"Greening the Playing Fields"

Strategies to reduce the amount of water used to maintain the sports fields at Occidental College

By Meredith Herman

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Introduction

Southern California suffers from a severe water shortage. This arid region has not produced enough rainfall to sustain its burgeoning population for many years. Most of the water used in Southern California is imported hundreds of miles before it even reaches this area. By understanding that over 50% of residential water use is for outdoor greening, it becomes apparent that gardening and lawn maintenance techniques have a significant impact on the total amount of water used by the state. The current water crisis calls for environmental stewardship. If all California residents made environmentally conscious decisions concerning lawn care, collectively this would make a significant impact.

At Occidental College 66% of all water consumed is used for irrigation purposes. The sports fields and turf area on campus use 60% of all consumed water. This roughly equates to 60,000 HCF, which stands for one hundred cubic feet or 748 gallons of water. In other words Occidental College uses 50 million gallons of water per year to water their lawns and sports fields. When I began to look for ways to cut water use on campus, it became apparent that the best

strategy was to try and identify ways to cut water consumption in the maintenance of Occidental's biggest water consumer. The tactics given in this paper are suggestions that should serve to cut both the amount of water used on the school's sports fields and the cost of maintaining them.

Overview of the Fields

Occidental College currently has five major sports fields: the Football field, the Baseball field, the Softball field, and the Upper and Lower Soccer fields. These fields are a major component of Occidental's leisure and competitive sports programs. The college is currently in the stages of building a new Softball field on the backside of Mt. Figi. After the construction of this sight the current Softball field will most likely be turned into a parking structure. Henceforth, Occidental plans to maintain five sports fields to accommodate the college's needs.

Though Occidental has already implemented a number of tactics to reduce water use for these fields, I feel that there is still more that can be done. In Los Angeles efficiently irrigated turf typically requires 1,500 HCF of water per acre each year to maintain.[1] Occidental's turf uses approximately 3,811 HCF of water per acre each year. It is important to consider that our sports fields receive a considerable amount of traffic and use, which contributes to the lawns needs for extra water. But seeing as though Occidental's fields use over twice the

[1] "Horticulture Solution Series," *Illinois Cooperative Extension Service*. http://www.ag.uiuc.edu

recommended amount of water, it seems as though there could be room to reduce water use. The current amount of money allocated to watering the turf at Occidental is approximately $140,000 per year. So if saving water is not incentive enough to lessen water use, the college should consider the large financial savings. By changing some of the current maintenance methods, the school might be able to cut down both the amount of water used and the overall maintenance costs. The school is currently in the unique situation of preparing to build an entirely new field. By analyzing the water use of the current fields, the school can plan for the new field to be financially and environmentally sound from the beginning.

For this project I looked at how the following techniques should help Occidental conserve both water and money: Watering techniques, soil types, grass selection, fertilizers, and aeration. The sprinkler system and the variation of soil types seemed to have the largest impact on the total water usage of the sports fields. Most of the data used in this paper pertains only to the two Soccer fields and the Football field. This is because the other fields on campus do not have water meters that exclusively measure how much water is going towards the fields, making it difficult to produce accurate data. The Soccer fields are the only fields that have their own meter. The meter that pertains to the football field also services Rush Gym, so it should be considered that all numbers pertaining to the Football field are inclusive of some human use, though the field does constitute 97.6% of the area that meter services.

The Computerized Sprinkler System

In 1997 Occidental installed a computerized sprinkler system that controlled the irrigation of four of the five sports fields. The system was designed by researchers at Cal Tech to be used as an instrument to cut water costs. Previously, Occidental had the same irrigation system, but the valves, which turn the sprinklers on and off, were controlled manually as opposed to by the computer.

The new system offers many beneficial tactics for saving water. First the system saves labor costs, as people are no longer needed to operate the system. The sprinkler system is programmed now to water throughout the night. This saves water, as during the night the weather is coolest and there is less water evaporation.

The second attribute of the system is that it waters the lawns in accordance to weather patterns. The computerized valves are connected to a weather satellite that sits near Keck Theater. This satellite monitors daily temperature and rainfall. This works in conjunction with tensiometers, which sit in the fields and measure the moisture at the plant's root level. Each day the lawn gives off a certain amount of water when it is exposed to the sun in order to stay alive. This process is referred to as evapotranspiration.[2] The tensiometers can accurately measure how much water is evapotranspired each day. These

[2] "Xeriscape Makes Cents." *A Handout from ESS-246.*

factors are compiled by the computer on a daily basis, the computer then waters the fields according to how much water they need.

