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SAR Irrigation Team Final Report:

Quantifying Water and Cost Savings from UCLA Turf Conversions

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ABSTRACT

As drought and climate change increase unpredictability in Southern California's water supply, UCLA has committed to replanting some of its natural turf areas with drought-tolerant, native plants. However, the UCLA Facilities department lacks crucial data on current water output due to irrigation and the projected water savings at conversion sites. Thus, the SAR 2023 Irrigation Team filled the knowledge gaps associated with turf conversion by exploring how water savings for turf conversion projects vary based on current irrigation type and how water and maintenance savings will offset the initial costs of turf conversion. This report provides UCLA with the data required to prioritize future conversions based on potential costs and water savings, and synthesizes the full scope of benefits associated with turf conversions.

To assess current and future water usage and analyze costs associated with turf conversion, the 2023 Irrigation team conducted field surveys of irrigation output on turf panels throughout campus, projected the water intake of the native plants to be installed, and performed a cost-benefit analysis on the expenses and savings associated with turf conversions. We found that turf conversions are extremely cost effective, with a return-on-investment time ranging from 1 to 3 years, and can result in significant water savings of up to 15 gallons per square foot per year. Our botanical research concluded that the plantings listed among UCLA's signature species are largely drought tolerant, with 45.8% of species being classified as having very low water usage. Our research also confirmed that native plants offer a variety of cultural and ecological non-monetary benefits. With these findings, the 2023 SAR Irrigation Team strongly recommends that UCLA continues with turf conversions as a means for long-term financial and water-usage savings. We also suggest that the plants installed in turf conversions are selected more thoughtfully in order to maximize the ecological and cultural benefits of turf conversions.

INTRODUCTION

The American Southwest is an arid region with a well-established history of cyclical, persistent droughts. However, in recent years, humans have burned a considerable quantity of fossil fuels, releasing carbon dioxide gas into the atmosphere and amplifying the greenhouse effect, which warms the surface of the Earth. Even an imperceptible increase in temperature can greatly reduce mountain snowpack, which accounts for a large portion of the region's water supply, and make reservoirs more vulnerable to evaporation (EPA, 2023). Furthermore, the Southwest has infamously supported rapid population growth and agricultural production by diverting water from the Colorado River. The city of Los Angeles, nestled in a geographic basin between mountain ranges, relies on several gravity-fed aqueducts that import water from the high Sierras and the Colorado River to its population of almost four million people. Today, the region faces impending water scarcity and cutbacks. In fact, California recently committed to reducing its water consumption by an equivalent of 4.8 million households over the next three years—more than the total consumption by the entire population of the city of Los Angeles (James, 2023). Consequently, the University of California in Los Angeles (UCLA) must be proactive by implementing strategies that reduce superfluous water consumption on campus. As freshwater supply becomes increasingly limited and climate change exacerbates unpredictable changes in precipitation and snowpack, it is necessary to increase water conservation efforts to sustain our water supply (Ashoori et al., 2015). UCLA can make strides in conserving water by reducing its irrigation output. Limiting irrigation would bolster the university's resiliency to water scarcity, and, as a well-regarded and longstanding institution, UCLA would set a positive example for other institutions by exhibiting widespread water-savings practices.

Research on campus water use has previously been conducted by various groups at UCLA, including the 2013 SAR Water Action Plan Team. This team helped the UCLA Water Task Force identify areas where water use reductions can be made, such as in changes to plumbing fixtures and residential landscapes. However, their research did not address irrigation practices on campus, and the Facilities team still lacks comprehensive awareness of UCLA's own irrigation output, including where reductions can be made and how those reductions can be made cost-effectively. Therefore, our team delved into this key area of research and worked closely with the UCLA Facilities department to investigate water conservation in landscaping. We learned that the Facilities department is working towards implementing water-efficient landscaping practices by converting underutilized areas of natural turf, or "turf areas that are not used for recreation and events and turf areas that serve only an aesthetic value," to areas native plants, which are substantially more drought-resistant and water-wise (UCLA Landscape Plan, 2022). As of May 2023, turf conversion has been completed at Moore Hall.

While UCLA is committed to these turf conversions, they lack critical information on the potential costs and benefits of turf conversion on campus. Specifically, the Facilities department lacks tools to measure current irrigation output, making it difficult to quantify the potential water savings and subsequent financial savings of turf conversion, and they lack data on the maintenance savings that will result from turf conversions. Thus, our research questions are: (1) How will water savings for turf conversion projects vary based on current irrigation type and species of native plants installed? (2) How will water savings offset the costs of turf conversion and affect return-on-investment time? Our deliverables, which will include data visualizations on water usage and a corresponding cost-benefit analysis, will address these questions, allowing the UCLA Facilities department to prioritize future conversions based on water savings.

METHODOLOGY

Irrigation Surveys

To assess the current water output at turf conversion sites, our team conducted surveys on the irrigation systems that are present at various lawn areas. To prepare for these surveys, we conducted three campus walkthroughs with Suzanne Gagliano, Greg Luna, Alex Gomez, and other UCLA Facilities staff to assess the irrigation that is present on campus and identify some of the knowledge gaps present in the current quantification of irrigation output.

Turf conversion sites for assessment have been selected from the Priority Areas for Turf Conversion Map provided by the UCLA Facilities department (Figure 1). Our team selectively sampled 1st priority sites from this map because these will be most immediately beneficial to our stakeholders (Figure 1). We were able to sample panels at four sites: Broad Hall, Kaufman Hall, Murphy Hall, and Public Affairs. At each site, our team surveyed the irrigation by recording the types of rotors and pop-ups that are present, the number of each type of rotor and pop-up, and the nozzles that are used. We also recorded the area of each conversion site with a measuring wheel or transect tape to standardize the irrigation output per square foot. To compile this data, our team created a spreadsheet to hold information about each first priority conversion area including: irrigation type, nozzles of each irrigation head, area in square feet, total gallons per minute poutputted for a panel, run time in minutes per week, and a standardized water output (in average gallons per square feet per year) for the entire building's collection of panels. This standardized output allowed our team to gain a more precise understanding of the total water output at each conversion site.

After collecting field data, we gathered information on irrigation output for each pop-up, rotor and nozzle using manufacturer data from Hunter and Rainbird. This information was readily available on the Hunter and Rainbird websites, which are the manufacturers of UCLA's main irrigation heads. We then multiplied the irrigation output by the number of irrigation heads and the irrigation runtime, and divided by the square footage of the panel to calculate the water output per square foot per year at each conversion site. This data was then compiled into charts of average water output based on location and irrigation type.

Water Intake Review of Signature Species

To supplement our irrigation surveys, our team assessed the water needs of native plants listed in UCLA's Landscape Plan and the Moore Hall plant palette. We utilized the Water Use Classification of Landscape Species (WUCOLS) database created and updated by expert horticulturists at UC Davis (2000). This database includes information on the water usage and estimated evapotranspiration rates of plant species in California. In addition to the database, the WUCOLS Landscape Coefficient equation can be used to quantify landscape water needs by taking into account species diversity, microclimate, and plant density (UC Davis, 2000). With the information from the plant database and external references, we came up with water use classifications for each of UCLA's signature species.

Ethnobotanical Review of Signature Species

In addition to our plant water use data, we researched the traditional cultural uses for each plant on the signature species list. For thousands of years, California native plants and people have supported each other in a reciprocal and dynamic ways. Today, these relationships are often left out of major landscaping plans, to the detriment of the UCLA community. In order to bring awareness to this important history and incorporate Equity, Diversity, and Inclusion (EDI) into our research, our team reviewed 48 native plant species, including a variety of oaks, grasses, and wildflowers, and recorded their known medicinal, culinary, and ritual uses. This effort aligns with several guiding principles in the UCLA Landscape Plan: to "incorporate traditional ecological knowledge" (23) and "promote the use of the landscape in research, teaching, learning and scholarship" (20). Specifically, our summary of the cultural uses of native plants will help the Facilities department "create landscapes that educate and bring awareness to indigenous knowledge" and "establish spaces on campus for land stewardship and programming by Indigenous people" (UCLA Landscaping Plan, 2022).

In addition to researching and incorporating Traditional Ecological Knowledge into the signature plant species list, we also recorded the unique ecological benefits of the native species in the Signature Species list. From a variety of sources, we recorded the non-monetary ecological benefits of each plant in the signature species list, from interactions with wildlife to abiotic factors. These factors are beneficial to the UCLA Facilities department because they can be used to incorporate biodiversity into future turf-conversion projects, attracting native pollinators and improving ecosystem function.

Cost-Benefit Analysis: Moore Hall Case Study

In addition to our analysis of water use and savings, we performed a cost-benefit analysis on turf conversion. Moore Hall's conversion to drought-tolerant plants served as a case study for a cost benefit analysis. In this case study, the pre- and post- conversion costs were calculated per square foot so that the results can be generalized to future turf-conversion panels regardless of their size.

We collected information from our stakeholders regarding all of the costs involved in the conversion process, as well as the yearly costs of irrigation and maintenance of the grounds. Our team divided the costs into two categories— fixed costs, which are the initial costs of conversion, and variable costs, which are the fluctuating, ongoing costs of maintaining the landscape. The initial investment of turf conversion would be calculated based on the bulk cost of the fixed category, while the savings per year would be based on the variable costs of turf conversion.

Data collected on fixed costs included the costs of native plant purchases, labor, new irrigation equipment, mulch, river-rock beds, and more. Additionally, we also considered a subtraction to the costs due to savings made by government rebates on usage of native flora. Data collected on variable costs was related to the recurring expenses occurring both post- and pre- conversion. Specifically, this relates to the cost of maintaining a turf area as compared to the cost of maintaining a landscaped area year after year. These costs include, but are not limited to, the costs associated with water, fertilizers, and maintenance, which are expected to change depending on the inputs required by native plants and current turf. Our team determined estimates for these costs based on predicted yearly maintenance spendings at Moore Hall. We also determined the cost of water of turf areas based on our field data for water use at turf areas, and we determined the cost of water for landscaped areas based on yearly fluctuations in landscaped plant water as they become established. All costs were standardized in cost per square foot per year so that they could be generalized to all panels.

