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Consumptive water use at the Mirage Hotel and the Mandalay Bay Resort & Casino in Las Vegas, Nevada

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Abstract

The Las Vegas Valley is one of the driest regions in the southwest United States. Due to limited water supplies from the Colorado River, rainfall, and groundwater sources, the water requirements of the valley's growing population is slated to surpass the current available water supply. The purpose of this comparative study is to quantify the amount of consumptive water used at a major Las Vegas resort/casino in one year. This, being of importance, because of the resort/casino industry's role as one of the largest, most visible, and most resource intensive industries in the Las Vegas valley. The goal of this project is to study the impact of this industry's consumptive water usage on the overall water availability in the Las Vegas valley. This project was completed by researching case studies and reports of water use in related industries, water consumption and sewer outflow records, and water conservation literature. The results of the study show that consumptive water use at the Mirage Hotel and the Mandalay Bay Resort & Casino is much less than previously estimated, concluding that the impact this industry makes on the available water supply for the Las Vegas valley is also much smaller than previously estimated.

I. Introduction

Southern Nevada is facing a potentially serious situation. With the population of the Las Vegas metropolitan area continuing to grow at a seemingly unrestricted rate, the valley is facing a looming shortage on water, its most precious resource. The 1922 Colorado River Compact apportioned 7.5 million acre-feet/year (MAFY) of Colorado River water to the lower basin states, consisting of Wyoming, Colorado, Utah, Nevada, New Mexico, Arizona, and California. Southern Nevada was later apportioned to use 300,000 acre-feet/year of that water in 1928 by the Boulder Canyon Project Act (Southern Nevada Water Authority [SNWA], 2002). At the time this seemed very reasonable, the population of Las Vegas was less than 5,000 and groundwater wells were adequately supplying the needs of the local community (SNWA, 2002). With current water consumption trends and the current population of Las Vegas exceeding one million and growing (University of Nevada, Las Vegas, 2000), the original 300,000 acre-feet of Colorado River water is no longer adequate to supply the needs of the population. According to the Southern Nevada Water Authority (SNWA) 2002 Water Resource Plan, the city of Las Vegas alone almost consumes that entire amount. Population growth rates have consistently outpaced predictions, as the Colorado River apportionment wasn't expected to be fully utilized until 2007 (SNWA, 2002).

In addition to the full utilization of Colorado River water, many groundwater wells throughout the valley are also being exploited to near 100% capacity (SNWA, 2002). Adding another degree of complexity to the problem, population growth models predict the number of valley residents to reach two million by the year 2012 (UNLV,

2000). If the valley's limited water supply is under heavy stress now, how will it fare when the number of people vying for their fair share of it doubles?

With an average annual rainfall of only four inches, the majority of water used by valley residents and industries is supplied by Lake Mead via the Colorado River (SNWA, 2002). With very few other significant sources for water available in this desert region, dependence on Colorado River flows for the water supply is very heavy. It is unlikely that the 300,000 acre-feet/year apportionment for Southern Nevada will change. This would require approval from the Secretary of the Interior, and possibly other states in the lower basin to give up portions of what was apportioned to them. With recent lower-than-average snowfalls in the Rocky Mountain range that supplies the Colorado River; other western states are also feeling the effects of water shortages. This essentially means that the amount of water the Las Vegas valley has access to may not substantially increase in the near future.

This is where the importance of water conservation and Lake Mead return-flow credits come into play. With conservation practices, the focus is shifted to increasing the efficiency of the current water usages in the valley, instead of attempting to acquire additional supplies to meet growing demands. With successful conservation measures, the current 300,000 acre-feet/year available supply can be efficiently "stretched" to accommodate the needs of the current population and for expected growth. This can allow for continued growth while retaining the standard and quality of living that the valley has experienced thus far. This can be achieved without having to rely on new sources of water being obtained, which can be both difficult and expensive. Conservation practices can include: implementing the use of water efficient technologies in industrial

and household equipment and appliances, reducing water waste from inefficient landscape irrigation, reducing water demands by limiting non-drought tolerant landscaping, and reducing evaporative loss from outdoor decorative water fountains and features.

