

Engineering Sustainable Water Consumption in the Western Part of the U.S. Casinos

Shammah J. Joseph

Advanced Technologies Academy

ABSTRACT

In recent years the frequency of the term sustainability has increased in both literature and pop culture, specifically regarding the environment. With Casinos utilizing hundreds, sometimes thousands, of gallons of water daily, the sustainability of their methods is often questioned. With the rise in innovations, existing studies tend to be outdated and usually lack content about initiatives made by engineers in sustainable systems, showing the need for research analyzing these gaps. This study defines sustainability according to engineers both working in the field and retired, as well as their insight on the efficacy of current sustainability initiatives in casinos. With a total of 6 interviews, this paper defines sustainability as the utilization of resources without jeopardizing the future generation's ability to utilize the same resources. It is uncovered how water is withdrawn from Lake Mead and most, if not all, is restored through the use of a credit system (defined in this paper). Plants across the valley ensure water is adequately cleaned and recirculated in Lake Mead to ensure Vegas' thus far outstanding credit is maintained. Recent laws have been passed completely banning the future construction of golf courses or long landscapes for sustainability. Casinos are under the same scrutiny and regulation of water consumption as residential consumers; they are required to limit landscaping and cooling systems that could potentially expend water in a way that cannot be reclaimed. This paper explains the effectiveness of water consumption procedures in Casinos to combat water depletion in the Las Vegas Valley.

INTRODUCTION

When it comes to Lake Mead and the Colorado River, there is no doubt that water resources are depleting at an alarming rate. In fact, according to the United Nations Environment Program (2022), two of the largest water reserves supplying water to the United States are at risk of deadpool status (no longer functioning). As a result, many wonder, where is all this water going? Regardless of the population growth and the natural climate disposition of the various geolocations lining Lake Mead, why are the surrounding states—Arizona, California, Nevada, and parts of New Mexico—not able to recoup the water lost? Analysis of this question has pointed to various things, many of them already being addressed by the state's regional water authorities. However, one discrepancy found in various studies is in their ability to not only account for the local population's water consumption but accounting for the water consumed by the thousands of tourists that flow through the cities each day.

For example, Nevada, with its city of Las Vegas booming in the gaming (gambling) industry, relies largely on its tourist population (Lang, 2011). Gambling in Las Vegas Casinos has been one of the biggest financial investments of Las Vegas' economy and in return provided immense revenue for the city (Lang, 2011). With this in mind, the hundreds of tourists as well as all the water attractions these casinos operate (for example, the Bellagio fountain) require a water source, and this source is primarily (90%), Lake Mead (Garcia, 2018). While water depletion is at an increasingly high rate, cities like Las Vegas do not have the option of cutting out key operations such as casinos, which leads people to point to them as a large cause of the problem. With this in mind, it is currently in our best interest to study the effectiveness of the strides that casinos in the Western part of the U.S. are taking to be more water sustainable.

LITERATURE REVIEW

To investigate this research question about the effectiveness of the strides that Western casinos are taking to be more water sustainable, it is predominantly important to understand why water scarcity is such an immensely important issue and why it is the focus of this study. It goes without saying that the great lakes/ivers of America are ecologically significant in sustaining various types of wildlife and organisms, crucial to a balanced ecosystem. The Colorado River actually has native endangered species that have only been put in further danger due to the fluctuation of temperatures (Bestgen, 2008). Not only does the ecosystem rely on the success and stability of Lake Mead and the Colorado River, but so does society. In fact, around 40 million people in America rely on the water resources stored and generated by the Colorado River alone (Wheeler, 2022). The reservoir known as Lake Mead has been shown to sustain nearly 25 million with its water resources (Edalat, 2019). An important factor to note is that Lake Mead is a man-made reservoir that stemmed off of the Colorado River once the Hoover Dam was completed (Weber, 2018). Therefore, Lake Mead and the Colorado River go hand in hand because water depletion in one directly impacts water levels in the other. Despite the intense reliance humanity and the ecosystem have on the Colorado River and Lake Mead, these bodies of water are not flourishing or even as stable as one would hope. The status of water resources is actually at a historic low. In fact, by the end of 2022, two of the largest reservoirs in the U.S. (one being Lake Mead) have gone from 95% full to 25% full (Wheeler, 2022). The effects of this drop have been substantial with states like California having experienced their most drastic drought in 200 years (Edalat, 2019). There are countless statistics showing the decline in water levels, forcing all reasonable environmentalists and scientists to conclude that water levels are currently at critical levels.

The consequences of water scarcity are often drastic because it not only affects the individual's level of healthy water consumption, but it directly impacts the environment. Studies have actually shown that ecological disaster and water scarcity go hand in hand. The occurrence of natural disasters and extreme hydrological events poses a threat to water security as well as agriculture and food production (Qing, 2020). This is not to mention the catastrophic effects that weather events have in rural areas. When disasters occur, they can destroy or contaminate whole water supplies, making them disease-ridden and unsafe (UNICEF, 2021). These contaminated water supplies can contain typhoid and even cholera, to which children are particularly susceptible (UNICEF, 2021). When water-related natural disasters occur, they not only affect the environment but also the people residing in the environment.