To determine if turf conversion is a worthwhile investment, our team calculated the time it will take for UCLA to recoup the fixed costs of turf conversion. We calculated this return-on-investment (ROI) time by determining the time it takes for the savings accumulated from the variable costs per year to equal the fixed cost of turf conversion. Since the amount of water saved yearly will change as native plants become established, the savings per year is non-linear. Therefore, we created a piecewise function of yearly savings, and determined the time it takes for this function to reach the fixed cost of turf conversion. This number reflects the amount of time needed to gain back the initial fixed costs of the conversion based on the savings made each year. After this amount of time, profit will start to accumulate in comparison to pre-conversion years. We also conducted graphical analysis of cost/savings versus time to portray this relationship more clearly.

CHALLENGES

Initially, our team struggled to identify a knowledge gap to explore and a deliverable to support ongoing landscape conversions. This challenge became evident while reviewing the UCLA Landscape Plan, which included goals and reasoning for landscape conversions, the areas selected for conversion, and plant palettes for five landscape zones. Furthermore, we learned from our stakeholders that all conversion projects have been approved, funded, and put into motion. Because we were unsure of how to contribute to this thorough plan, we had an in-depth conversation with our stakeholders that succeeded in narrowing down our project deliverables. As a result, this challenge highlighted the need for effective communication with our stakeholders moving forward with this project.

For challenges concerning our data collection, our campus irrigation tour and irrigation output methods demonstration were delayed due to stakeholder responses and weather conditions in winter quarter. Our general approach to confirm a specific time for in-person events via email proved to be inefficient since we consistently received delayed responses or no response at all from our stakeholders. Additionally, the aforementioned events were both postponed by at least a week due to the rain which caused an increase in work orders for the Facilities department. We realized our approach to scheduling in-person events with our stakeholders was unreliable and instead discussed availability during our bi-weekly stakeholder meetings where responses are mostly guaranteed. Overall, we realized the inefficiency of online communication and better optimized our time during future stakeholder meetings.

In spring quarter, we were able to begin data collection, but did end up needing to be accompanied by members of the landscaping staff in order to locate and collect data on the irrigation systems. This was initially a challenge in the planning process, but we were able to have four data collections successfully over the course of one month. Another issue we ran into during data collection was finding ways to measure the areas of the turf panels. Initially we were using a transect tape, however we were unable to use it for our final data collection and had to have an additional session using a measuring wheel provided to us by Alex Gomez.

Finally, we faced challenges towards the end of the project when we were conducting our informant interviews to gather information for our cost benefit analysis. We had to wait until the second half of spring quarter to begin collecting the cost of the Moore Hall conversion as it was not available until then. We sent over an initial round of questions where we tried to be as specific as possible to get all the costs necessary, but we found after we received the responses that there were some parts that were not completely clear and that we had not asked but needed to. When we followed up, it took quite a while to receive a response with clarification, which meant that we had to wait to conduct a large part of our cost benefit analysis. We were able to get the numbers, the most important of which was the length of the dripline at Moore Hall, before our presentation on June 1 and complete the cost benefit analysis. Because we were unaware if we were able to get the numbers in time, members of the team had to estimate the length of the dripline, but thankfully this estimation was not needed and we could use the more accurate measurement.

RESULTS

Irrigation Surveys

Our initial field surveys of campus irrigation systems helped our team develop a deeper understanding of the different irrigation types used on campus. From these surveys, we found that there are two categories of irrigation heads on campus: rotors and pop ups. UCLA uses four types of rotors on campus: the I-40 rotor, PGP Ultra/I-20 rotor, the PGP Regular rotor, and PGJ rotor , which are all manufactured by Hunter. For pop-ups, UCLA uses two models of 1806 SAM pop-up: the U-series and the VAN-series, both of which are manufactured by Rainbird. The output of these rotors varies based on the nozzle that is applied, which is selected by the landscaping staff based on the topography of the area. We also learned that areas irrigated by pop-ups are irrigated for 16 minutes per week during all seasons, and that areas irrigated by rotors are irrigated by 30 minutes per week during all seasons. Both of these runtimes are based on drought requirements from LADWP. Additionally, we found that irrigation backflows typically operate at a pressure of 80 psi.

Using our knowledge of the UCLA irrigation system, we conducted field surveys to determine the irrigation output at four first-priority conversion sites: Murphy Hall, Kaufman Hall, Broad Hall, and Public Affairs. Irrigation output was calculated based on irrigation type, square footage, and irrigation run time. With this we were able to calculate the average water use for each first priority area in a standardized unit gallons per square foot per year, which enabled us to compare water output for buildings with different combinations of rotor and pop-up irrigation. On average and in ascending order, Murphy Hall uses 13.6 gallons per square foot per year on, Public Affairs uses 14.2 gallons per square foot per year, Kaufman Hall uses 14.8 gallons per square foot per year, and Broad uses 16.8 gallons per square foot per year (Figure 3). Thus, from the four buildings we collected data on, we determined that Broad Hall should have higher priority for upcoming landscape conversions. Overall, these averages will help our stakeholders determine which buildings currently use the most water and which would benefit the most from conversion.

Alternatively, we also quantified water output by irrigation type using our field data from irrigation surveys. The same unit was applied to compare the average water usage for panels that are irrigated with pop-ups and those that are irrigated with rotors. On average, panels irrigated with pop-ups use 14.2 gallons per square foot per year while panels irrigated with rotors use 15.4 gallons per square foot per year (Figure 4). Although the difference in water usage is marginal, stakeholders may use this information to classify panels that are irrigated with rotors as having higher priority for landscape conversion given that they use roughly 1 more gallon per square foot per year.

Water Intake Review of Signature Species

We used the WUCOLS database to gather water intake information for both the signature species in the UCLA Landscape Plan and the Moore Hall species list as outlined above. Looking at the signature species in the landscape plan, we used the categories for water intake utilized by WUCOLS in the south coastal region that is home to UCLA. The categories are very low, low, moderate and high, with evapotranspiration percentage brackets of <10%, 10-30%, 40-60%, and

70-90% respectively. We also categorized the plants by their type, such as tree, shrub, perennial, or grass (Table 1). In our initial analysis, we found that out of the 47 species, 45.8% are categorized as very low water use, 33.3% are low water use, 14.6% are moderate water use, and the remaining 4.2% are high water use. In total, the vast majority of the signature species are categorized as very low or low water usage (79%). This reduction in water use signifies a major improvement from the turf that is being converted, which is characterized as moderate to high water use by WUCOLS, depending on the turf species.

For the Moore Hall Species List, we categorized the plants based on their water usage and whether or not they are native to California (Table 2). Of the 8 species that were planted at Moore Hall, 3 were categorized as having very low water usage, and 5 were categorized as having low water usage. Additionally, 4 of the species are native to California, while the other 4 are not native (Table 2).

Ethnobotanical Review of Signature Species

Our team found that each of the native species in the Key Species list has unique cultural and ecological benefits to the UCLA community (Table 3). Species such as California Buckwheat, Black Walnut, Sagebrush, and Monkeyflower continue to support the livelihoods of Southern California indigenous groups, particularly the Chumash, Kumeyaay, Tongva, and Gabrielino nations. Other species such as the Coast Live Oak As we learned about these traditional uses, we began to appreciate the relationship that native peoples held with the land before it was developed and transformed by settlers. As a part of our final deliverable, we recommend that UCLA establish more endemic species on campus to go beyond land recognition and promote engagement with native histories.

Furthermore, our plant database includes information about each plant's ecological role. We found that native plants provide habitats for birds, produce food for insects, and improve soil resiliency and fire resistance. Certain species also prevent soil erosion and stabilize stream banks through their root structure. Planting native plant gardens on campus would attract a variety of pollinators and insects, creating microhabitats for many of California's threatened species. Through our ethnobotanical research, we were able to confirm that native species offer a multitude of benefits besides the reduction in water and maintenance costs. Our team's report of non-monetary benefits of native plants highlights the importance of one of the Landscaping Plan's main objectives, to "restore native plant communities, promote biodiversity and create habitats" (15) on campus (UCLA Landscaping Plan, 2022).

Cost-Benefit Analysis: Moore Hall Case Study

The results from the Cost Benefit Analysis have been derived from analyzing 4 other metrics needed to calculate a return on investment (ROI) time for the Moore Hall Conversion. All of the data has been examined on a per year time scale. The metrics used are as follows:

1. Fixed Cost of Conversion- The one-time costs associated with conversion were investigated through the use of Key Informant Interviews with technicians in the Facilities department. These included plant purchases, equipment costs, labor charges, river rock purchases, and other miscellaneous costs. All of these totalled to be $120,500 (Table 4). A per square foot standardization of the cost based on the area converted reaches $7.98 per square foot of non-recurring cost of conversion. This can be understood as an initial investment.

2. Rebates- The Los Angeles Department of Water and Power supports institutions and organizations with rebates of varying degrees on per square foot of conversion to drought tolerant plants. Based on certain metrics, UCLA qualifies to receive $5 for every square foot of area converted. This rebate can be understood as a one time saving. Adjusting the initial investment cost by subtracting the rebate cost thus provides a final or adjusted fixed cost of conversion of $2.98 (Table 5). However, a key factor to consider is that there is no certainty on when this incentive program will last until. Therefore, the cost benefit analysis was done both with and without taking into account the effect of the Rebate.
3. Maintenance Savings- Native and drought resistant plants use less inputs compared to turf for their maintenance and upkeep. This is because these plants are more adapted to and can utilize their natural environment better. Specifically, the converted landscape requires no fertilizer or aeration saving $800 and $1625 per year respectively. Cost of replacement goes down from $300 to $50 per year as well. However, the cost of obtaining wood chips and mulch doubles from $250 to $500 per year as the turf is converted to drought tolerant landscaping. Adjusting all these savings on a per square foot level leads to savings of $2.57 per year per square foot (Table 6). It is important to note that the future maintenance costs of converted landscape are educated estimates made by professionals in the field. However, there is still a high degree of confidence in these numbers due to the well known easily adaptable nature of native plants from our literature review research.
4. Water Usage Savings - In order to calculate the volume of water saved and consequently the cost savings with conversion, a few variables had to be considered. Firstly, we had to

estimate the water use of turf areas using our previous estimate of average of the current water use for turf on campus from our field data. From our field data, we determined that there is a marginal difference in the water usage of rotors and pop-ups, with panels irrigated with pop-ups using an average of 14.2 gallons per square foot per year and panels irrigated with rotors use 15.4 gallons per square foot per year. Since this difference is marginal, our team chose to use the average of the water output per square foot per year for pop ups and rotors as an estimation for turf water usage. We used this to estimate that Moore Hall would use 232,432 gallons of water per year on turf areas. Secondly, we had to determine the expected use of water by native plants via drip irrigation. The native plant's water usage will decrease over time as the plants become more and more established and adapted to their environments. Based on prior research and popular methods in the landscaping field, we calculated estimated water usage for 3 years after the conversion. We estimated that in the first year of establishment, landscaped plants would be watered for 30 minutes twice a week. In the second and third year of establishment, landscaped plants would be watered for thirty minutes once a week. After the third year of establishment, landscaped plants would be watered for thirty minutes once a month, which will result in a total water use of 12,000 gallons per year (Figure 5). Thus, once the plants are established, Moore hall will save a total of 220,432 gallons of water, which is equivalent to 14.6 gallons per square foot, yearly.