In discussion of Lake Mead return-flow credits, by returning domestically used water to Lake Mead through the Clark County Water Reclamation District's (CCWRD) system of sewer lines and treatment facilities, the valley is given water return-flow credit against what has been withdrawn from Lake Mead. This system is crucial to providing an adequate supply of water because it allows Nevada to exceed the 300,000 acre-feet/year withdraw limit, provided that the amount of treated water returned to Lake Mead through the CCWRD equals or exceeds the surplus that was withdrawn. This system of "borrowing" water from the Colorado River, combined with progressive conservation efforts, are some of the keys to sustaining adequate water supplies in the valley without having to acquire additional water from outside sources.

Knowing how and where water is used is helpful in learning and understanding the impact of water conservation practices and the potential water saving results of conservation measures. This study will specifically look at consumptive water use in two of the largest resort/casino properties in the Las Vegas valley. This industry has been chosen because it is one of the largest, most visible, and most resource intensive industries in the Las Vegas valley. The purpose of this study is to quantify the consumptive water usage of the Mirage Hotel and the Mandalay Bay Resort & Casino. Studying the water usages of these properties can lead to insight on how water usages in this industry impact the available water supply of the entire valley. This information can

then lead to a better understanding of how effective allocation of water resources throughout the valley's industries and residents can help in preserving a long-term sustainable water supply.

The remainder of this research study is organized and presented in the following format. Section II discusses important literary sources on consumptive water use and general water usages in various resort and related industries. Section III describes the methods used for data collection in this study and how they were designed and implemented. Section IV presents the results of the data collection. Section V discusses the relevance of the results and their relationship to the original hypothesis.

II. Literature Review

There has not been extensive research done on the specific water uses that exclusively account for consumptive water use in the resort/casino industry in the Las Vegas valley. Private properties, such as the Mandalay Bay Resort & Casino and the Mirage Hotel, retain the ability to use water for purposes it deems beneficial, so long as it does not violate the condition of service rules set forth by the LVVWD. These rules mainly address the irresponsible and non-beneficial use of water that is allowed to flow or spray off of the property creating a wasteful condition (SNWA, 2002). These rules don't set guidelines for what the water can be used for; this is the discretion of the property owners.

Within recent years, major construction projects in the Las Vegas valley that receive water from the LVVWD and that incorporate large constructed bodies of water have been required to submit detailed plans for proposed water consumption to the LVVWD (Montgomery-Watson, 1996). This requirement has been, in part, to document and study the efficiency in the local water usages. These water-use reports are intended to provide a complete breakdown of the many water uses intended on the property, including both indoor and outdoor total usages. A report of this nature provides important insight on the many water uses of a large resort/casino property and offers a guideline for creating a water use profile that can be applied to other similar properties. The Mandalay Bay Resort & Casino submitted its report in February 1999, the Mirage Hotel in December 1993. Both of these reports offer information on intended water uses on the respective properties. These reports have been studied, along with total water demand data from the LVVWD and total sewer outflow from the CCWRD, to calculate the total

consumptive water use on each property. For the purpose of this research study, consumptive water use is defined as water supplied to a property by the LVVWD that does not leave the property through the CCWRD sanitary sewer system.

Case studies have been done on other related properties in the resort/hotel industry as well, that look at just total water use. This includes studies done in New Mexico at the Marriott Hotel, La Vida Llena Lifecare Retirement Community, and the Hillcrest Park in Albuquerque in 1997 (New Mexico, 2001). These studies have all looked at water conservation methods as applied to the needs and goals of the individual properties. With the exception of the Hillcrest Park case study, these studies looked at both indoor and outdoor water use, and didn't specifically consider consumptive use in the total water usages.