This type of dangerous water contamination is not only visible in rural areas but there have been clear cases in urban locations, such as casinos and hotels. In just May of 2017, an article titled “Cryptosporidiosis Outbreak Associated With a Single Hotel” was published in the *Journal of Environmental Health* by Mary-Margret A. Fill and various others working in centers of public health and disease control, in which they details their in-depth investigation into what spread a gastrointestinal illness to a group of baseball attendees (Fill, 2017). They concluded that it was a hotel pool that everyone who was diagnosed was at some point in contact with. Even more recently, in 2019, a paper was published titled “Legionnaires’ Disease at a Hotel in Missouri, 2015: The Importance of Environmental Health Expertise in Understanding Water Systems.” This paper detailed how the pool lacked various documentation of maintenance and how, when tested, the pool had ideal conditions for sustaining the disease *Legionella* (Ahmed, 2019). All these cases go to show that even in modern times, cutting corners in efforts to ‘save water’ can be immensely dangerous. This paper will analyze how casinos in the Western part of the U.S. go about conserving water while not jeopardizing public health and safety.

Finally, it is important to understand the contingencies of effective water usage in Western Casinos. It has already been stated that in modern society, water is no longer merely used for hygiene or plumbing, but for additional aesthetic purposes (Sedighi, 2017). This includes casinos as tourist attractions. The concept that “tourism both depends on clean water and exacerbates water problems” can be seen through these aesthetic aspects of casinos (Moyle, 2022). For the sake of public health and safety, the water used must be clean and because of this excess use of clean water in tourist attractions instead of home taps, water insecurity is exacerbated. Adding to this, Western cities have no shortage of water attractions for visitors to see; from the Bellagio Fountain shows to Treasure Island’s show (Siren’s Cove) to

Cirque du Soleil's O show, thousands of gallons of water resources are expended every week. This again leads us back to the question of how U.S. casinos in the West are taking into account water scarcity and making their consumption more sustainable.

Water scarcity is a very present issue in this modern world. While every measure to save water can make a difference, when it comes to expending resources on advertising and spreading awareness, it is crucial to focus on what matters. The purpose of this research is not only to bring awareness to the current situation of water scarcity but to bring awareness to the main contributors to water scarcity. It not only brings attention to the sustainability of casinos but portrays them in a more accurate light. Current research circulated in the field of discussion focuses strongly on the statistics and involves heavy qualitative research like the sources used above. While this is beneficial to have, to further the discussion researchers need to look at new perspectives and lens. Currently, they are seen as constantly wasting much-needed water to appease tourists and visitors, while residents face the consequences. However, this may not be true. Through this research, water conservation methods can be more effective, in turn, slowing the current rapid rate of water depletion.

In order to proceed with the findings, readers should understand *sustainability*: a term used throughout this paper. The consumption of a resource is sustainable if it is capable of lasting for a long time without negatively impacting the environment or future generation's ability to use the same resource. This definition was a synthesis of statements made by all the participants when they were asked about their definition of sustainability.

METHODOLOGY

In order to answer the questions, a research method of semi-structured interviews interpreted through relational content analysis was implemented. Interviews are a method of research that allows for a better understanding of a phenomenon through direct inquiry (Virginia Tech, 2018). These interviews utilized open-ended questions that encouraged in-depth responses from the participant to better understand their opinion on the topic. A primary goal of this method was to better understand the different perspectives on water consumption and sustainability between different parties involved in the sustainability efforts (from the employee to the engineer). This was interpreted alongside the primary goal of understanding the efforts made by engineers in ensuring the effectiveness of sustainability methods as well the things that impede their efforts.

Participant Selection

In order to collect accurate data on the water sustainability methods and whether they fulfill their purpose, it was necessary to interview individuals from a variety of fields. Initially, the aim was to get a majority of interviews from professionals in the field. From there, a target group of water transportation-related careers was chosen. After that, the search narrowed down to individuals that work with water sustainability and from there, to individuals who at some point worked on casino projects. This would give them expert knowledge to accurately explain water sustainability phenomenon and terminology, as well as give input on specifically Casino water consumption. These individuals ranged from environmental engineers to civil engineers working in water transportation.

The selection of participants for this study was an extensive portion of the research process considering the specificity of the research question. First, starting with a broad pool, the possible participants were narrowed down to those who had been licensed engineers for at least 5 years - for those being questioned as experts. From there, the participants were narrowed down to those with some experience with water resource usage or management, for both the experts and the employees. From there, they were narrowed to those who have worked in Casinos, whether directly or indirectly. Because only one participant was currently employed in the Casino, it was a goal that the engineers be versed in Casino related operation so they could provide data that made up for the minimal employee feedback.

Semi-Structured Interviews

Semi-structured interviews are formal interviews in which the interviewer walks in with a rough guide as to how they plan to approach certain discussions (RWJF, 2008). Appropriately, the researcher may stray away from the guide when a relevant topic arises in the interview and may follow up with an adjusted line of questioning (RWJF, 2008). For these interviews, due to the various qualifications of participants, questions were adjusted to better fit the knowledge and capabilities of the different individuals. For example, different questions were asked to the professionals in water management compared to the employees of the Casino.