5. Water Cost Savings - To determine the savings in water costs, we had to consider that the LADWP charges different rates for water from January to June and July to December. After considering these factors, we determined that UCLA will save approximately $0.12 per square foot per year on water costs per year once landscaped plants are established.

Based on the above metrics, we calculated a breakeven point where the initial investment cost meets the savings made per year. When accounting for rebates, we determined that the return on investment time from turf conversion is 1.130 years (Figure 6). This is the amount of time that UCLA will take to recoup its initial investment through savings. In contrast, the return on investment time without rebates is significantly different being 3.006 years (Figure 7). While these results still indicate that there is an economic benefit to turf conversions, they point to the large economic impact of the government policy. It is important to note that the savings per year change marginally due to the variable nature of the water savings, which is indicated by the legend on our graphs (Figure 6, Figure 7). However, the return on investment graph still appears to portray a straight savings line. This is due to the comparatively much larger effect of the maintenance savings in reaching a break even point than water savings, which occurs due to the minimal cost of water.

In conclusion, it is extremely cost effective to convert to native and drought tolerant landscaping. The rebates further amplify this. The majority of cost savings come from maintenance cost cutting rather than money saved from using less water. The environmental and societal impact of using less water, however, cannot be understated.

DISCUSSION

Our results concluded that turf conversions result in significant water and cost savings. While the initial investment of turf conversions are significant, UCLA can recoup their investment within 1-3 years, indicating that turf savings have a significant financial and ecological benefit. Moving forward, our team hopes that our data and analysis will be used to advocate for and reinforce turf conversion efforts. Our work overwhelmingly supports converting turf to native, drought-resistant landscaping because of the many environmental and monetary benefits. Converting turf to drought-resistant landscaping conserves a significant amount of water and greatly reduces UCLA's spending on lawn maintenance. Furthermore, our team urges UCLA to act quickly while the LADWP rebates are still available. Because these rebates might not be available for many more years, the best course of action is to proactively initiate as many turf conversions as is feasible for UCLA Facilities to take on at this time.

Additionally, we hope that our research will help the UCLA Facilities department accelerate turf conversions by helping them choose optimal first-priority sites. We procured irrigation output data for the turf panels surrounding Broad Hall, Kaufman Hall, Murphy Hall, and Public Affairs and determined which areas should be prioritized for conversion first. Our calculations for the average output of pop-ups vs. rotor heads will also inform the choice for which turf areas should be converted first based on the predominant irrigation type present in that area.

Looking towards the future, our team urges UCLA to embrace native species in future landscapes beyond Moore Hall, not only because of the reduction in water use and maintenance costs, but also because they promote education and engagement with indigenous histories and knowledge. Native species also support our local ecosystem by providing habitat for native insects, birds, and other native fauna. Overall, incorporating more native species will foster a sense of place-based community and add educational and aesthetic value to the UCLA campus.

APPENDIX

Table 1

Plant Water Usage Classification for Proposed Signature Landscape Species

Plant Name	***Scientific Name***	**Water Usage (for south coastal)**	**ET0**	**Plant Type**
Engelmann Oak	*Quercus engelmannii*	very low	< 10%	Tree
Coast Live Oak	*Quercus agrifolia*	low	10-30%	Tree
Valley Oak	*Quercus lobata*	moderate	40-60%	Tree
Torrey Pine	*Pinus torreyana*	low	10-30%	Tree
Toyon	*Heteromeles arbutifolia*	very low	< 10%	Shrub
California Buckwheat	*Erigononum fasiciculatum*	very low	< 10%	Shrub
Ashy Leaf buckwheat	*Eriogonum cinereum*	very low	< 10%	Shrub
Coyote bush	*Baccharis pilularis*	low	10-30%	Shrub
Purple needlegrasses	*Stipa pulchra*	very low	< 10%	Grass
Dune Sedge/Meadow Sedge	*Carex pansa/praegracillis*	moderate	40-60%	Grass
California Sycamore	*Platanus racemosa*	moderate	40-60%	Tree
Southern California Black Walnut	*Juglans Californica*	low	10-30%	Tree
Fremont Cottonwood	*Populus fremontii*	moderate	40-60%	Tree
Arroyo Willow	*Salix lasiolepis*	high	70-90%	Tree
California Bush Sunflower	*Encelia californica*	very low	< 10%	Shrub
California WIld Rose	*Rosa californica*	low	10-30%	Shrub
Mulefat	*Baccharis salicifolia*	high	70-90%	Shrub
Lemonade Berry	*Rhus integrifolia*	very low	< 10%	Shrub
Mugwort	*Artemisa douglasiana*	moderate	40-60%	Perennial
California Goldenrod	*Solidago californica*	low	10-30%	Perennial
Basket Rush	*Juncus textillis*	moderate	40-60%	Perennial
Giant Wild-rye	*Elymus condensatus*	low	10-30%	Grass
Incense Cedar	*Calocedrus decurrens*	moderate	40-60%	Tree
Coast Live Oak	*Quercus chrysolepis*	low	10-30%	Tree
Coast Live Oak	*Quercus agrifolia*	very low	< 10%	Tree

Island Ironwood	*Lyonothamnus floribundus ssp. aspleniifolius*	low	10-30%	Tree
California Bay	*Umbellularia californica*	low	10-30%	Tree
California Barberry	*Berberis pinnata*	low	10-30%	Shrub
Hollyleaf Cherry	*Prunus illicifolia*	very low	< 10%	Tree
Western Redbud	*Cercis occidentalis*	low	10-30%	Tree
Coffeeberry	*Frangula californica*	very low	< 10%	Shrub
Hummingbird Sage	*Salvia spathathea*	low	10-30%	Perennial
Douglas Iris	*Iris douglasiana*	low	10-30%	Perennial
Evergreen Currant	*Ribes Viburnifolium*	very low	< 10%	Shrub
Coast Live Oak	*Quercus agrifolia*	very low	< 10%	Tree
Southern California Black Walnut	*Juglans californica*	low	10-30%	Tree
Laurel Sumac	*Malosma laurina*	very low	< 10%	Shrub
Sugar Bush	*Rhus ovata*	very low	< 10%	Shrub
Elderberry	*Sambucus nigra spp caerulea*	low	10-30%	Shrub/Tree
California Sagebrush	*Artemisia californica*	very low	< 10%	Shrub
California Bush Sunflower	*Encelia californica*	very low	< 10%	Shrub
Purple Sage	*Salvia leucophylla*	very low	< 10%	Shrub
Toyon	*Heteromeles arbutifolia*	very low	< 10%	Shrub
Bush Monkeyflower	*Mimulus aurantiacus*	very low	< 10%	Shrub
California Buckwheat	*Eriogonum fasciculatum*	very low	< 10%	Shrub
Black Sage	*Salvia mellifera*	very low	< 10%	Shrub
Blue-eyed grass	*Sisyrinchium bellum*	no data	n/a	Perennial

Note: Plants were selected from the Signature Species List for each landscape zone in the UCLA Landscape Plan. Data on plant water usage was collected from the UC Davis WUCOLS database.

Table 2

Moore Hall Plants

Plant Name	***Scientific Name***	**California Native?**	**Water Usage (for south coastal)**	**ET0**	**Plant Type**
Purple Sage	*Salvia leucophylla*	Yes	very low	< 10%	Shrub
California Buckwheat	*Erigononum fasiciculatum*	Yes	very low	< 10%	Shrub
Feathery Cassia	*Senna artemisoides*	No	low	10-30%	Shrub
Common Yarrow	*Achillea milefolium*	Yes	low	10-30%	Ground Cover, Perrenial
Morning Light Coast Rosemary	*Westringia fructiose*	No	low	10-30%	Shrub
Rosemary	*Rosmarinus officinalis*	No	very low	< 10%	Shrub
California Fescue	*Festuca californica*	Yes	low	10-30%	Ornamental grass
Strawberry Tree	*Arbutus unedo*	No	low	10-30%	Shrub/tree

Note: Key data on the plants that are being installed at the Moore Hall turf conversion project. The Moore Hall plant list was provided by Alex Gomez of the UCLA Facilities Department on March 1st, 2023. Data on plant water usage was collected from the UC Davis WUCOLS database.