Finally this system ensures that excessive water is not used while watering. Normally, sprinkler valves that are electrically controlled run off clocks that are programmed to water the same amount each day. Often times these controllers are not even reprogrammed to accommodate seasonal weather patterns. This means that sprinklers may turn on even when it is raining if someone does not continually check the system. But the computer at Occidental has a rain watch guard that automatically shuts off the sprinklers when there has been any rainfall. Other problems associated with more rudimentary sprinkler systems is that they are frequently turned on too high in the interest of trying to save time while watering. When this occurs often times misting takes place. This is when excess water actually floats away in a fog that is created by the high water pressure. Another critical way in which excess water is wasted is in overspray. This term refers to the water from irrigation systems that spray sidewalks and streets, a common occurrence when persons go to turn their systems on or off.[3] Water is also frequently wasted when people leave sprinklers on for too long.

It is apparent that this program has great potential; though it has not yet ~~been~~ proved that it saves water. Using a water analysis report that showed Occidental's water and sewage billing for the five years of 1993 through 1998, I compared the amount of water used by the Soccer Fields and the Football field, before and after the computerized sprinkler system was installed. Remember

that 1998 was the first full year that the system was intact. Please reference the graph entitled "Appendix 1." The Soccer field used less water in 1998 than it had the previous year; but more water than it had used in 1994 or 1996. The football field used significantly less in 1998 than it had the two previous years; but only slightly less than it had in 1994. However in 1998 this area saw massive rainfalls due to El Ninio, so there should have been a drastic reduction in water use on both fields. The fact that the soccer fields barely showed a reduction in water use, raises questions as to how accurately this machine is assessing the fields needs for water. It is difficult to come to any conclusions, seeing as there is only one full year of data pertaining to water use since the computer system has been installed. After a few more years the school should be able to make a much better assessment. Also, now that the technology is in place, it should not be that difficult to reprogram the computer to water at a lesser rate.

Part of the inefficiency of the current computer program might be attributed to some of the following factors. The current system assesses the need to water the fields on a daily basis, yet the Lawn Institute of America states that the healthiest lawns are produced when they are watered heavily at infrequent intervals. The Institute recommends one watering per week when temperatures are not to hot. The Institute also suggests that the combination of both rain and irrigation should supply a lawn with one inch of water per week when temperatures range between 45 to 85 degrees, one and a half inches when temperatures range from 85 to 90 degrees, and two inches per week when

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[3] "Xeriscape Makes Cents." *A Handout from ESS-246.*

temperatures exceed 90 degrees.[4] If the computer system at Occidental compiled its measurements on a weekly basis, or even every few days, the system might determine that less water was necessary for the fields.

The Different Soil Types

The soil type used for a field makes a significant difference as to how much water is needed. Different soil types allow water to absorb at faster rates, preventing excess water from running off. And some soil types have a better water retention rate that helps keep the soil around the roots of the grass longer.[5]

The Football field at Occidental uses a soil that is primarily composed of clay. Clay soil has just about the slowest absorption rate of any soil type. It takes one inch of water five hours to absorb into clay soil. This number is extremely high when you compare it to sand soil, which will absorb that same amount of water in half an hour. Difficulties can arise from having a soil that absorbs at this slow of a rate. Generally speaking, most watering systems will apply water faster than a clay field can absorb it. This lends itself to the creation of puddles and excess run-off. Also, any time there is water on top of the soil that has not yet been absorbed soil erosion can occur. Water standing on the field can also lead to plant disease and the killing of young grass sprouts.[6] An important aspect of clay soil is that it has a fairly good water retention rate.

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[4] "What you need to know about proper watering practices." *The Lawn Institute*, Marietta, GA. http://www.lawninstitute.com

[5] "What you need to know about proper watering practices." *The Lawn Institute*

[6] "What you need to know about proper watering practices." *The Lawn Institute*

Water tends to hold at root level as opposed to moving through the soil quickly and pooling underneath the soil. Clay has one other specific characteristic, when it absorbs water it swells, and as it loses water it dries and shrinks. This is an important quality to consider, because if a proper balance of water is not kept on a clay-based field, the soil will undergo extreme changes which can easily lead to the death of the grass.