When planning the interview structure for all the participants, 4 questions were asked regarding their personal education and occupation, and from there a minimum of 5 questions were asked discussing each segment (such as sustainability) before moving to the next major area. Keeping in mind that these questions are open-ended, in-depth responses were encouraged for each of the 5 questions in order to obtain as much detail as possible about the interviewees' experiences with water sustainability. While semi-structured interviews do not call for chronological order like other interviews, the questions asked in the interviews still followed the structure of building up credibility and addressing pertinent pre-knowledge and then addressing the main issue to help the interviewer and participant follow along.

Relational Content Analysis

Once the interviews were completed and the recordings were transcribed, the research moved to thematic coding. The main purpose of coding is to separate the data into analyzable units (Armbrorst, 2017). This was important for the interviews, seeing as they were difficult to analyze and draw conclusions from in isolation. The codes were then identified (refer to Table 1) based on common themes and concepts in the individual interviews. The statements that were associated with a code were then grouped together with statements with the same code in other interviews and analyzed in context to each other. There are generally considered 5 ways to analyze interview data, but for this study, content analysis was found the most appropriate. Content analysis is a form of interview data analysis that identifies recurring terms and keywords as well as the context in which they are discussed (Columbia University, 2023). For this study, the content analysis method was used to examine the different iterations of water sustainability as well as accurately identify how accurately it is applied in western casinos according to engineers and staff alike. This method was used to analyze the complexities of the responses they gave and to cross-reference them with one another and identify commonalities.

To further define content analysis, there are two primary routes one can take: conceptual analysis and relational analysis (Columbia University). The relational analysis route was chosen for this research question because it does not limit the transcripts to the frequency of codes (key words) like conceptual analysis does (Columbia University). Relational content analysis utilizes both statistical and qualitative data without necessarily being a mixed method (Armbrorst, 2017; Bos & Tarnai, 1999). Relational analysis was ideal for this study because the interviews were the entire portion of the data collected and analyzed and it was important that ample information was deduced from the data.

An important step in this research process is analyzing all the complexities existing in the current field and this is usually done through many interviews. Due to the time constraint, however, the number of interviews conducted was limited and therefore not as representative. To combat this limitation, data collected from the 6 interviews were analyzed in-depth and the conclusions were drawn partially with the use of pre-existing scholarly works (which can be seen in the Discussion section of this paper), which a relational content analysis paper can coordinate without fully converting to a mixed-methods.

While there are other appropriate methods of research, it was found that semi-structured interviews with relational content analysis were the most effective in determining the impediments engineers face. Due to the nature of the different professions, semi-structured interviews were determined to be the most effective method to allow for

the flexibility necessary to inquire about the necessary topics. The grounded theory of analysis was also strongly considered, and while it is more based on data, which could be useful given the nature of the study (relying strongly on data), it is not meant to prove or disprove a hypothesis but more so to initially create one. After thorough research, it was found that content relational-based analysis of interviews would be the best way to analyze the data collected.

RESULTS

In order to fully analyze the data, the codes that consistently arose are listed in the table below along with their corresponding definitions. The codes listed below were compiled from the terms consistently brought up in the interviews by the participants themselves. Each interview collected was around 45 minutes to 90 minutes in duration to ensure ample time was spent on each pertinent topic. From all 6 interviews, a total of 7 specific codes emerged and are listed below.

Table 1: Codes

Theme	Definition
Water Reclamation	The process of reprocessing municipal and sometimes industrial wastewater so it is clean enough to use again for other purposes.
Credit	The process of borrowing a resource from an organization and then paying it back in the assigned periods. If done so, one builds up a good credit score. The resource being borrowed in this case is water.
Landscaping	Any tending to or changing of the visible features of any section of land. Examples include watering plants, planting plants, etc.
Drainage	The method of removing water, oftentimes excess, from an area of land. This can be both artificially through pipes or naturally.
Evaporation	Water in the form of liquid vapor which cannot be consumed or reprocessed. Often occurs in large shallow bodies of water.
Costs	The money expended on certain methods compared to others and the reason why some options are more appealing to residents and building owners.
Filtration/ Quality	The use of primary, secondary, or tertiary processes to filter water. Quality being the standard of which processed water must maintain/reach.

The participants were referred to by pseudonyms to maintain their privacy. Their office of employment was also included as it gives context to how their work relates to the discussion. Their years of experience, job title, and specialty were included to detail the knowledge they have to provide their statements and where they fit in the discussion. It is important to note however that the statements made by the participants in their interviews do not directly reflect their places of employment, but are their educated opinions based on their experiences. A list of all the participants as well as their corresponding credentials were compiled and displayed in the table below.