Table 3

Ethnobotanical and Ecological Benefits of Signature Species

Plant Name	**Scientific Name**	**Landscape Zone**	**Plant Type**	**Ethnobotanical and Cultural Information**	**Ecological Benefits**
Engelmann Oak	*Quercus engelmannii*	Grand Savanna	Tree	Engelmann Oaks are probably the most imperiled of all three oaks and are one of the most endangered natural plant communities in California. It has played an important role in the lives of native people since history. Tribes collected and stored acorns from the tree to make a special kind of porridge.	A wide variety of wildlife is attracted to oaks. Many insects are attracted to Oaks generally, including the following butterflies which use Oaks as host plant: California Sister, Propertius Duskywing, Mournful Duskywing, Golden Hairstreak, and Gold-Hunter's Hairstreak.
Coast Live Oak	*Quercus agrifolia*	Grand Savanna	Tree	It is the only California native oak that thrives in the coastal environment. The acorns of the tree have been known to be used by at least 10 native tribes. The wood of the tree has also been historically used for charcoal and gunpowder. The wood also has special applications for ship building. The Spanish name of the tree has been used to name many land grants in California.	The california oak caterpillar almost exclusively relies on living on the leaves of this tree. They live in a mutually beneficial symbiotic relationship. They also support acorn woodpeckers who store their food in the trunks of these trees.
Valley Oak	*Quercus lobata*	Grand Savanna	Tree	It grows into one of the largest of California oak trees. The acorns have been historically used by tribes to create sweet bread. Historically, domesticated pigs were driven to these valley oaks for feeding purposes.	It is food for a variety of animals from beetles to woodpeckers. It is the only known food type of Chionodes petalumensis caterpillars. The oak can also withstand wildfires. Collectively, valley oak forests support 67 nesting bird species, more than any other California habitat for which data are available.

Torrey Pine	*Pinus torreyana*	Grand Savanna	Tree	It is a critically endangered species growing only (where it is considered a cultural icon as well) in coastal San Diego County, and on Santa Rosa Island, offshore from Santa Barbara in Santa Barbara County. It is the earliest conifer to be (recorded) deliberately planted at a massive scale. In terms of the number of alive trees and the area they occupy, they are among the rarest pines in the world. Torrey pine is widely planted as an ornamental and has been evaluated as a commercial species in Kenya, Australia, and New Zealand	Seeds of Torrey pine are eaten by birds, rodents, and other mammals. It is also considered to be a plantation tree for creating forestries in many countries.
Toyon	*Heteromeles arbutifolia*	Grand Savanna	Shrub	Made into cider and fruitcakes by boiling the raw berries to remove the astringent flavor, then mashing them into round cakes that can be dried and eaten. The city of Hollywood was named after this holly-like shrub!	Mature fruits are extensively utilized by numerous wildlife species, particularly birds. The California quail, band-tailed pigeon, and raccoon all readily consume toyon berries. Toyon is apparently of localized importance as deer browse in portions of California
California Buckwheat	*Erigononum fasiciculatum*	Grand Savanna	Shrub	Kumeyaay tribe "boiled the flowers or leaves into a tea to be used as an eyewash, a mouthwash and a remedy for headaches, stomach aches and bladder infections." The seeds can also be ground into flour.	Important nectar source for bees. Has an extensive shallow system of roots that quickly take up water. Makes useful ground cover!
Ashy Leaf buckwheat	*Eriogonum cinereum*	Grand Savanna	Shrub	Flowers are soft rosy pink, very attractive. Found on bluffs near the seacoast blooming abundantly for many months, sometimes on into the winter season.	It supports many butterfly species and other pollinators including wasps which prey on harmful garden pests

Coyote brush	*Baccharis pilularis*	Grand Savanna	Shrub	There is a report of an infusion of coyote brush used as a general remedy by the Costanoan Indians. A decoction prepared from the leaves was a remedy for poison oak rash used by the Chumash Indians on the Santa Ynez Reservation in the late 1950s. They also reported using branchlets of coyote brush to brush away the small spines when harvesting prickly pear cactus fruit. The Indians of Mendocino County formerly used the brittle stems of coyote brush as arrows.	Very attractive to insects, especially when in flower. It is common to find wasp galls on leaves.
Purple Sage	*Salvia leucophylla*	Grand Savanna	Shrub	Medicinal uses: treating colds, headaches, influenza, and epilepsy. Possesses anti fungal, anti-inflammatory, antioxidant, antiseptic, antispasmodic, aromatic, nervine, and cerebral tonic properties.	The flowers are highly aromatic and attract a variety of birds and insects. Sage makes great groundcover and has very low water needs.
Blue-eyed grass	*Sisyrinchium bellum*	Grand Savanna	Perenn ial	Its leaves and roots have been used after mashing as a cure for stomach diseases by various native people for centuries. Used very often at edge of meadows for aesthetic benefits	It hosts several moth species as well as other small insects. It is also a noted fire resistant plant. It is very easy to grow and supports various companion plants
Purple needlegrass	*Stipa pulchra*	Grand Savanna	Grass	This grass is the preferred material used by the California Indian basket weavers for teaching the art of basket weaving.	It hosts a lot of small insects and mammals with 5 confirmed butterfly species being frequent visitors. Hence, it is often used as grass cover in butterfly gardens. The extensive root system can reach 20 feet deep into the soil, making the grass more tolerant of drought.

Dune Sedge/Meadow Sedge	*Carex pansa/praegracilis*	Grand Savanna	Grass	Also serves as material for basket-weaving. The strong leaves of this plant and its triangular-edged blades are used to make ropes and matting.	It is a solid alternative to turf grass as it is relatively more drought tolerant but serves the same aesthetic and functional uses
California Sycamore	*Platanus racemosa*	Alluvial Corridor	Tree	The California or western sycamore is native along the streams of valleys, foothills and mountains of coastal, central and southern California to Mexico. Trees in the sycamore family are valued for their wood for everything from musical instruments to cutting boards. These trees have been considered sacred by many people throughout ancient history.	The California sycamore provides food and nesting sites for birds including red-tailed hawks, woodpeckers and hummingbirds. It is a food source for the larva of the western tiger swallowtail butterfly.
Southern California Black Walnut	*Juglans Californica*	Alluvial Corridor	Tree	Historically, the Chumash Indians ate the walnuts and used the nutshells for dice. The bark of the walnut tree was used to make baskets.	CA Black Walnut trees provide an invaluable habitat and source of food for many species of wildlife. Surveys have shown Walnut woodlands can provide habitat for 29 species of birds. The walnuts are eaten by different bird and rodent species, such as the CA ground squirrel and West Gray squirrel. Owls use the upper branches as roosts and nesting places. The CA ground squirrel digs burrows at the bases of the older walnut trees. Deer use the shade cover provided by the branches and leaves.

Fremont Cottonwood	*Populus fremontii*	Alluvial Corridor	Tree	The Hopi Indians of Arizona consider the cottonwood tree sacred and carve Kachina dolls from the roots of the tree. They believe the rustle of the wind through the quaking leaves to be the gods speaking to people. Several California tribes used Populus roots to make loosely twined baskets. The Hupa, from Northern California, use cottonwood roots to begin making twined baskets. The Maidu and Yokuts Indians use cottonwood twigs in their basketry. Chumash skirts were made of fibers of Populus inner bark. Cordage, made from the inner bark of cottonwood or milkweed, held the rest of the fibers hanging freely. Sometimes small teardrop-shaped pieces of asphaltum, shell beads or Pinus seeds were used as weights to make the fibers hang properly. Wintun also used Populus fibers for skirts and for padding baby cradles.	As one of the major overstory trees in riparian areas of the western United States, and since riparian areas are some of the most productive wildlife habitats, the Fremont cottonwood is one of the most important plant species to western wildlife. Beavers use cottonwood for making dams and lodges and eat the bark for food. Rabbits, deer, elk, and moose feed on the tree's shoots and stems. Many insects—and the birds and other predators that feed on them—thrive in cottonwoods. Raptors often use cottonwoods for nest sites. Once cottonwoods start to die, cavities in the trees are used by over 40 animal species for nesting or roosting. Hollowed trees are used by hibernating bears and sometimes bats. The trees are also important for stabilizing stream banks, producing debris that provides habitat for fish, and providing erosion control and shade.
Arroyo Willow	*Salix lasiolepis*	Alluvial Corridor	Tree	Willows were extremely important to the Kumeyaay. A group of willows indicated a source of freshwater, and the branches, twigs, leaves and bark were used to make a number of items of daily life. Willow leaves and bark contain a compound (salicin) , the active ingredient in aspirin; they were brewed into a tea to reduce pain and fever.	Many insects utilize willows, making them excellent habitat for insect-eating songbirds. At the Nature Center willow grove, there are occasional outbreaks of the colorful Western Tussock Moth caterpillars. Arroyo willow is a host plant for the Lorquin's admiral, mourning cloak and western tiger swallowtail butterflies. Among the more interesting insects are several species of plant gall inducers. Each insect stimulates a unique plant growth (a gall) around its eggs or larvae. These galls provide food and shelter for the developing insect. A variety of other insects have learned to invade galls and prey

					on, or compete with, the inducing species.
California Bush Sunflower	*Encelia californica*	Alluvial Corridor	Shrub	The Gabrielino Indians of the Los Angeles Basin boiled all parts of the plant into a thick paste that was used to relieve aching joints and toothaches. The stems were chewed as a breath freshener.	The large, bright yellow sunflowers attract a variety of pollinators including bees, flies, and butterflies. These pollinators usually tend to stay put for a good amount of time, in order to drink the nectar or collect all the pollen. Fruits serve as a carrier for the seeds to continue reproduction of the E. californica.
California Wild Rose	*Rosa californica*	Alluvial Corridor	Shrub	The Rose has indeed been associated with human culture since antiquity, for example, in the gardens of ancient Persia and ancient China. Roses, like so many members of the Rose Family, have a multitude of nutritional and medicinal benefits. The rose hips are a well-known source of vitamin C, but preparations from the seeds, petals, and the essential oil have been used for such conditions as diarrhea, coughs and colds, sores, nervous tension, lethargy, painful joints, nervous tension and depression, and various urinary tract disorders. It was traditionally the symbol of royalty, and now represents the enduring quality of human love.	Wild roses in the landscape could be considered a “keystone” species, that is, a plant that cements a relationship between the other plants, the animals, birds and insects that inhabit the area. The flowers support many pollinator species. It provides excellent nesting habitat for songbirds. It will attract butterflies. Its long blooming season will be a compliment to all the plants nearby. After the bloom season, wild rose hips persist on the plant and are an important food source for birds and mammals.
Mulefat	*Baccharis salicifolia*	Alluvial Corridor	Shrub	Mule Fat, or Seep Willow — is the wood used by Native Americans to make hand drill spindles. They grow straight, are of the right diameter, and are also of the right density for firemaking. The Cahuilla and Costanoan tribes both made an infusion of the leaves and washed their hair and scalp in order to promote hair growth and prevent baldness.	Numerous types of insects pollinate Baccharis salicifolia, including many kinds of bees and butterflies. Butterflies use mule fat as a nectar source while bees collect pollen from the small white flowers. Since mule fat blooms nearly year round it makes a great addition to a garden if you are hoping to attract pollinators