The Upper and Lower soccer fields currently have a soil that is a mixture of granite and decomposed granite. Please see the picture entitled "Current Soil Composition of the two Soccer Fields" in the appendix section for further reference. This soil mixture does not lend itself to grass production. For starters it has poor absorption qualities. When the soil receives water, usually the water passes right through the soil and falls down to the base rock. This means that none of the water stays near the roots of the grass long enough for the grass to absorb it. Granite soil also has a property that allows the soil to compact easily. Considering how much traffic the Soccer Fields receive, the soil is probably compacted to the point that it is hard as cement for most of the year. When compaction occurs to this degree, the water can not penetrate the soil, so puddles and run-off occurs.

After discerning the properties of the soil used on the Soccer and Football Field, I looked at the water report to compare the amount of water used by the different fields. I took the total amount of water, in gallons, used by the two soccer fields and the football field, and divided this number by the area of the fields. Please reference "appendix 2" for an illustration. I equated this formula

for both fields for the years 1994, 1996, 1997, and 1998. What I found was that for all four years the Soccer field used almost twice as many gallons of water per sq. ft. as the Football filed. Seeing as though the soil type is the most differentiating factor in both composition of the fields and maintenance, I think that the soil type is causing the discrepancy in the amount of water needed to maintain the two fields.

After researching other soil options I came up with a soil composition that I think would lend itself to usage of the most minimal amount of water. Please reference the picture entitled "Optimal Soil Conditions" in the appendix section. On an optimal field, sand would be the major component of the soil. Sand has the fastest absorption rate of any type of any type of soil, helping to minimize excess run-off and soil erosion. Sand does not easily compact, so the surface is always porous and ready to receive water. The other critical aspect of this plan would be the construction of the base of the field. The base rock that sits underneath the soil should be graded at a slight angle, about one to two degrees. This slight slope allows water that is not used by the grass to drain out of the field, and in the event of major rains, it will prevent the field from being flooded. Finally, I would place a layer of plastic and an oil sealant over the base rock. This element is very important when constructing a field that will have a lot of traffic. Each time someone runs on the field the soil compacts. After time the compacted soil will begin to push into the base rock causing it to crack, break apart, and eventually mix with the soil. The base rock is usually composed primarily of granite and concrete, two elements that you do not want in your soil.

Also, if the base rock breaks up at its surface, than the slope that it was graded on will be destroyed, ruining the field's drainage mechanism. The plastic seal will keep the soil and base rock intact and indefinitely separated.

Since Occidental is in the planning stages of a new Softball field, a plan such as this should be considered to help save water. When constructing a field from the initial stages, to implement this plan would not cost a significantly different amount than it would cost to put in any other soil type. When environmental considerations are made during the original planning, conservation can be attained much more easily. In order to remedy the excessive amount of water that the soccer fields use, it would almost be necessary to tear out the field and start anew. An outside contractor gave the price estimate of $150,000 to totally redo the existing Soccer Fields. This seems like an exorbitant amount of money; but it should be considered that it costs about $20,000 more each year to water the Soccer fields than it does the Football field, which have almost identical areas.[7] Please see the graph of the cost of watering the two fields entitled "appendix 3." This means that the cost to redo the fields would be made back in water savings in seven to eight years. Also the current granite fields are subject to having major renovations to break up the soil every few years since it compacts so easily. Once this new field would be installed, with proper maintenance it should not require any major renovations for many decades.

Additional Techniques

The type of grass selected for a field can have a large impact on how much water is needed to maintain it. Occidental has seeded most of their sports fields with a mixture of annual rye and Bermuda grass. This grass blend has been chosen since it tends to lend itself to a "fast field" that balls move quickly across. But more importantly, this blend probably has the best ability to adapt to the hot and arid climate of Los Angeles.

Bermuda grass is the predominant grass species throughout the southwest. More so than any other grass type, it demands sun and has little tolerance for shade. Bermuda grass tends not to have any significant disease or insect problems when properly mowed, fertilized and watered. Bermuda grass has one of the lowest water and fertilization needs of any grass types.[8]

The Perennial Ryegrass that is mixed with the Bermuda grass is also drought tolerant; yet not to the same degree. This ryegrass has very rapid seed germination. This is an important quality for fields that get an abundance of use. When the field becomes torn up, or there are dirt patches in the turf, the rye grass seed can be thrown onto the field and they will quickly grow grass in the needed spaces. The ryegrass also has a high cold tolerance for a grass that is normally grown best in warm climates; this helps the grass to survive in the event

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[7] The total area for the football field if 110,054 sq.ft. and the total arc for the two soccer fields combined is 116,741 sqft. This information is taken from the "Analysis of Water Use and Sewer Discharge at Occidental College."