Table 2: Participant Descriptions

Participant Name	Office	Years of Experience	Job Title	Specialty
Theo	Water Reclamation Office in Western Region	26	Civil Engineer	Design
Ethan	Water Reclamation Office in Western Region	20	Principal Civil Engineer	Design Team Leader
William	Southern Nevada Water Authority	12	Water Engineer	Inspector/Site Analysis
Grace	Western Casino Employee	6	Ground Staff	Waitress
Blake	Water Reclamation Office in Western Region	44	Civil Engineer	N/A
Harper	Stantec Consulting	7	Water & Wastewater Engineer	Process Engineering

The interviews detailed the perspective of educated specialists and a member of floor staff. Their statements were analyzed to determine whether there was a consensus among topics. These concepts were then analyzed and put in categories, also known as codes. By analyzing the recurring codes and the context in which they are discussed, the intricacies of water sustainability impediments in Western Casinos can be determined. The graphs listed under each subcategory depict the frequency of each code in each interview as well as their context.

Filtration/Quality

The theme of filtration/quality as defined in Table 1 is the use of primary, secondary, or tertiary processes to process water for reuse. Quality is a requirement that parallels filtration. In order for filtration to be under regulation and be deemed efficient, the water it produces must reach a certain requirement of cleanliness. Seeing as water filtration and water quality were frequently brought up by the participants, it was classified as a code. The frequency of the term however, was not considered. This is because water filtration is essential to sustainability and there already exists much research and data stating that sustainability and filtration go hand in hand. Counting the frequency and context of this term would serve no purpose in filling the gap because its status is already thoroughly understood. Referring to the frequent instances of health-related issues due to improper filtration, what resulted from those experiences was a standard of water quality to ensure that the safety of the public was ensured.

Water Reclamation

Water reclamation, as defined in Table 1, is the process of recycling water so it can be repurposed (re-claiming the used water). This is the basis for water conservation everywhere, as the participants explained. The ability to continue the cycle of using water and cleaning it allows for the continued preservation of this resource as the participants explained. Water reclamation is a requirement for all districts and jurisdictions that pull water from Lake Mead. As will be explained in the next term, water is essentially only "borrowed", and the repayment of this debt is done through

the reclaiming of water aka water reclamation. Because this term is undisputed and essential to making water consumption sustainable (according to most participants), it was counted as a code. The frequency and content however, like the previous code, were not considered to prevent the reiteration of already understood and undisputed concepts. What was finally concluded from the interviews regarding this term, is that the ability for a district to reclaim water directly impacts their water sustainability levels.

Credit

Defined in Table 1, credit is the trust that is associated with allowing a person or organization to borrow a resource, with the expectation that it will be paid back. The resource being borrowed in this case is water. When this term was discussed by the participants it was always in the context of Western Regions. In addition to this, it was often referred to in a positive light by the participants, even mentioning how western cities had an amazing record in paying back the water they consumed. The frequency of this term as well as synonymous terms are graphed below.

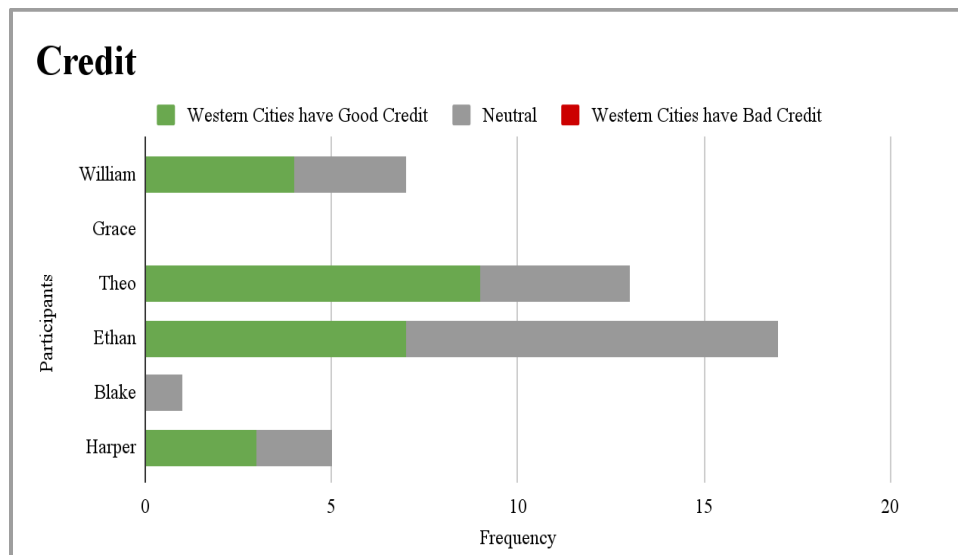


Figure 1: Credit

Through this data it can be understood that credit is under constant consideration of engineers, seeing as it determines their future ability to consume water. One thing to note is that Grace’s failure to mention the term is attributed to her lack of knowledge in engineering terminology due to her alternative field of employment.

Costs

Costs, as defined in Table 1, are the expenses associated with water consumption and sustainability efforts. For example, William works closely with casino managers and warehouse staff to discuss water consumption and wastage. In his interview, he explained how the cost is often an impediment to sustainability efforts. Oftentimes, managers resist improvement efforts for the sake of sustainability mainly because of the large cost associated with it. In a sense, why would casino managers spend money to change systems that already work for the sake of sustainability, especially when it costs them more money than they are willing to spend? As William explained, a compromise is usually found so water can be conserved while maintaining the efficiency of the building. Below is a graph depicting the frequency of the term “costs” and synonymous words.