Lemonade Berry	*Rhus integrifolia*	Alluvial Corridor	Shrub	Kumeyaay and early settlers soaked the berries in water to make a refreshing beverage; when sweetened, it is a bit like lemonade. Kumeyaay ground seeds into a beverage to drink when feverish.	Lemonade berry fruits are eaten by a variety of birds and mammals. In one study, the most important bird consumers were Bush Tits, but they ate only the fleshy outer layer and not the hard seed. Transport of seeds away from the parent plant was due primarily to small mammals. The short, stiff branchlets make excellent support for funnel-web-weaving spiders, and their flattened webs often festoon lemonade berry shrubs.
Mugwort	*Artemisa douglasiana*	Alluvial Corridor	Perennial	Mugwort is used by Native Americans in California for medicinal and ceremonial purposes. Many Californian tribes burned mugwort leaves for its medicinal purposes including promoting healthy sleep, invoking sacred dreams, and warding off wicked spirits. They also inhaled the smoke to treat ailments including the flu, a cold, and a fever. The Chumash tribe chewed mugwort to treat dental problems including tooth pain, and gum pain. One of the most interesting uses of Mugwort is its use of it as an insect repellent. Not only does it repel insects but the plant has also been used as a sedative for nervousness and insomnia. California tribes used Mugwort for many holistic and ceremonial purposes and still use it today although it is currently not recommended to take internally	In the fall mugwort seeds are eaten by local seed-eating birds including song sparrows, lincoln's sparrow, spotted towhee, red-winged blackbird, brown-headed cowbird, and American goldfinch. Year-round the plant is utilized as cover and protection for small animals. Not much is known about the interactions between insects and mugwort but it is said that native bees use the plant as nesting material. It is also said that this plant attracts predatory insects which will decrease the number of pest insects. It's known that this plant is a host for butterflies and moths including the American Lady, cosmopterix opulenta, and platyptilia williamsii.
California Goldenrod	*Solidago californica*	Alluvial Corridor	Perennial	Native Californians use powdered, dried leaves as a disinfectant powder for skin sores, wounds, burns and rashes. A decoction (tea) made from leaves was traditionally used for feminine hygiene, as a	The European Honey Bee is among the many types of bees attracted to California goldenrod. In fact, the goldenrods are excellent pollinator habitat plants. They bloom in fall, when food can be scarce. Their abundant flowers, with their tasty nectar and pollen,

				wash for skin sores and as a hair rinse.	provide an important source of food for adult pollinators and their offspring.
Basket Rush	*Juncus textillis*	Alluvial Corridor	Perenn ial	This species of rush has been used historically and is still being used today for basket weaving by several Native American peoples of southern California, such as the Cahuilla, Kumeyaay, and Chumash, among others.	Rush seeds are eaten by waterfowl, songbirds, and small mammals such as jackrabbits, cottontails, muskrats, porcupines, and gophers.
Giant Wild-rye	*Elymus condensatus*	Alluvial Corridor	Grass	The Giant Rye Grass, also known as Canyon Prince Wild Rye, was an important plant to Native Americans in Southern California, who historically used the semi-woody stems to fashion arrow shafts. The Chumash also used Giant Wild Rye to collect sugar. Aphids on the plant secrete sugars and then the sugars were harvested by thrashing the leaves onto animal hides and then collecting the sugars into balls. This was a main source of sweetener for the Chumash.	Other perennial rye grasses similar to the Wild Rye can be found in the chaparral slopes, one such grass is Deergrass, it is a similar bushy bunchgrass that is very important to wild- life. Deer use clumps of deergrass for cover when they have young fawns, and many mammals graze on the young grass blades. The seeds provide food for many birds, and the plant itself is an important larval food source for several butterfly species.
Incense Cedar	*Calocedrus decurrens*	Urban Canyon	Tree	The California Incense cedar has thick and durable bark that was used by indigenous tribes to fashion bows and arrows and conical shelters. The leaves were often used to soothe stomach ailments, and the twigs were often used to fashion brooms. Today, the wood of the California Incense Cedar is used in the pencil industry to manufacture pencils.	The California Incense-Cedar has an important fire ecology. Its thick bark makes the tree more resistant to fires. Additionally, when a fire occurs, the tree uses fire-created canopies to accelerate seed dispersal. The tree is also drought-adapted, and closes its stomata during drought to prevent water loss.

Canyon Live Oak	*Quercus chrysolepis*	Urban Canyon	Tree	The acorns of the Canyon Live Oak served as a staple food source for indigenous tribes across California. However, these acorns were used less commonly than those of other species.	The Canyon Live Oak is a key member of California plant communities, and is found in nearly every forest type in California. It is typically found in canyons, slopes, or along stream banks, and tends to stabilize the soils in these locations. It provides acorns as food sources for wildlife such as Stellar jays, woodpeckers. wild turkeys, squirrels, and bears, and provides habitat for butterfly species such as the Western Tiger Swallowtail.
Coast Live Oak	*Quercus agrifolia*	Urban Canyon	Tree	The acorns of the Coast Live Oak served as a staple food source for several Indigenous Tribes. The seed of the acorn contains bitter tannins which are leached out. Traditionally, seeds were leached by burying them in boggy ground over the winter in boggy ground, a process that could take several weeks. Once prepared, the seed can either be used whole or dried and ground into a powder. Galls on the tree are also used medicinally, treating hemorrhages, diarrhea, and more.	The Coast Live Oak provides key habitat and food sources for numerous wildlife species in woodland and riparian ecosystems. Additionally, Coast Live Oak is extremely fire resistant when compared to other oak species due to its evergreen leaves, thick bark, and ability to resprout from the root-crown post-fire.
Island Ironwood	*Lyonothamnus floribundus ssp. aspleniifolius*	Urban Canyon	Tree	The Island Ironwood is endemic to three of the Channel islands: Santa Cruz Island, Santa Rosa Island, and San Clemente Island. The Chumash used the hard and sturdy wood for posts for houses, shafts of canoe paddles, shovel-shaped tools, and wooden knives.	The Island Ironwood grows in rocky canyons in chaparral and oak woodlands. It is a rare species that is endemic to California. The tree blooms in May-July, providing pollinator habitat for native bees and birds.

California Bay	*Umbellularia californica*	Urban Canyon	Tree	The California Bay Laurel was used for medicinal purposes by numerous Indigenous tribes. The crushed leaves were inhaled or brewed in teas for pain relief, nasal congestion, and headaches. The oils were also used for earaches, sores, and to prevent springtime allergies. In the Karok tribe, the leaves were thrown in fires during ceremonies, and the foliage was burned during the traditional Brush Dance.	The California Bay Laurel attracts numerous insect and bird species, hosting the Cameraria umbellularia butterfly. The leaf litter of these trees may be toxic to vegetation, and therefore understory species may be unable to grow underneath its canopy.
California Barberry	*Berberis pinnata*	Urban Canyon	Shrub	The California Barberry has traditional medicinal uses. Its edible bark was prepared to treat fever, rheumatism, and dysentery by several Indigenous tribes.	In the spring, California barberry sprouts clusters of bright-yellow flowers that attract pollinators. These flowers give rise to berries that provide food sources to numerous bird species.
Hollyleaf Cherry	*Prunus illicifolia*	Urban Canyon	Tree	The Hollyleaf Cherry has small edible cherries that are considered to be a delicacy by some tribes, including the Tempakpakh and the Cahuilla tribes. Other Indigenous tribes cracked the dried fruit to access the seeds of these berries, and would leech and grind the seeds into meal. The Ohlone used the wood to make bows, and the Mahuna used the bark, roots, and leaves to make cough medicine.	The Hollyleaf cherry provides food sources and habitat for caterpillars of the pale swallowtail. It also attracts bees, and serves as a larval host for the California hairstreak, Lorquin's admiral, Nevada buckmoth, and tiger swallowtail.
Western Redbud	*Cercis occidentalis*	Urban Canyon	Tree	The Western redbud is a flowering plant. Its twigs were used by Indigenous people to weave baskets, and its bark can be used to produce a reddish dye.	The Western redbud has special value to native bees and bumblebees, providing nesting material and structure. It is commonly used in hummingbird gardens, and hosts up to 12 butterfly and moth species.
Coffeeberry	*Frangula californica*	Urban Canyon	Shrub	🌱used to treat constipation caused by acorns 🌱the Chumash and Costanoan dried and ground the inner bark to create a laxative tea	🌱great for erosion control on dry steep hillsides 🌱California coffeeberry is a staple browse of big game and livestock during the fall

				🌱the leaves were directly rubbed on skin as a remedy for rheumatism 🌱the bark was used to treat influenza and as a kidney remedy 🌱a heated root was placed in the mouth for toothaches	🌱birds, black-tailed deer, and black bears eat the fruits 🌱supports beneficial insects and attracts native bees
Hummingbird Sage	*Salvia spathathea*	Urban Canyon	Perennial	🌱the Chumash rubbed fresh leaves over the body to cure illness by sorcery 🌱leaves an analgesic and sedative effect	🌱supports butterflies and moths including *Anstenoptilia marmarodactyla*
Douglas Iris	*Iris douglasiana*	Urban Canyon	Perennial	🌱iris cordage was used for fishing nets, string, rope, snares, hairnets, and regalia 🌱 tea from iris roots was used for kidney trouble 🌱the Yana chewed iris roots to cure coughs 🌱the Modoc used an iris root decoction to soothe sore eyes 🌱 the Monache and Yokut tribes made flour from iris seeds	🌱supports butterflies and moths including *Hyles lineata* and *Amphipoea americana*
Evergreen Currant	*Ribes Viburnifolium*	Urban Canyon	Shrub	🌱Nothing noted in Native American Ethnobotany database	🌱supports about 37 species of butterflies and moths including *Polygonia gracilis* and *Aglais milberti* 🌱great for erosion control in dry, shaded spots 🌱a nectar source for hummingbirds, butterflies, and bees 🌱endangered plant species by USDA National Genetic Resources Advisory Council