[8] "How to Select the Best Grass Seed for a Southern Lawn." *The Lawn Institute*, Marietta, GA. http://www.lawninstitut.com

of a overnight freeze.[9] This grass blend that Occidental has chosen is probably the best fit for both the sports that are played on the fields and the hot climate.

Fertilization has one of the largest impacts on the quality of a field. Nitrogen is the most important nutrient in a fertilization program. It is the faction that helps promote a lawn's green color and it's thickness.[10] At Occidental the fields are fertilized with a slow release nitrogen fertilizer. This provides the soil with the nutrients it needs over a period of time, which helps to attain even growth. Slow release nitrogen fertilizers help to reduce rapid topgrowth and the need for frequent mowing. This cuts back on labor costs as the fields are both fertilized and mowed at more infrequent rates.

Another technique used at Occidental to help maintain the lawns is aeration. Aeration is a process in which an aerifier is rolled over a lawn, where it inserts metal tines into the soil and removes small cores of grass and soil. The small holes left behind make it easy for water to move down into the soil. This also gives grass roots additional room to grow. This process is critical for fields that are subject to heavy foot traffic, which causes the soil to compact.[11] Occidental uses this technique on both the soccer and football fields when needed. Considering the high compaction rate of the soil on both of these fields, this process is critical, especially during the sports seasons.

Conclusion

[9] "Turfgrass Species Selection." *The Ohio State University.* http://www.ag.ohio-state.edu
[10] "Lawn Care Plans." *The Ohio State University.* http://www.ag.ohio-state.edu

At Occidental a large percentage of the total water used by the school goes directly towards the maintenance of the sports fields. This study showed that soil type has the most critical affect on the amount of water needed to maintain a field. The Soccer fields are currently two of the biggest consumers of water on campus. The soil type of these fields, which is primarily composed of granite, does not lend itself to water conservation and poses a variety of maintenance problems. In order to drastically reduce the amount of water used to maintain the sports fields, it can be recommended that the soil type for all the fields is changed over the course of time. In the near future, my best suggestion is to plan for the new Softball field to have a soil composition that will easily absorb and retain water, which will eventually save enormous costs. I also suggest that the school renovate the current soccer fields. Though this will cost a large amount of water up front, the extreme savings will pay for the renovation in a short period of time.

I also suggest that the school continue to monitor their new sprinkler system. This new technology has great potential to help reduce the amount of water used on the fields. The program that the system runs on may need to be fine tuned, or structured in a way that uses less water. It is important to remember that grass is a very drought tolerant plant and that less water is always better than too much. Possibly reprogramming the system to water at less frequent intervals may help to save enormous amounts of water.

The sports fields at Occidental provide the school with both visual beauty and recreational benefits. They are an important part of student life and the