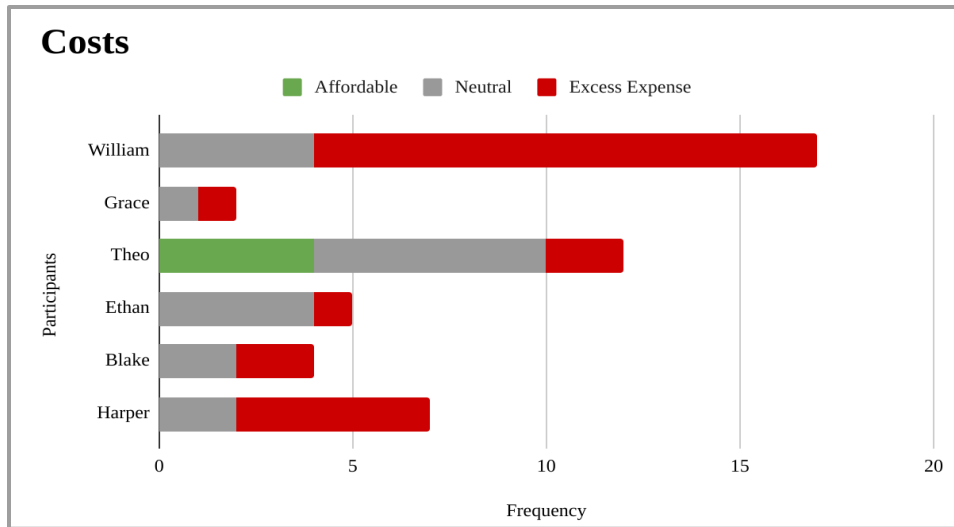


Figure 2: Costs

Through this it can be seen that costs are under constant consideration by not only engineers but also by the casino staff. The dominance of red communicates that costs were often described as an impediment to sustainability efforts and something both engineers and staff have had to work against.

Landscaping

As previously stated, the landscaping theme is identified when a participant brings up anything that involves the tending of land or watering of plants. This was associated with the discussion of things like golf courses, grass, and turf. In terms of golf courses, the responses generally leaned towards their high water consumption and regulations recently formed to limit their development. As Water Inspector William conveyed, golf courses can no longer be built in Clark County per recent regulations. The frequency of ‘landscaping’ as well as terms synonymous to landscaping - such as irrigation and watering - by each participant as well in its context is graphed below.

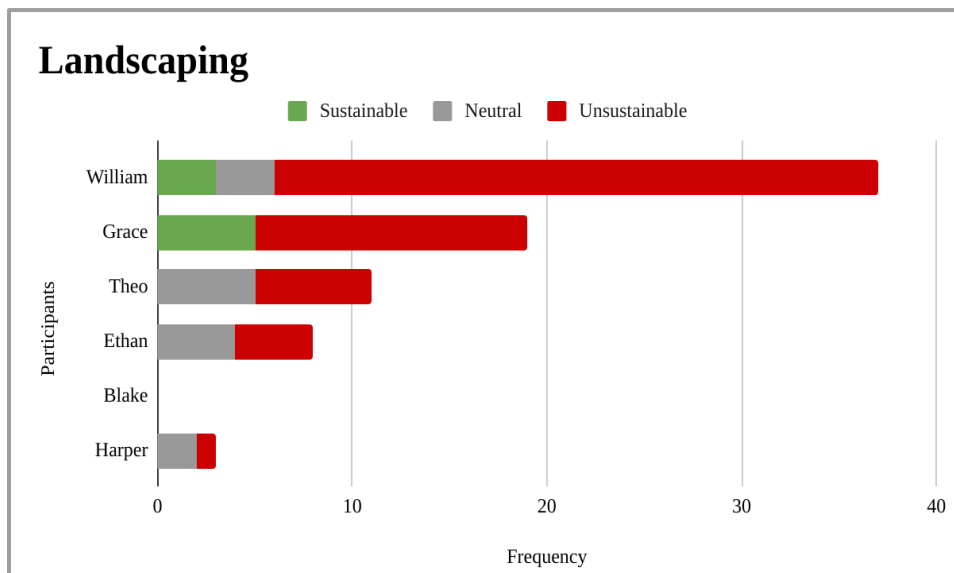


Figure 3: Landscaping

Landscaping is an immense impediment to engineers’ efforts at sustainability. The dominance of red compared to the positive green and neutral grey clearly depicts almost consistent referencing of the term landscaping, and similar terms, as an obstacle engineer have had to overcome.

Drainage in Relation To Gravity

Referring to Table 1, the theme drainage was outlined by any form of water removal from a section of land, in this case, casinos. This also includes things such as sinks, taps, and appliances since water is essentially being removed. When this theme arose, in various interviews the concepts that were brought up included sewage systems, pumps, and the benefits of gravity. In terms of drainage, referring to the interview conducted with Civil Engineers Theo and Ethan, all water that goes down the drain is recycled. It travels, ideally with the assistance of gravity, to plants like the one at the reclamation district office, and gets filtered. Once it is filtered it gets carried to the Wash and then to Lake Mead. The frequency of the terms relating to drainage by each participant as well as the context of their discussion is graphed below.