This resort/casino study is different because it is focused only on properties in the Las Vegas valley; more specifically in the resort sector know as the Las Vegas strip. The reason for focusing on consumptive use in this specific setting is to study the impact of a resort/casino's water use on the total available potable water supply for Southern Nevada. Total water use is considered but not the main focus because total use is not proportional to water returned to Lake Mead through the CCWRD and the Las Vegas Wash, and therefore is not counted against the amount of water southern Nevada has been apportioned from the Colorado River.

Borrowing from research techniques and ideas in the New Mexico case studies and the LVVWD water efficiency reports, an analysis of expected water uses and requirements for the Mirage Hotel and the Mandalay Bay Resort & Casino are the keys to understanding their consumptive use. There were three major areas in which reoccurring

consumptive water use was noticed in related case studies: landscape irrigation systems, evaporative loss from water features, and evaporative loss from cooling tower operation. Therefore, the consumptive water use profiles will be generated taking these usages into account.

The reason that the bulk of consumptive water use is attributed to the above three sources is simple. When applied to one of the resort/casino properties, each source requires a significant inflow of water that generally results in a much smaller contribution to total sewer outflows, meaning that the water is consumed on-site. This is important because not only does the water not leave the property, but by doing so it doesn't contribute to Lake Mead return-flow credits either. This is the true measure of consumption.

The first of the consumptive uses being studied is water used for landscape irrigation systems. This usage is easily identified as consumptive because water sprayed onto turf grass, shrubs, trees, and other vegetation is absorbed by the soil and plant roots. There isn't an opportunity to re-capture or re-use this water; it is essentially gone from the system. The New Mexico case studies identified outdoor landscaped areas as prime locations for reducing water usage, as well as water waste (from poorly designed landscapes or inefficient watering practices).

The second of the major consumptive uses is evaporative loss from outdoor water features. In related studies this was commonly identified as a source for potential water conservation. With summer season temperatures in the Las Vegas valley regularly exceeding 100 degrees F, evaporation from exposed swimming pools, spas, fountains, and other features can easily contribute to consumptive water use. Based on average

weather conditions in Southern Nevada, the SNWA uses 9.4 feet/year as the average evaporation rate from exposed water surfaces (Dudek & Associates, 2001). This corresponds to approximately 70.3 gal. /year of evaporative loss per square foot of exposed water surface.

The third major consumptive water use to be considered is water lost through the operation of evaporative cooling towers. These cooling towers provide the means for air conditioning each property and are often large water consumers. Cooling towers are designed to use evaporating water to remove heat. This process works by exposing circulating water to an air flow, thus removing heat when some of the water is evaporated. A heat exchange can then occur when the cooled water is sent through an air conditioning unit. The heated water is then re-circulated through the cooling tower again, and the cycle continues. This procedure requires the evaporation of water for the transfer of heat, and this is where consumptive water usage occurs (New Mexico, 2001). Evaporated water, similar to water used for landscape irrigation, is essentially lost and cannot be re-gained and re-used.

As stated earlier, the purpose of this research study is to quantify the annual consumptive water use at major Las Vegas resort/casino properties, specifically the Mirage Hotel and the Mandalay Bay Resort & Casino. Based on initial information gained through researching total and consumptive water use in related industries, it is hypothesized that the consumptive water use on these properties will account for less than fifty percent of the total water delivered by the LVVWD.

III. Methods

The first step was to determine which properties within the resort/casino industry in Las Vegas are suitable for studying. There are several factors that influenced selection. The ideal property was to be located along Las Vegas Blvd., between Russell Rd. and Sahara Ave., in the city of Las Vegas, Nevada. This specific location has been chosen because it contains a high density of resort properties that are among the largest, most popular, and busiest attractions in Las Vegas, thus requiring considerable supplies of water. This ideal property will have a minimum of 3000 hotel rooms, to ensure that its large size allows for a diverse profile of water usages. The ideal property will have outdoor water features as well as extensive landscaping features. The last requirement is that the property must have been built within the past 10 years. This is to ensure that the property is a fairly new resident of the Las Vegas valley and is therefore required to submit a water efficiency report to the LVVWD, detailing expected on-site water usages and requirements. There are two properties that have met the above requirements and will be studied, the Mandalay Bay Resort & Casino and the Mirage Hotel.