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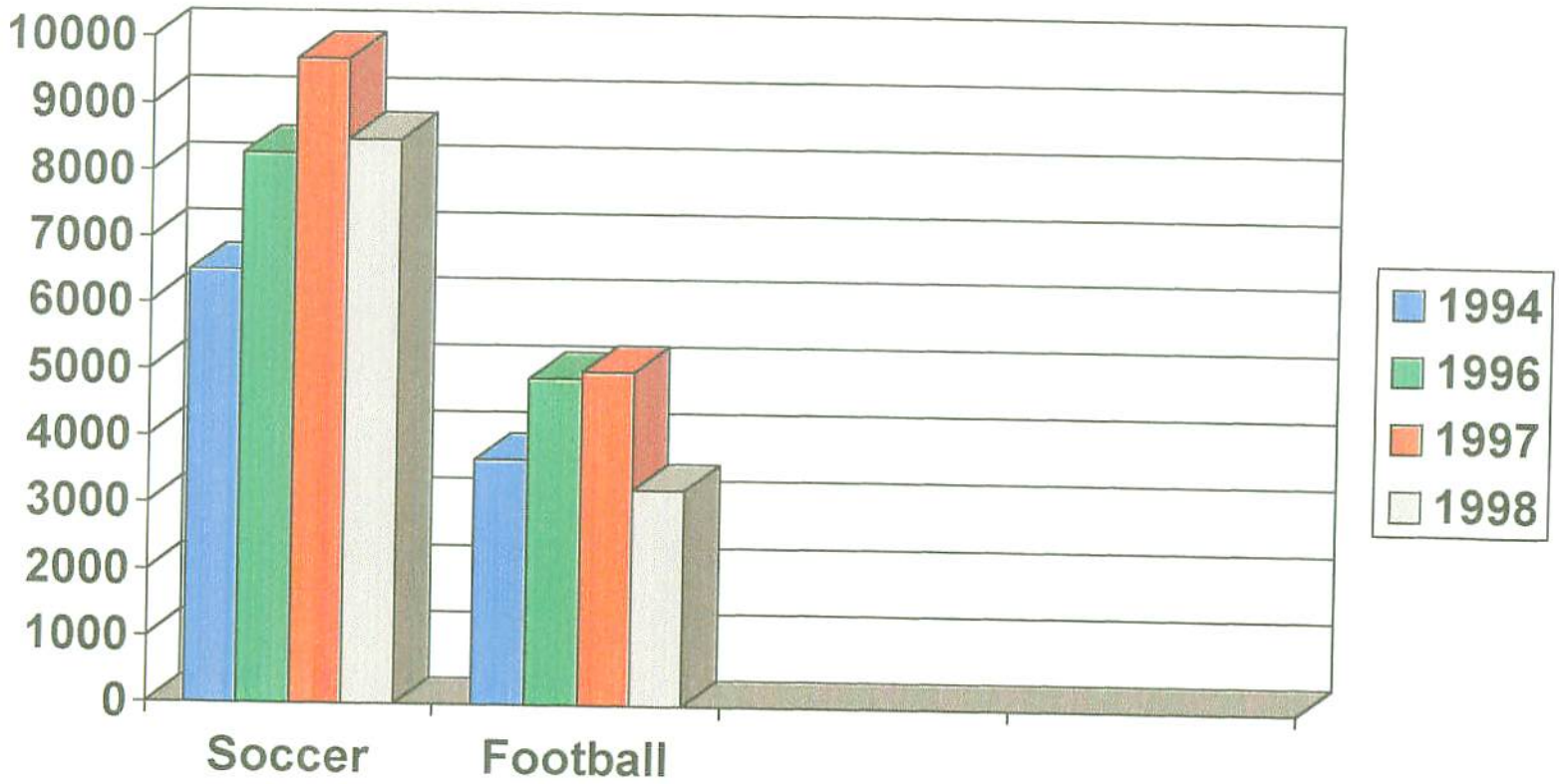
[11] "What you need to know about proper watering practices." *The Lawn Institute*

cosmetics of the campus. Maintaining the fields should be a high priority of the school. But in lieu of the severe water shortages in Southern California, the school should be aware of how much water their fields are using. By continually assessing the maintenance program of the fields, the school will be more conscious of how much water the fields are using, and be more able to change factions that maybe wasting unnecessary water.