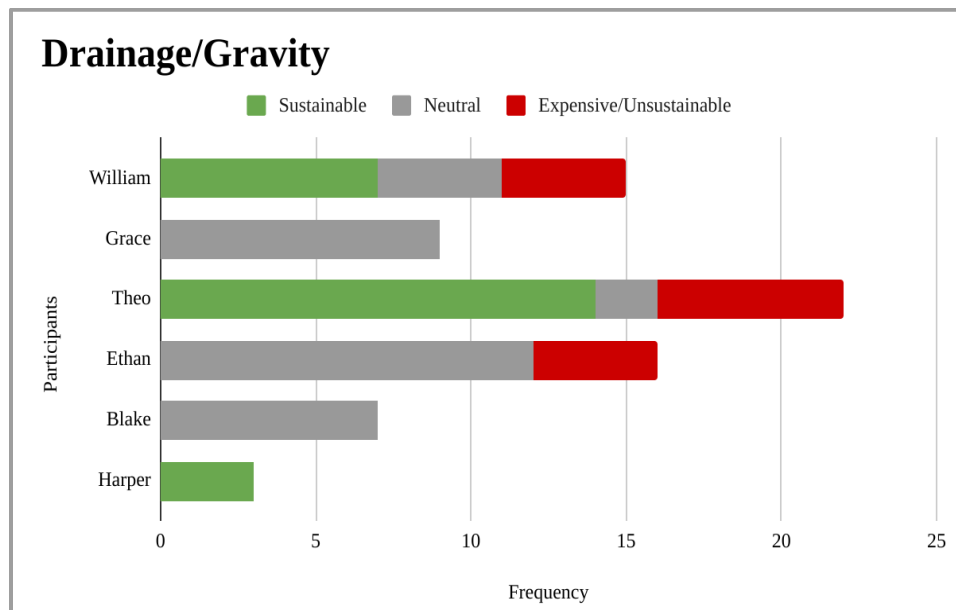


Figure 4: Drainage in Relation to Gravity

This data can be seen as less skewed, with the participants leaning towards neither consistent negative referencing of the word nor consistent positive referencing. The purpose of this code was to account for the fact that this is a consideration that engineers have to make in their sustainability efforts. When taken into consideration, depending on the presence of gravity, it can either be a positive in the sustainability effort or act as an impediment (negative).

Evaporation

As Table 1 detailed, the definition that outlines the theme of evaporation includes anything that has to do with the vaporization of water. The frequency of the theme as well as other terms that arose insinuating this theme, such as discussion of cooling tanks as well are graphed below.

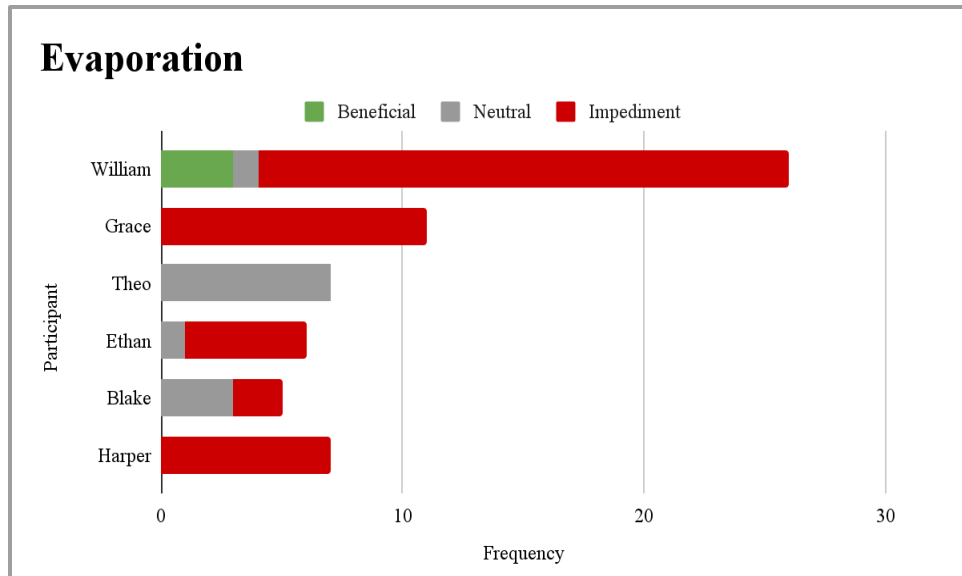


Figure 5: Evaporation

This term was considered the most polarized, with everyone reaching the same consensus. Almost every time the word landscaping—or words synonymous to landscaping—were used, it had a negative connotation. This means it was almost always referenced as a severe impediment to sustainability efforts.

