	-54.0	16.3	0.0
	Aug	31	200,000	6,200,000	19.0	0.0	19.0	0.3	0.1	11.0	19.0	0.1	1.4	0.2	33.7	-16.3	0.0	0.0
	Sep	30	200,000	6,000,000	18.4	0.2	18.6	1.4	0.3	8.2	18.6	0.0	0.0	0.0	18.6	0.0	0.0	0.0
	Subtotal				224.0	25.1	249.1	100.0	21.3	70.3	249.1	19.9	26.3	9.3	233.4	0.0		0.0

	Month	STORAGE - UPPER EFFLUENT STORAGE POND (UESP)							LA CONTENTA GOLF COURSE - IRRIGATION POND #7								IRRIGATION	POND #7 DISCHARGE	
									Inflow (ac-ft)			Outflow (ac-ft)		Surface Water Discharge (ac-ft)					
		Effluent to UESP	Precipitation	Evaporation	Percolation	Evaporation by Misters	Change	Stored Volume	Recycled Water From LESP	Raw Water	Precipitation	Evaporation	Golf Course Irrigation	Change	Pond Volume	Surface Discharge	Golf Course Demand (ac-ft)	Pond Turnovers	Recycled Water as Pond Discharge
	(1)								(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
100-yr Precipitation	Oct	0.0	0.5	0.0	0.0	0.0	0.5	22.6	0.0	0.4	4.8	0.0	5.3	0.0	25.8	0.0	5.3	1.00	NA
	Nov	0.0	1.5	0.3	0.3	0.0	0.9	23.6	0.0	0.0	34.6	0.3	0.0	34.3	25.8	34.3	0.0	2.35	0.0%
	Dec	0.0	2.2	0.2	0.3	0.0	1.7	25.3	0.0	0.0	60.4	0.2	0.0	60.3	25.8	60.3	0.0	4.70	0.0%
	Jan	0.0	2.6	0.2	0.4	0.0	2.1	27.4	0.0	0.0	77.9	0.2	0.0	77.8	25.8	77.8	0.0	7.73	0.0%
	Feb	0.0	2.3	0.3	0.4	0.0	1.7	29.0	0.0	0.0	66.5	0.2	0.0	66.2	25.8	66.2	0.0	10.31	0.0%
	Mar	0.0	2.2	0.5	0.4	0.0	1.3	30.3	0.0	0.0	61.0	0.5	0.0	60.5	25.8	60.5	0.0	12.70	0.0%
	Apr	0.0	1.1	0.9	0.4	0.0	-0.2	30.1	0.0	0.0	19.8	0.7	13.7	5.3	25.8	5.3	13.7	NA	0.0%
	May	0.0	0.3	1.3	0.4	0.0	-1.4	28.7	36.0	0.0	1.4	1.6	35.8	0.0	25.8	0.0	35.8	NA	NA
	Jun	0.0	0.0	1.5	0.4	9.0	-10.9	17.8	53.8	0.0	0.2	2.0	52.0	0.0	25.8	0.0	52.0	NA	NA
	Jul	0.0	0.0	1.2	0.3	9.0	-10.4	7.4	68.6	0.0	0.0	2.4	66.2	0.0	25.8	0.0	66.2	NA	NA
	Aug	0.0	0.0	0.4	0.1	6.9	-7.5	0.0	58.4	0.0	0.0	2.1	56.3	0.0	25.8	0.0	56.3	NA	NA
	Sep	32.8	0.0	0.0	0.0	10.7	22.1	22.1	16.7	18.7	0.2	1.6	34.0	0.0	25.8	0.0	34.0	0.79	NA
	Subtotal	32.8	12.9	6.7	3.4	35.6	0.0		233.4	19.1	326.9	11.7	263.3	304.4		304.4	263.3		
Average Precipitation	Oct								0.0	11.3	0.1	0.0	11.4	0.0	25.8	0.0	11.4	1.22	NA
	Nov								0.0	2.8	7.3	0.3	9.8	0.0	25.8	0.0	9.8	1.62	NA
	Dec								0.0	0.0	16.1	0.2	0.0	16.0	25.8	16.0	0.0	2.25	0.0%
	Jan								0.0	0.0	22.7	0.2	0.0	22.5	25.8	22.5	0.0	3.14	0.0%
	Feb								0.0	0.0	18.4	0.2	0.0	18.1	25.8	18.1	0.0	3.86	0.0%
	Mar								0.0	0.0	16.3	0.5	7.4	8.5	25.8	8.5	7.4	4.51	0.0%
	Apr								21.0	0.7	3.0	0.7	24.0	0.0	25.8	0.0	24.0	NA	NA
	May								40.2	1.3	0.3	1.6	40.2	0.0	25.8	0.0	40.2	NA	NA
	Jun								53.4	1.9	0.1	2.0	53.4	0.0	25.8	0.0	53.4	NA	NA
	Jul								66.4	2.3	0.0	2.4	66.4	0.0	25.8	0.0	66.4	NA	NA
	Aug								33.7	24.9	0.0	2.1	56.6	0.0	25.8	0.0	56.6	NA	NA
	Sep								18.6	18.4	0.1	1.6	35.6	0.0	25.8	0.0	35.6	0.78	NA
	Subtotal								233.4	63.6	84.5	11.7	304.7	65.1		65.1	304.7		