Appendix 1


10000
9000
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Soccer
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1994
1996
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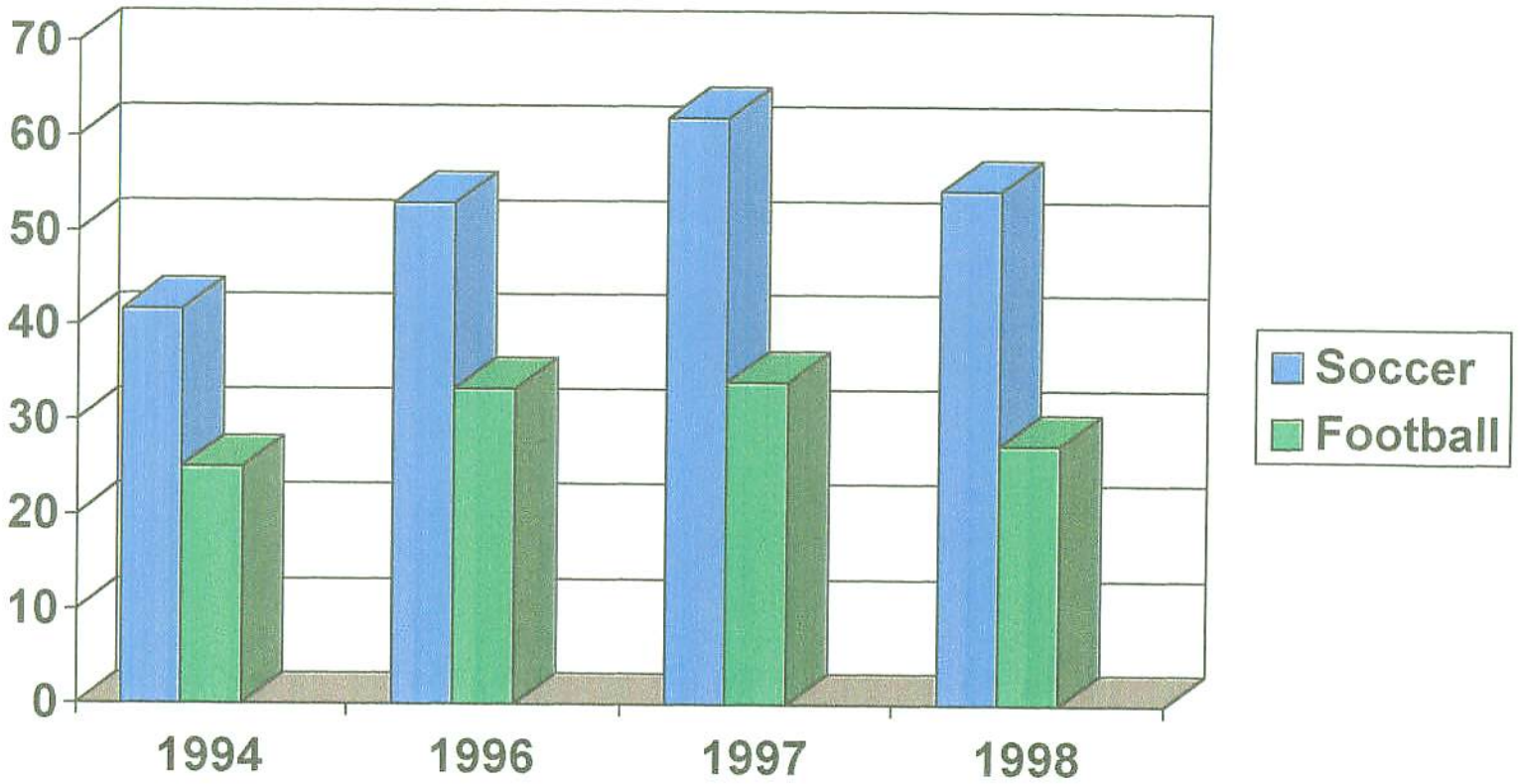
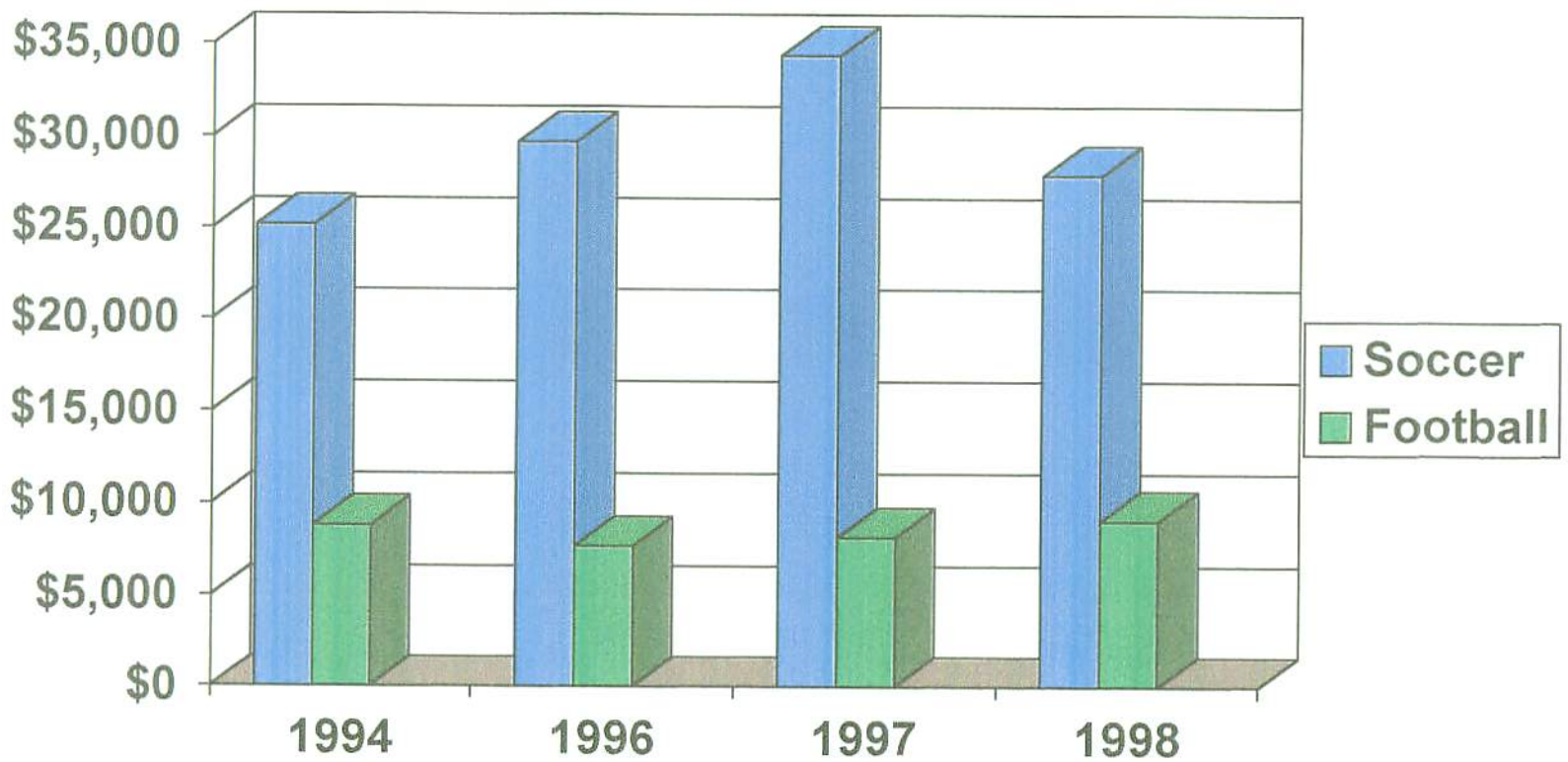
1998