Coast Live Oak	*Quercus agrifolia*	Hill District	Tree	🌱native to hillsides, mountain slopes and savannas of inland San Fernando, San Gabriel, and Santa Clarita valleys 🌱oakwood was important to many indigenous communities 🌱acorns were a main food source for most native California diets 🌱Tongva people made wet acorn meal 🌱center of creation of indigenous myths bc they were essential to life	🌱 exceptional fire resistance accelerates post-fire recovery 🌱 provide high soil fertility through nutrient cycling 🌱 22% of CA land animals eat acorns 🌱 25-68% reduction in bird populations after SOD 🌱 hydraulic lifting stabilizes soils and watersheds
Southern California Black Walnut	*Juglans californica*	Hill District	Tree	🌱Chumash: ate walnuts, used nutshells for dice, bark for baskets	🌱29 species of diurnal birds and many rodents rely on southern california walnut for food and habitat 🌱planted for erosion control 🌱raptors use the upper trees as roosts and nesting paces
Laurel Sumac	*Malosma laurina*	Hill District	Shrub	🌱Chumash: flour from dried fruits, root bark for tea 🌱contains urushiol which produces severe contact dermatitis (same family as poison oak and poison ivy; "some people have such reactions") 🌱common name "taco plant" because its large, thin leaves fold up along the midrib 🌱Kumeyaay: used leaves for tea, made into wash for childbirth 🌱"model railroad enthusiasts use the dried flower remains as miniature trees" 🌱farmers used laurel sumac as an indicator of frost-free climate that was suitable for avocado and citrus 🌱crushed leaves have an apple and bitter almond aroma	🌱pollinators include: marine blue, polistes dorsalis, tansy mustard sweat bee, and gray hairstreak 🌱primary consumers include: house finch, northern mockingbird, white-crowned sparrow, cuscuta ceanothii, american crow, california towhee, leaf-footed 🌱fire-adapted: quickly resprouts after fires, seed sprouting is enhanced by heat

Sugar Bush	*Rhus ovata*	Hill District	Shrub	🌱fruit used as sweetener, for porridge, and a cold remedy 🌱Cahuilla: infused leaves treat colds and coughs 🌱small fruits are pressed to make a tart beverage (like lemonade) 🌱Kumeyaay: leaf infusion drank before childbirth to aid the delivery	🌱provides erosion control 🌱seeds are stimulated to germinate by heat from fire 🌱also in family with poison oak but presence of urushiol (irritant) is undetermined 🌱provides for for upland game birds, songbirds, and large and small mammals 🌱attracts large numbers of native bees 🌱native bees nest beneath or within and also use parts to construct their nests
Elderberry	*Sambucus nigra spp caerulea*	Hill District	Shrub/ Tree	🌱branches were used to make arrow shafts, flutes, and whistles 🌱blossoms and berries are edible in small quantities (e.g. pancakes, fritters, jellies, syrups, wine, etc.) 🌱liquid made from flowers and leaves was used for medicinal purposes 🌱some use the wood to make combs, spindles, and pegs	🌱host plant to Valley Elderberry Longhorn Beetle (threatened species) 🌱berries and nectar feed bluebirds, magpies, warbling vireo, western tanager, house finch, green-tailed towhee, woodpeckers, etc.
California Sagebrush	*Artemisia californica*	Hill District	Shrub	🌱leaves to make a poultice for tooth aches, wounds, and asthma 🌱sagebrush decoction used for menstrual problems, childbirth, menopausal symptoms, newborn to flush out their systems, colds, rheumatism, and coughs 🌱leaves chewed fresh or dried for smoking 🌱Luiseno: burned bushes with white sage in ceremonial fires before hunting 🌱used in a spray to get rid of fleas on beds 🌱Tongva: girl's puberty ritual, men smudged with CA sagebrush and white sage before hunting	🌱planted for erosion control on slopes and revegetation 🌱provides foraging and nesting habitat for the threatened California gnatcatcher and Bell's sage sparrow 🌱supports dusky-footed woodrats and desert woodrats

California Bush Sunflower	*Encelia californica*	Hill District	Shrub	🌱Tongva: chew leaves for fresher breath 🌱all parts of the plant are dried into a ceremonial incense 🌱leaves, flowers, and stems are mashed up to treat wounds and pain	🌱attracts pollinators including butterflies and native bees (fatal metalmark, dwarf tawny wave, white-lined sphinx) 🌱supports convergent lady beetle, red-eared blister beetle, honey bee, golden-crowned sparrow, anthophora, urbana, monarch butterfly, funereal duskywing
Purple Sage	*Salvia leucophylla*	Hill District	Shrub	🌱no Southern Californica groups eat the seeds of purple sage	🌱nectar attracts hummingbirds, butterflies, bees, and other pollinators 🌱seeds feed goldfinches, quails, sparrows, juncos, and towhees 🌱odor of leaves repel deer and rabbits
Toyon	*Heteromeles arbutifolia*	Hill District	Shrub	🌱Chumash, Tongva, Costanoan, Luiseno, Kumeyaay and Cahuill collected and ate berries 🌱Cahuilla and Costanoan made infusion to treat infected wounds, regulate menstruation	🌱berries eaten by mockingbirds, cedar waxwings, American robins, coyotes, and bears
Bush Monkeyflower	*Mimulus aurantiacus*	Hill District	Shrub	🌱Miwok and Pomo used the plant for sores, burns, diarrhea, and eye irritation 🌱flower extract used as eyewash and antiseptic 🌱tea from root used to treat diarrhea	🌱sticky resin deters herbivores but some butterflies use this plant as a larval host 🌱provides larval food plant for buckeye butterflies and variable checkerspot 🌱orange flowers attract hummingbirds and butterflies
California Buckwheat	*Eriogonum fasciculatum*	Hill District	Shrub	🌱Costanoans: used to make decoctions for urinary problems 🌱Diegueno: made into an antidiarrheal decoction 🌱Navajo: plant used for anti-witchcraft 🌱Omaha and Zuni: made into poultice for wounds 🌱Kawaiisu: used wood to pierce ears	🌱attracts honey bees, bernardino blue butterfly, villa bombyliid fly, callophrys butterfly, mordella beetle, etc. 🌱larval food for *apodemia mormo*, *lycaena heteronea, and* satyrium tetra 🌱harvester ants collect the achenes

Black Sage	*Salvia mellifera*	Hill District	Shrub	🌱Tongva: ground seeds into meal, stems and leaves used to make seasonings, warded off bad spirits, perfume, used for coming-of-age ceremonies, smoked 🌱heated leaves applied topically for earaches and sore throats 🌱some plant parts used to treat bronchitis and paralysis	🌱indicator of air pollution: sensitive to increased levels of ozone and sulfur dioxide 🌱rapidly reoccupies burns in coastal sage scrub and chaparral communities 🌱not eaten by deer and rodents 🌱gambel's quail and scaled quail eat seeds

Table 4

Costs of Moore Hall Turf Conversion

Expenditures	**Cost**
Plant Purchases	$38,000
Cost of Labor	$47,000
River Rock	$12,000
Irrigation Equipment	$10,000
Mulch and Other Material	$13,500
Total Cost	**$120,500**

Cost per square foot	**$7.98**

Note. Key data on the fixed costs of turf conversion were collected from Alex Gomez of the UCLA Facilities department on May 17th, 2023. Moore Hall has an area of 15,108 square feet

Table 5

Adjusted Moore Hall Turf conversion Costs with LADWP rebate

Expenditure	**Adjusted Cost**
Cost per square foot	$2.98
Total Cost	**$44,960**

Note. The LADWP Turf Replacement program grants a $5.00 per square foot rebate for turf under 50,000 square feet that are converted to areas of California Friendly plants.

Table 6

Yearly maintenance costs for Turf at Moore Hall

Expenditure	**Yearly Costs**
Mulch and woodchips	$250
Tool repairs and replacement	$300
Irrigation repairs	$500
Aeration	$800
Fertilizer	$1625
Labor	$54,512.64
Total Cost	**$57,987.64**

Cost per square foot	**$3.84**

Note: Key data on the yearly costs of turf maintenance were collected from Cornelio Franco of the UCLA Facilities department on May 24th, 2023.. Moore Hall has an area of 15,108 square feet.