With the specific properties chosen for study, the next step was to determine basic land use characteristics of each site. ArcView GIS software was used to examine the layout of the Mandalay Bay Resort & Casino and the Mirage Hotel. The information required was the total area that each property encompasses, including analysis of the land use characteristics, such as the total area of all buildings, parking lots, outdoor water features, landscaped areas, etc. The data on total area of buildings and other structures was used to examine ratios of developed vs. undeveloped lands. This is to compare the size of areas that consume water to those that do not. The areas of outdoor water features

and landscaped areas was used to calculate the amount of water lost yearly due to evaporation, as well as estimating the watering requirements of various landscaped areas on the property.

The next step was to examine LVVWD records to determine current and past water use histories of each of the properties. This was to record the total amount of water supplied to each property by the LVVWD through metered pipelines. The water use history was used to calculate monthly and seasonal changes in water use as well as calculating comparisons of water use during peak and off-season tourism.

The next step was to contact the CCWRD to inquire about sewer outflows and sewer billing of the specific properties. This information was used to quantify the amount of water flowing out of each property through the sanitary sewer system. Inquiries were made on the exact method for determining the amount of sewer outflow at each property. This information, along with the LVVWD records that show total inflow, was used to estimate an amount of water consumed on-site.

Next, these results were compared with the results of the ArcView study. The next step was to use the information gained through LVVWD records, CCWRD records, and ArcView to create a water use profile that calculated total water use, total sewer outflow, and total consumptive water use. Comparisons were made on the estimated vs. actual total water use, as well as comparisons on total water use vs. consumptive water use. This water use profile for each property serves as an estimate on consumptive and total water use, related to land use characteristics.

IV. Results

The results of the data collection are organized in the following tables: (1) land use profile, (2) and (3) total water inflow/outflows for each property, (4) estimated annual consumptive use, and (5) calculated consumptive water use. The calculated consumptive water use is comprised of total water used for: outdoor irrigation, outdoor water features, and cooling tower usage.

Table 1: Land Use Profile

	Estimated total property area	Area occupied by landscaping (turf, trees, and shrubs)	Area occupied by pools and water features
Mirage Hotel	3,920,400 sq. ft. (approx. 90 acres)	609,840 sq. ft. (approx. 15.55 % of total area)	36,300 sq. ft. (approx 0.92 % of total area)
Mandalay Bay Resort & Casino	3,049,200 sq. ft. (approx. 70 acres)	433,546 sq. ft. (approx 14.20 % of total area)	72,662 sq. ft. (approx 2.96 % of total)

This table provides a general look at the ratio of land use types vs. total property size that characterizes each resort/casino property. This information was obtained through ArcView GIS analysis and examination of the water efficiency reports for each property.

Table 2: Estimated Water Inflow and Outflow

	LVVWD inflows, 2/2002-2/2003	Average annual CCWRD outflows (estimated)	Estimated average annual consumptive use
Mirage Hotel	366,825,000 gal./year	385,075,000 gal./year	-18,250,000 gal./year
Mandalay Bay Resort & Casino	306,059,000 gal./year	538,375,000 gal./year	-232,316,000 gal./year

This table provides a general overview of the amount of water that each resort/casino property receives from the LVVWD and the estimated amount that passes through their respective systems and on to the CCWRD water treatment process. The difference between inflow and outflow is the initial estimated consumptive use. Inflow records were obtained through the LVVWD water consumption data for each property, recorded by metered pipelines. Outflow records were obtained through CCWRD estimations on average flow rates multiplied by the total number of water fixtures on the property.