ANALYSIS

From this data, we can clearly see the issues that are prevalent in the discussion of sustainability. In the same way that a presidential candidate would frequently bring up policies that are considered in their campaign, these engineers frequently brought up concepts that they regarded as cardinal in the discussion of sustainability in casinos. From looking at the data collected costs, landscaping, and most importantly, evaporation, were major impediments in these engineers' sustainability efforts. As nearly all the engineering versed participants explained, when water evaporates, which it often does in landscapes, it cannot be reclaimed. Although there were many complexities to the responses, with this data it can clearly be seen that there is a consensus on these impediments.

Limitations

Although this paper has attempted to limit the effects of the constraints, such as a limited timeframe, they are still important to acknowledge. If there were more time, more interviews would have been conducted from a more representative sample. Although the interviews conducted did bring out valuable information to this discussion, it may have been more rounded if there was time for more interviews. In addition to this, many of the casino employees that were asked for an interview denied the request because of privacy issues. This led to a more unrepresentative sample in participants, with most being engineers and only 1 being a casino employee. The effects of this limitation were mitigated by requiring the engineering participants to be knowledgeable about casinos, but it is still important to acknowledge it as a limitation.

Implications

The conclusions that were drawn from this data are sufficient in filling the previous gap in the scholarly discussion of

the impediments' engineers have to face when making water consumption in casinos in the West sustainable. From this study we learned that in order for sustainability to be a reality, we must target the key issues. These issues include landscaping, evaporation, and costs. The key detail is that there already exists initiative in landscaping such as the landscaping rebate system. However, this initiative is not as effective as it could be since there is insufficient advertising on its benefits. Along with providing details on more targeted advertisements, this research shows alternative ways of promoting sustainability. By creating engineering-based solutions to target the problem, there can be many more advancements in sustainability. For example, something that is currently in development is the toilet-to-tap system. Although it has an unappealing name, it could be substantial if properly developed (Thorten, 2022). If more attention was brought to engineering-based initiatives such as this, efficient water consumption can be even more realistic.

DISCUSSION

The amount of water consumed by landscapes such as golf courses and grass is immense. The significance of this in comparison to other consumers that may utilize even more water is that the water consumed by landscapes cannot be recovered. As discussed, Lake Mead functions on a credit system, so they must return almost the same, if not the same amount of water withdrawn at the end of the annual period. When reflecting on the Western Region's ability to do that, most of the water that cannot be returned is consumed by golf courses and grass fields (parks, recreation areas). In the same way that golf courses are now restricted, in casinos, the quantity of live plants and grass is being exponentially reduced to conserve water. They are now replaced with plastic plants and astroturf (realistic plastic grass). Something that the Water District office currently offers is a landscape rebate. The purpose of this initiative is to promote the removal of landscaping in residential and commercial areas ("Water Smart Landscapes Rebate"). In other words, citizens who own property receive a monetary reward for each square foot of landscaping that they remove and replace with astroturf (artificial grass).

Future Directions

There are many directions this research can help direct in the future. Currently there already exists many initiatives to mitigate the effects of evaporation in landscaping like the rebate system and toilet to tap initiative. Although these are already relatively effective, there are other solutions that can be researched to reduce water depletion even further. Australia has always struggled with water consumption and conservation; something they have decided to implement is a Water Market based on Credit (Australian water markets - DCCEE). To further explain this process, here is an example. A farmer has a certain amount of water they are allowed to consume (i.e., credits). If this farmer were to retire, they would still have these credits in their possession. If they are no longer using them, instead of letting them disappear, they can sell them to larger companies who may consume more quantities of water. This creates a very effective mini economy that both encourages economic growth in Australia and maintains the amount of water being circulated. What is particularly interesting about this process is that the government only set up the system, the consumers are the ones who developed it and made it as successful as it is today (Australian water markets - DCCEE). Researching the possibilities of implementing this water market in the United States could be an incredible development in the field. In addition to this, the usage of gray water could be explored in the future. Something that a few of the participants explained in their interview—although not consistent enough to be a code—was the policies involved in gray water. Gray water is essentially reusable wastewater with less desirable qualities that are not safe for consumption (Campisano, 2010). A possible future direction in the research of water sustainability is advancement and further development of gray water purposes. This paper served to answer the question as to the impediments' engineers face and with this new knowledge there are many new questions that arise. Overall, there are many future directions that this field of research could take.