Table 7

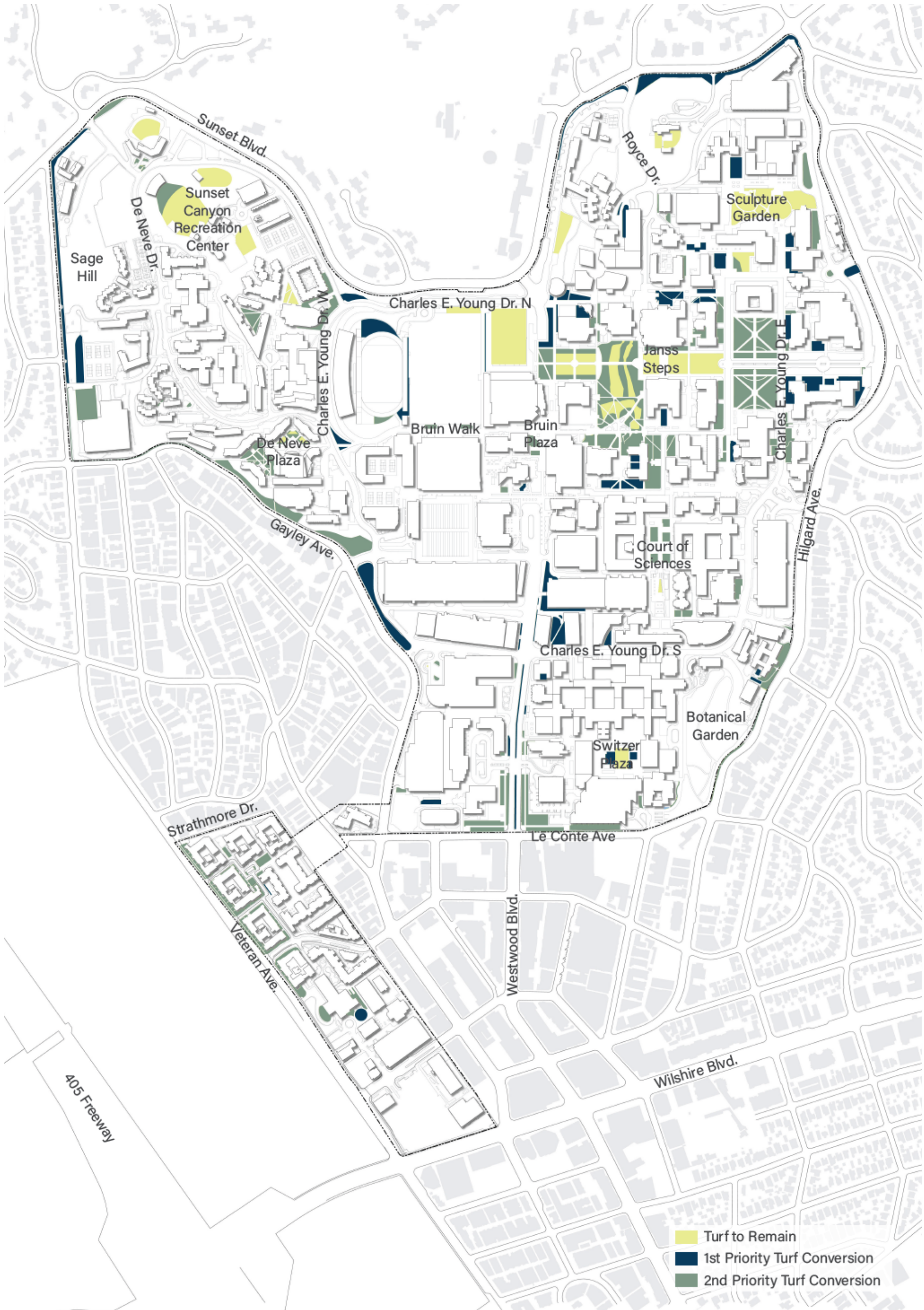
Yearly maintenance costs for landscaped plants at Moore Hall

Expenditure	**Yearly Costs**
Mulch and woodchips	$500
Tool repairs and replacement	$50
Irrigation repairs	$500
Cost of labor per year	$18,170.88
Total cost	$19,220.88
Cost per square foot	$1.27

Note: Key data on the yearly costs of turf maintenance were collected from Cornelio Franco of the UCLA Facilities department on May 24th, 2023. Moore Hall has an area of 15,108 square feet.

Figure 1

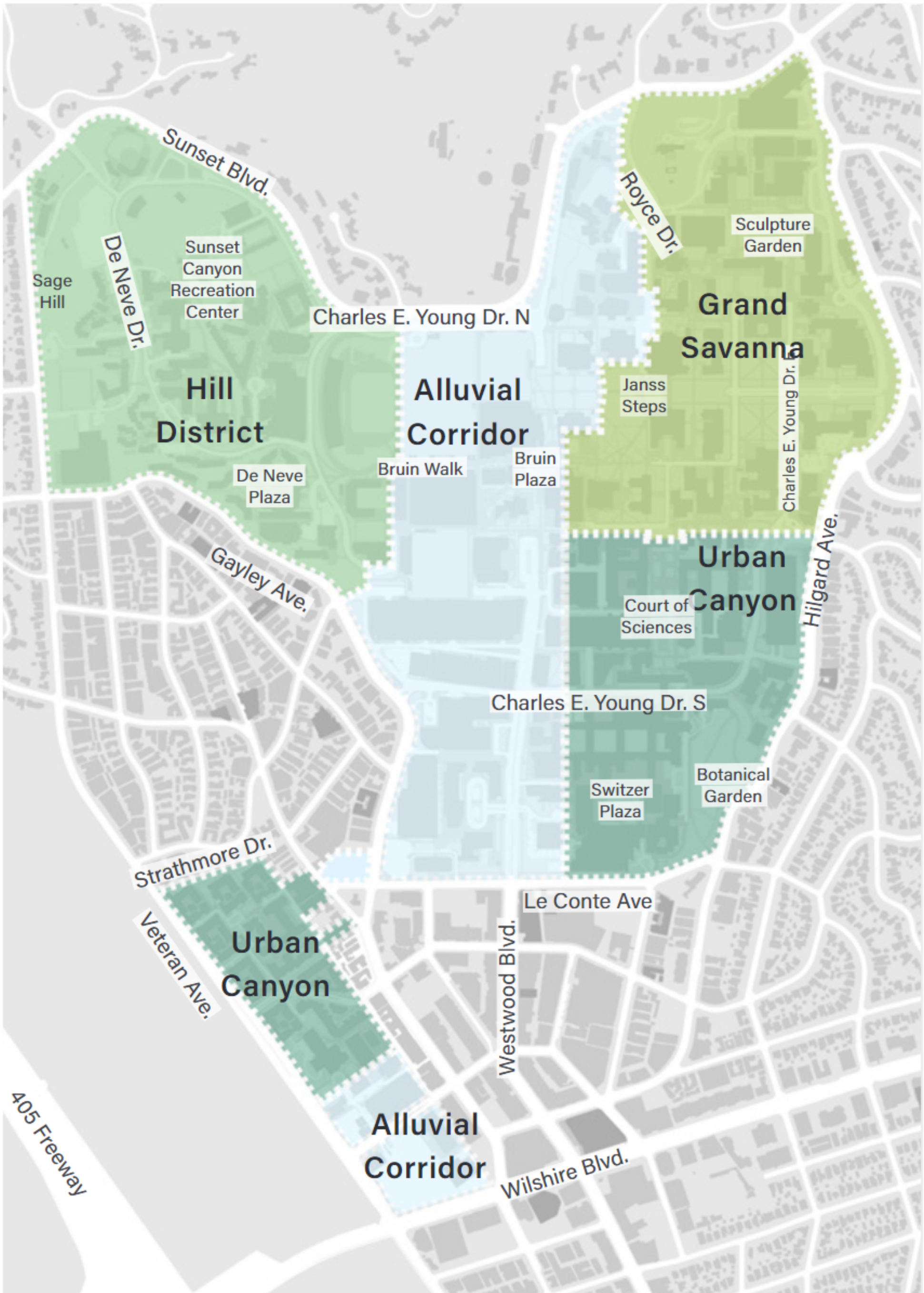
Priority Areas of Turf Conversion on the UCLA Campus



Note: Data provided by UCLA Facilities department. 1st priority turf conversion sites, which are depicted in dark blue, will be sampled for irrigation type by our team.

Figure 2

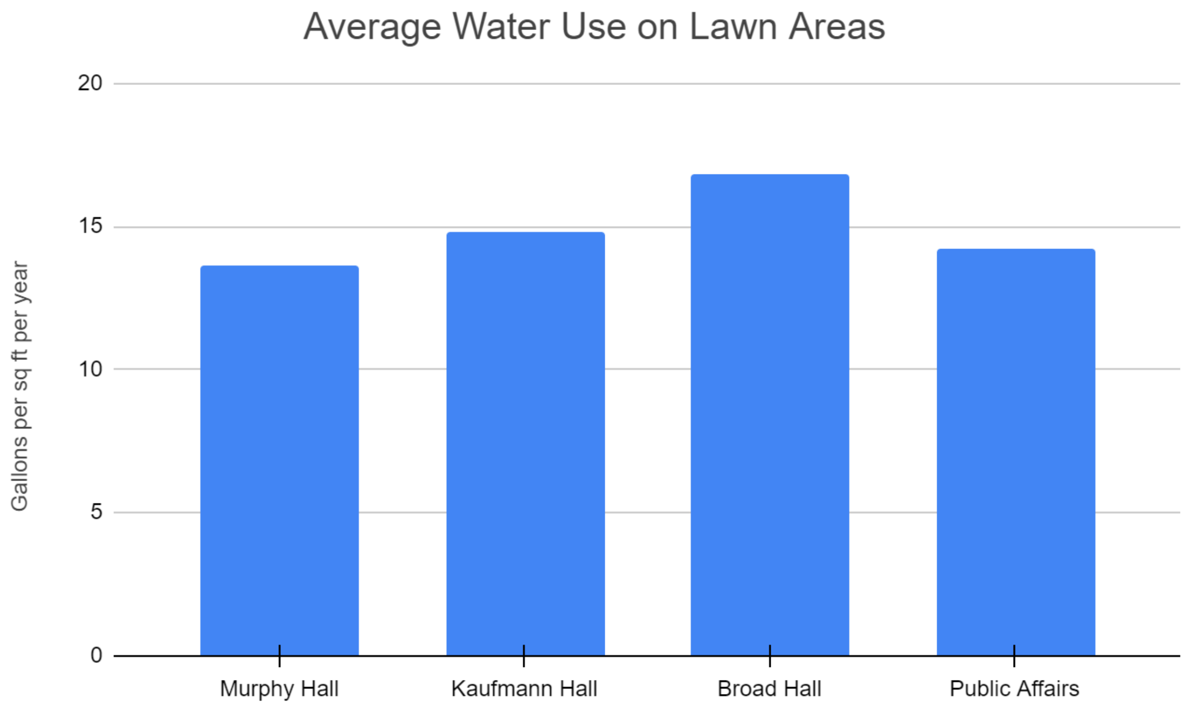
Landscape Zones on the UCLA Campus



Note: Image provided from UCLA Landscape Plan.