NOTES:

(1) Months. Recycled water accumulation in storage ponds begins in October.
(2) Average dry weather flow (ADWF) converted to acre-ft/month.
(3) Estimated inflow and infiltration (I/I) flows based on monthly peaking factors which were applied to the ADWF in Column (2).
(4) Total effluent flow is equal to the sum of the ADWF plus I/I. Column (2) + Column (3)
(5) Estimated percent of total annual rainfall within a given month.
(6) Precipitation obtained from Camp Pardee historical data from the Department of Water Resources.
(7) Class A pan evaporation rates for Camp Pardee.
(8) Effluent conveyed to the LESP. Equal to Column (4).
(9) Estimated precipitation inflow to LESP based on Column (6), total pond catchment area, and curve number of 90.
(10) Estimated evaporation outflow from LESP = Pan Coefficient x Evaporation Factor x Column (7) x Storage Pond Surface Area. Pan coefficient = 0.7 (October - April), Pan coefficient = 1.0 (May - September). Evaporation factor = 0.70.
(11) Estimated percolation outflow from LESP. Percolation can be 1.3 - 2.9 x10-6 cm/sec. Percolation in the water balance was based on the lower percolation value.
(12) Recycled water to storage at either LESP or Pond #7 for golf course irrigation.
(13) Change in stored volume in LESP = Effluent (8) + Precipitation (9) - Evaporation (10) - Percolation (11) - Recycled Water Conveyed to Pond #7 (12).
Negative value represents emptying of LESP. Storage ponds fill October through March.
(14) Effluent storage requirements. Pond volume assumed to contain 0 acre-ft at the beginning of October.
(15) The LESP has a volume of 172 ac-ft at a 4 ft freeboard from the dam crest. Volume of water exceeding the 172 ac-ft volume will be stored in either:
(a) The Upper Effluent Storage Pond (UESP) which will serve as a dual purpose pond, providing treated effluent storage and emergency storage for non-compliant effluent.
Per Title 22 , Article 20, Section 60341, long-term storage used as a reliability feature, providing emergency storage, must provide at least 20 days of storage. The District's maximum month flow during an average year is about 0.34 mgd.
At this flow, the District would need about 21 ac-ft of emergency storage. The UESp has a capacity of 49 ac-ft. This leaves about 28 ac-ft for storage of flows exceeding LESP capacity.
(b) Boards will be installed around the LESP spillway to reduce the freeboard and increase capacity. An additional 49 ac-ft will be available. The District will need to notifiy the DSOD prior to this operation.
(16) Recycled water conveyed from LESP to Pond #7. Equal to Column (12).
(17) Raw water conveyed to Pond #7 to supplement recycled water.
(18) Estimated precipitation inflow to Pond #7 based on Column (6), total pond catchment area, and curve number of 66.
(19) Estimated evaporation outflow from Pond #7 = Pan Coefficient x Evaporation Factor x Column (7) x Pond Surface Area. Pan coefficient = 0.7 (October - April), Pan coefficient = 1.0 (May - September). Evaporation factor = 0.70.
(20) Total water used for irrigation of the golf course. Equal to Column (12).
(21) Change in stored volume in Pond #7 = inflow from LESP (16) + Raw Water (17) + Precipitation (18) - Evaporation (19) - Recycled Water Use (20). Pond #7 is always full.
(22) Pond #7 volume. This pond is not a storage pond. It is the surface water discharge point and is always full.
(23) Volume of the surface water discharge from Pond #7.
(24) Estimated irrigation rate based on historical golf course reycled water and raw water use from 2007 - 2009.
(25) Pond Turnovers: Pond volumes of raw water and precipitation after recycle water deliveries cease; recycled water in Pond displaced by raw water and precipitation without mixing. NA = not applicable (no turnovers)
(26) Recycled water as percent of water discharged from Pond #7. NA = not applicable (no discharges)