References

- Ahmed, Sana S., et al. "Legionnaires' Disease at a Hotel in Missouri, 2015: The Importance of Environmental Health Expertise in Understanding Water Systems. (Cover Story)." *Journal of Environmental Health*, vol. 81, no. 7, Mar. 2019, pp. 8–13. EBSCOhost, <https://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=134820306&site=ehost-live>.
- Armbrorst, Andreas. "Thematic Proximity in Content Analysis." SAGE Open, vol. 7, no. 2, Apr. 2017, pp. 1–11. EBSCOhost, <https://doi.org/10.1177/2158244017707797>.
- "Australian water markets - DCCEEW." Department of Climate Change, Energy, the Environment and Water, 11 October 2022, <https://www.dcceew.gov.au/water/policy/markets>. Accessed 18 April 2023.
- Bestgen, Kevin R., et al. "Survival, Condition, Habitat Use, and Predation on Stocked Bonytails (*Gila Elegans*) in the Green River, Colorado and Utah." *Southwestern Naturalist*, vol. 53, no. 4, Dec. 2008, pp. 488–94. EBSCOhost, <https://doi.org/10.1894/GG-29.1>.
- Bos, W., & Tarnai, C. (1999). Content analysis in empirical social research. *International Journal of Educational Research*, 31, 659-671. <https://www.sciencedirect.com/science/article/abs/pii/S0883035599000324>
- Campisano, A., and C. Modica. "Experimental Investigation on Water Saving by the Reuse of Washbasin Grey Water for Toilet Flushing." *Urban Water Journal*, vol. 7, no. 1, Feb. 2010, pp. 17–24. EBSCOhost, <https://doi.org/10.1080/15730621003596739>.
- Columbia University. "Content Analysis Method and Examples | Columbia Public Health." *Columbia University Mailman School of Public Health*, Columbia University, <https://www.publichealth.columbia.edu/research/population-health-methods/content-analysis>. Accessed 31 March 2023.
- Edalat, Mohammad Masih, and Haroon Stephen. "Socio-Economic Drought Assessment in Lake Mead, USA, Based on a Multivariate Standardized Water-Scarcity Index." *Hydrological Sciences Journal/Journal Des Sciences Hydrologiques*, vol. 64, no. 5, Apr. 2019, pp. 555–69. EBSCOhost, <https://doi.org/10.1080/02626667.2019.1593988>.
- Fill, Mary-Margaret A., et al. "Cryptosporidiosis Outbreak Associated With a Single Hotel." *Journal of Environmental Health*, vol. 79, no. 9, May 2017, pp. 16–22. EBSCOhost, <https://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=122700856&site=ehost-live>.
- Garcia, Margaret, and Shafiqul Islam. "The Role of External and Emergent Drivers of Water Use Change in Las Vegas." *Urban Water Journal*, vol. 15, no. 9, Nov. 2018, pp. 888–98. EBSCOhost, <https://doi.org/10.1080/1573062X.2019.1581232>.
- Lang, Robert E., and Christina Nicholas. "The World City of Gaming." *UNLV Gaming Research & Review Journal*, vol. 15, no. 2, Oct. 2011, pp. 3–4. EBSCOhost, <https://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=69735825&site=ehost-live>.
- Moyle, Brent D., et al. "Are Water-Centric Themes in Sustainable Tourism Research Congruent with the UN Sustainable Development Goals?" *Journal of Sustainable Tourism*, vol. 30, no. 8, Aug. 2022, pp. 1821–36. EBSCOhost, <https://doi.org/10.1080/09669582.2021.1993233>.
- Qing, Y., et al. "Ultra-High Resolution Regional Climate Projections for Assessing Changes in Hydrological Extremes and Underlying Uncertainties." *Climate Dynamics*, vol. 55, no. 7/8, Oct. 2020, pp. 2031–51. EBSCOhost, <https://doi.org/10.1007/s00382-020-05372-6>.
- "RWJF." *Qualitative Research Guidelines Project*, 2008, <http://www.qualres.org/HomeSemi-3629.html>. Accessed 7 February 2023.
- Sedighi, Samaneh, and Ali Asghar Sedighi. "Water in Architecture and Its Usage in Contemporary Houses Interior Design." *Journal of History, Culture & Art Research / Tarih Kültür ve Sanat Araştırmaları Dergisi*, vol. 6, no. 4, Sept. 2017, pp. 1176–95. EBSCOhost, <https://doi.org/10.7596/taksad.v6i4.1138>.

- Thornton, Stuart. "From Toilet to Tap." National Geographic Society, 2 June 2022, <https://education.nationalgeographic.org/resource/toilettotap/>. Accessed 18 April 2023.
- UN Environment Programme. "As the climate dries the American west faces power and water shortages, experts warn." *UNEP*, UN Environment Programme, 2 August 2022, <https://www.unep.org/news-and-stories/story/climate-dries-american-west-faces-power-and-water-shortages-experts-warn>. Accessed 9 November 2022.
- Virginia Technology. "Interview Research - Research Methods Guide." Research Guides, 21 September 2018, <https://guides.lib.vt.edu/researchmethods/interviews>. Accessed 7 February 2023.
- "Water and the global climate crisis: 10 things you should know." *UNICEF*, 18 March 2021, <https://www.unicef.org/stories/water-and-climate-change-10-things-you-should-know>. Accessed 13 December 2022.
- Water Smart Landscapes Rebate." Southern Nevada Water Authority, <https://www.snwa.com/rebates/wsl/index.html>. Accessed 18 April 2023.
- Weber, Joe. "The Colorado and Virgin Rivers before Lake Mead." *Journal of Maps*, vol. 14, no. 2, Nov. 2018, pp. 583–88. *EBSCOhost*, <https://doi.org/10.1080/17445647.2018.1517700>.
- Wheeler, Kevin G., et al. "What Will It Take to Stabilize the Colorado River?" *Science*, vol. 377, no. 6604, July 2022, pp. 373–75. *EBSCOhost*, <https://doi.org/10.1126/science.abo4452>.