Table 3: Annual Consumptive Water Use Profile, Mirage Hotel

Landscape Irrigation	22,605,073 gal./year
Water Feature Evaporative Loss Swimming Pools-- Dolphin Habitat--	 1,778,590 gal./year 773,300 gallons/year
Estimated Cooling Evaporative Loss Hotel Cooling Tower-- Dolphin Habitat Cooling Tower-- Kitchen Evaporative Cooler--	 54,662,400 gal./year 1,010,320 gal./year 1,401,600 gal./year

Table 4: Annual Consumptive Water Use Profile, Mandalay Bay Resort & Casino

Landscape Irrigation	16,696,983 gal./year
Pools and Water Feature Evaporative Loss	5,108,138 gal./year
Estimated Cooling Tower Evaporative Loss	59,130,000 gal./year

Tables 3 and 4 present the breakdown of the three major consumptive water usages at each of the resort/casino properties. This information was calculated through examination of the water use efficiency reports submitted by each property.

Table 5: Measured Total Consumptive Water Use

	Measured Total Annual Consumptive Water Use	Corresponding Percent of LVVWD Inflow
Mirage Hotel	82,231,283 gal./year	22.41 %
Mandalay Bay Resort & Casino	82,186,110 gal./year	26.85 %

Table 5 displays the calculated total consumptive water use at each property, taken from Tables 3 and 4, compared with the corresponding LVVWD inflow.

V. Discussion

The main focus of this section is the relationship between the total amount of LVVWD water flowing into each property and the amount flowing out through the CCWRD sewer system. This discussion chapter is divided into five sections, each corresponding with its respective table in the Results chapter.

Table 1 illustrates the land use profile for each property. This information is useful for gauging consumptive water use in relation to land use characteristics. These figures can also be used in comparisons for water uses on non-resort properties. This table shows that the amount of area occupied by landscaping and outdoor water features is very small, in comparison with the total land area of each property.

Table 2 shows the measured amount of the total LVVWD supplied water passage through each resort/casino property in a one year period, during February 2002 to February 2003. It also displays the estimated amount of annual sewer outflow for each property. This figure is calculated by the CCWRD using standard formulas regarding expected water use for indoor domestic water use. The difference between the inflow and outflow amounts was expected to give a rough estimation of on-site consumptive use. This proved to be an unreliable method, as in both cases outflow estimations far surpassed the amount of inflow. Possible reasons for this include sewer outflows that vary from the estimated amounts, and a possible increase in the amount of groundwater rights (if any) that each property may have recently obtained. The sewer outflow estimations are calculated for each hotel based on maximum occupancy and maximum use of hotel facilities, which usually only occurs during peak tourism and convention seasons. An addition of water from a non-LVVWD source would also skew the total

amount of inflow, possibly affecting outflows if the groundwater were used for domestic purposes. Based on the water efficiency reports submitted by each property, the Mirage Hotel doesn't receive any additional water from groundwater sources, and the Mandalay Bay Resort & Casino receives approximately 2.86 acre-feet/year.

Table 3 provides a consumptive water use profile for the Mirage Hotel and Table 4 provides a consumptive water use profile for the Mandalay Bay Resort & Casino. Each table is comprised of the three major consumptive water uses typically found in an industry of this nature. Both tables illustrate the amount of calculated consumptive water use at each property, a significantly different amount than shown in Table 2. These amounts were calculated using industry standard estimations and formulas found in the water efficiency reports. The estimated evaporative loss for cooling tower usage was calculated using the following formula: 3 gallons per minute per 100 tons cooling capacity, at an annual average operational capacity of thirty percent.