Appendix 2

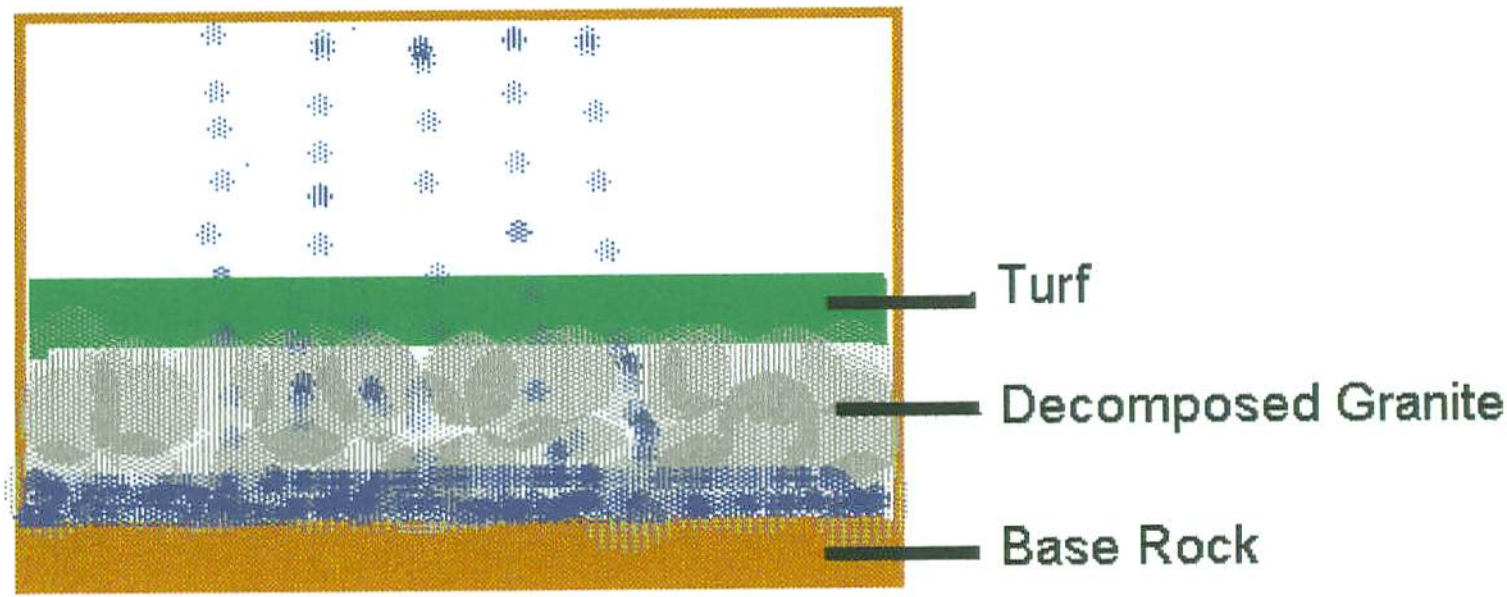
water used in gallons per sq. ft.