Figure 3

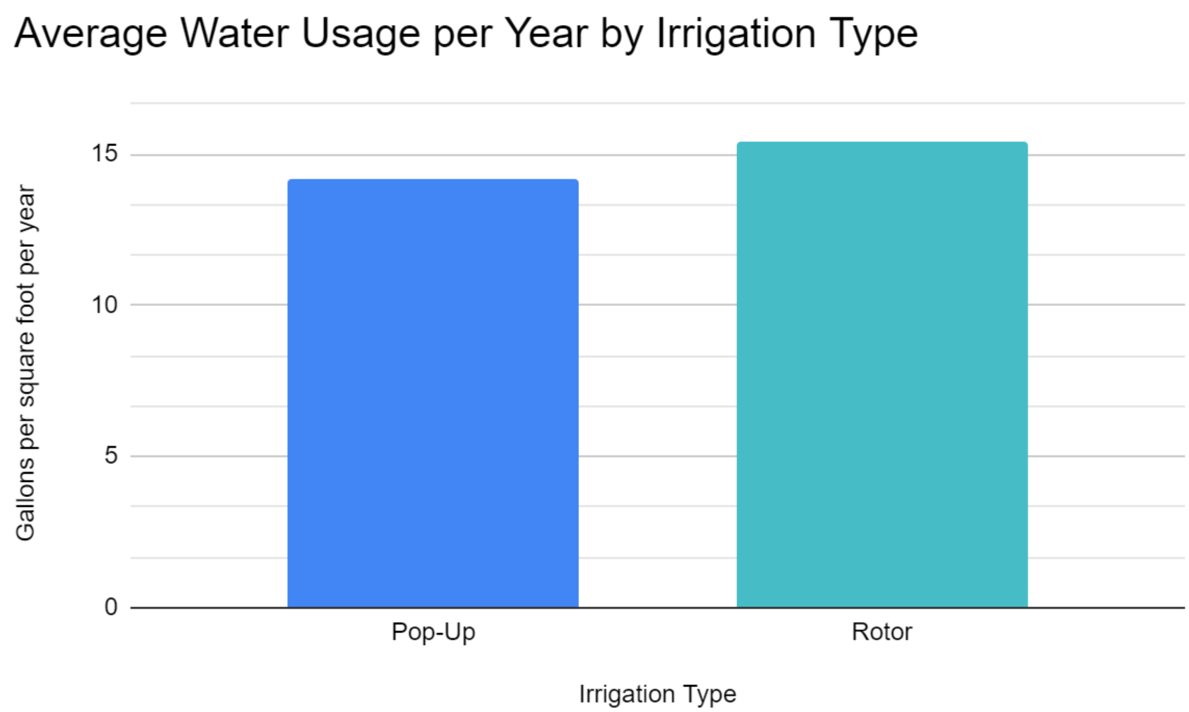
Average Water Use on Lawn Areas



Note: Average water use for four different first priority buildings calculated from irrigation survey data including, irrigation type, panel area in square feet, and runtime for irrigation type.

Figure 4

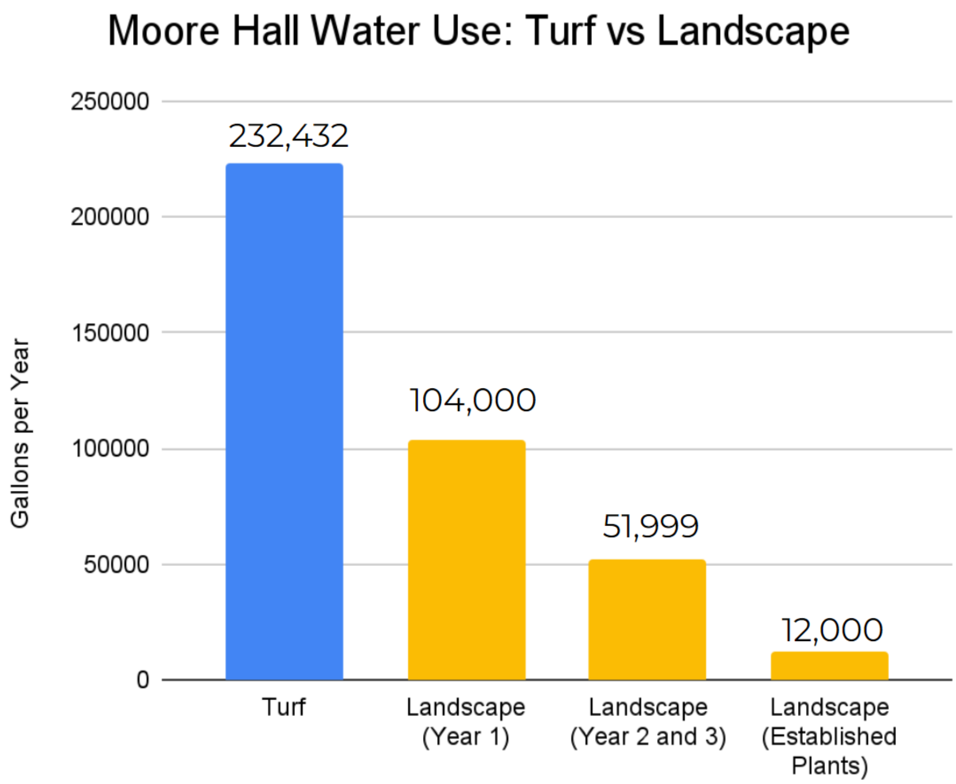
Average Water Usage per Year by Irrigation Type



Note: Comparative graph of average water usage per year for pop-up and rotors calculated from average water output of panels at first priority conversion sites.

Figure 5

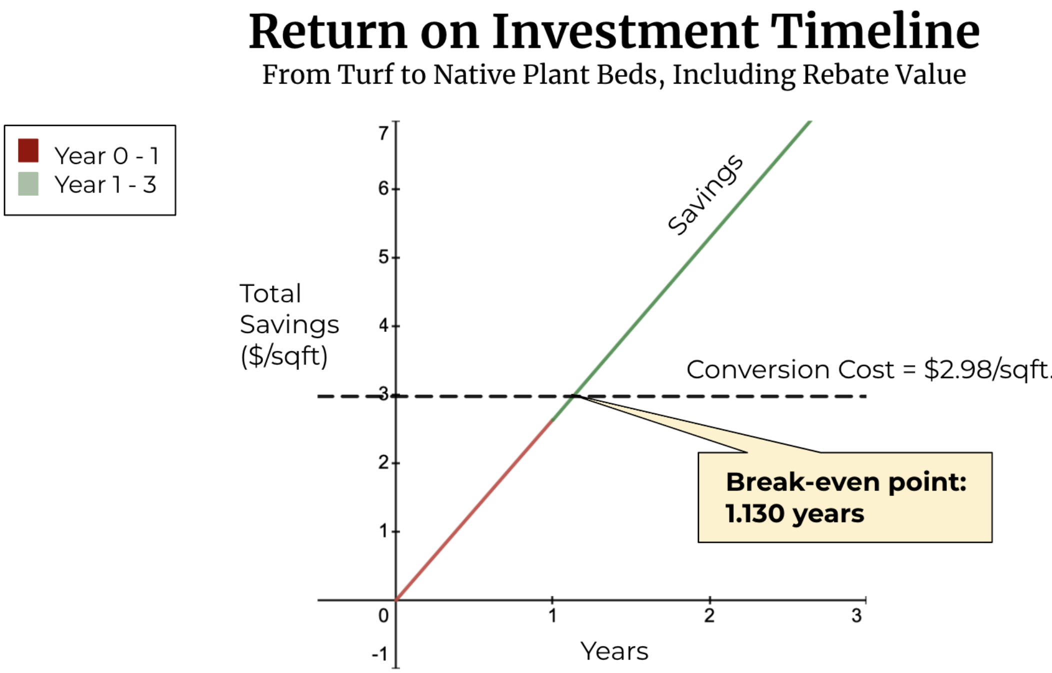
Water Use at Moore Hall



Note: Water usage was estimated based on field data on turf irrigation and the estimated yearly watering schedule for landscaped plants. In their first year, we expect that landscaped plants will be watered once weekly. In their second and third year, we expect that landscaped plants will be watered thirty minutes weekly. Once landscaped plants are established, we expect that they will be watered thirty minutes monthly.

Figure 6

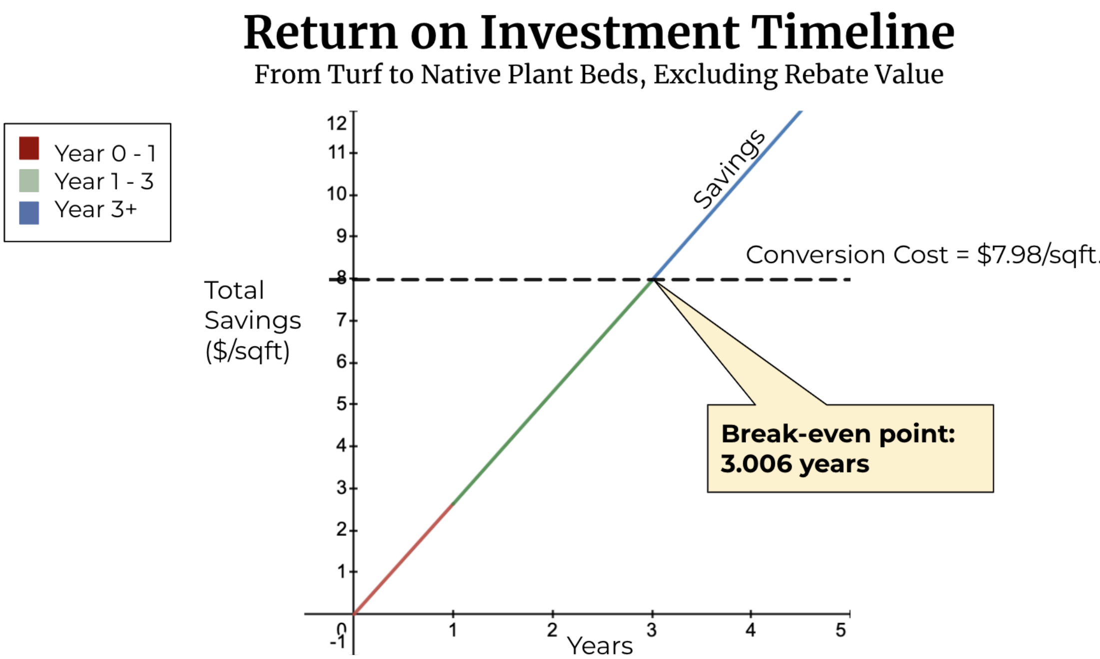
Cost Benefit Analysis Return on Investment



Note: Return on Investment graph portraying the time needed to recoup adjusted cost of conversion through water and maintenance savings.

Figure 7

Cost Benefit Analysis Return on Investment excluding rebates



Note: Return on Investment graph portraying the time needed to recoup cost of conversion (without rebates) through water and maintenance savings .

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