Table 5 shows the comparison of total LVVWD supplied water and total consumptive use, as calculated by the water use profiles shown in Tables 3 and 4. In both cases consumptive water use accounted for less than one-third of total water received. This also shows that greater than two-thirds of the total water received passed through the property and moved on to the water treatment facilities of the CCWRD, which will eventually garnish additional Lake Mead return-flow credits. In comparison, average single family homes in the Las Vegas valley can use between 60-90% (of the total water delivered by the LVVWD) on outdoor irrigation alone, depending on seasonal weather conditions (SNWA, 2002). That use is entirely consumptive and does not generate Lake Mead return-flow credits. SNWA calculations estimate that sixty-five

percent of the 300,000 acre-ft. /year Southern Nevada apportionment supplies residential properties, with just ten percent flowing to resort/casino properties (SNWA, 2002). Assuming the calculations in Table 5 are correct and assuming the Mirage Hotel and the Mandalay Bay Resort & Casino are representative of common water uses in the entire industry, that could mean that of the ten percent flowing to resort/casino properties, less than one-third is actually consumed.

VI. Conclusion

In summary, while both the Mandalay Bay Resort & Casino and the Mirage Hotel have total water usage characteristics that appear staggering, the overall effect that their water use has on the availability of water resources of the entire Las Vegas valley appears to be very small. With the consideration of Lake Mead return-flow credits, data at this point shows there is a great difference between total and consumptive water use at these properties. When looking at other related resort/casino properties in Las Vegas, the same principles can be applied. Close examination of water use characteristics on individual properties can give much greater insight on exactly how great the impact is on total available water resources.

Understanding and considering consumptive water use in the Las Vegas valley is one of the keys to managing water resources in a responsible manner. It also provides a guideline for water conservation efforts by revealing where the greatest amounts of consumptive water are being used, and where the greatest water savings can be made with the least amount of cost and effort. In conclusion, the original hypothesis has been supported. The consumptive water use at both the Mirage Hotel and the Mandalay Bay

Resort & Casino was found to be significantly less that fifty percent of the LVVWD supplied water.

References

Bennett, Doug. (2002-2003). Conservation Manager, Southern Nevada Water Authority. Interview.

Braga, BPF. (2001). Integrated urban water resources management: a challenge into the 21st century. International Journal of Water Resources Development, 17 (4), 581-599.

California University, Berkley. (1982). Municipal and domestic use. Competition for California Water, alternative resolutions. University of California press: Berkley, CA. 37-58.

Dudek & Associates Inc. (2001). Water efficiency report, Wynn resort "A". Anaheim, CA: Dudek & Associates.

Flack, J.E. (1981). Residential water conservation. Journal of the water resource planning, and management division, processings of the American society of civil engineers. 107, 85-95.

Gunatilake, HM, Gopalakrishnan C., & Chandrassena, I. (2001). The economics of household demand for water: the case study of Kandy Municipality. International Journal of Water Resources Development. 17 (3), 277-288.

Gysi, M; Lamb, G. (1977). An example of excess urban water consumption. Canadian journal of Civil engineering. 4 (1), 66-71.

Hunt, David. (2002). Conservation Programs Coordinator, Southern Nevada Water Authority. Interview.

Kobrick, J.D., Black & Veatch. (1993). Water Management Study: The Mirage Hotel. Las Vegas, NV.

Martin & Martin, Inc. (1999). Mandalay Bay Resort & Casino: Water Efficiency Report. Las Vegas, NV.

Montgomery-Watson. (1996). New York, New York Hotel and Casino: Water Efficiency Report. Las Vegas, NV.

New Mexico Office of the State Engineer. (2001). A water conservation guide for commercial, Institutional and industrial users. Albuquerque, NM: Schultz Communications.

Southern Nevada Water Authority. (2002). 2002 Water resource plan. Las Vegas, NV: Southern Nevada Water Authority.

University of Nevada, Las Vegas. (2000). Clark County Nevada Population Forecast 2001-2035. Las Vegas, NV: Center for Business and Economic Research at University of Nevada, Las Vegas.

Vickers, Amy. (2001). Handbook of water use and conservation. Amherst, MA: Water Plow Press.

Williams, M; Suh, B. (1986). Demand for urban water by customer class. Applied Economics APPEBP. 18 (12), 1275-1289.