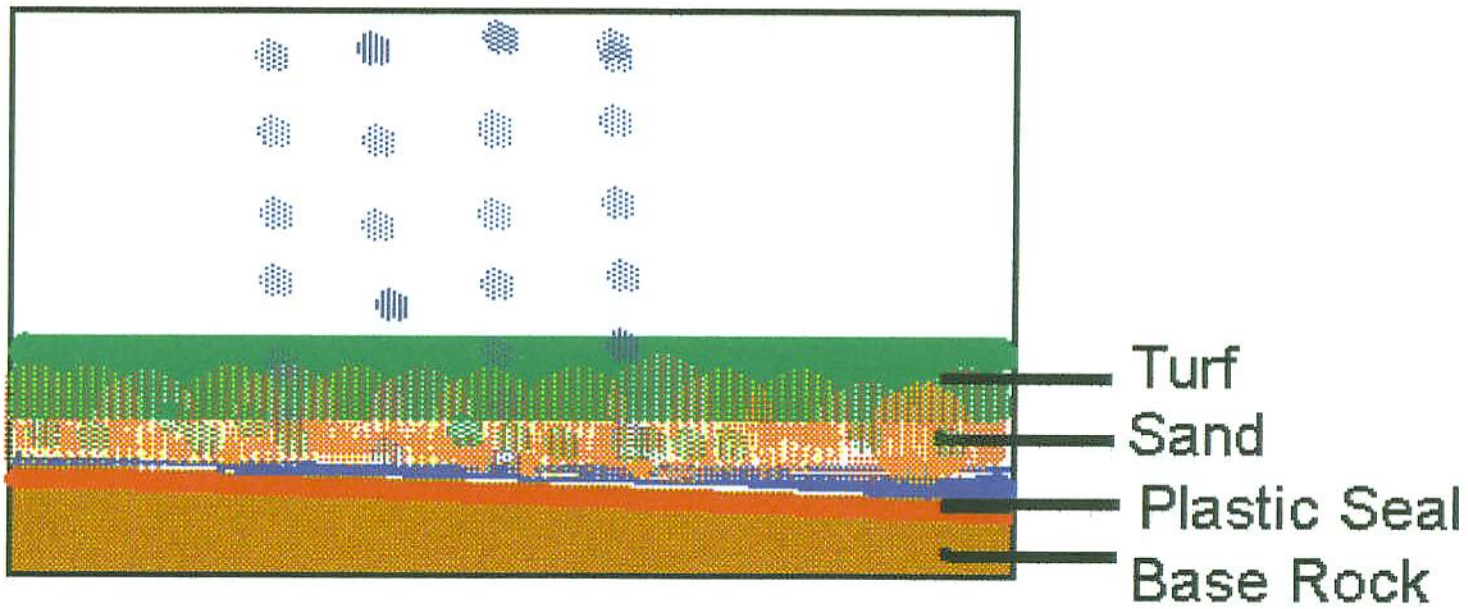
Appendix 3


$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
1994
1996
1997
1998
Soccer
Football

Current Soil Composition of the 2 Soccer Fields



Optimal Soil Conditions



Power point Outline- speech to accompany individual slides

1. "Greening the Playing Fields"- Strategies to reduce the amount of water used to maintain sports fields at Occidental College
2. At Occidental 66% of all water consumed is used for irrigation purposes- The sports fields/ turf area on campus use 60% of all water consumed. This equates to roughly 60,000 HCF (which stands for a hundred cubic feet, which equals 748 gallons) in other words 50 million gallons of water per year.
3. It takes a large amount of water to maintain sports fields, yet there are measures that can be taken to reduce water use to a minimum
4. It is important to remember that in lieu of the amount of water a lawn needs, a properly maintained lawn can actually serve as an environmental benefactor: -"Thick grass prevents soil erosion, filters contaminants from rain water, and absorbs many types of airborne pollutants, like dust and soot. Grass is also highly efficient at converting carbon dioxide to oxygen, a process that helps clean the air."
5. Also keep in mind that: sports fields are fun, and promote outdoor activity!!!
6. Occidental college currently has 5 major sports fields: 1. The football field 2. Baseball field 3. Softball field 4. Upper Soccer Field 5. And the Lower Soccer Field These fields are used throughout the year for a variety of sports and activities. The fields are a major component to Occidental's leisure and competitive athletic program. Occidental is currently in the planning stages of building a new softball field on the back side of Fiji, after the construction of this field the present softball field will most likely be converted into a parking structure. Henceforth Occidental stands to maintain the amount of 5 fields on our campus. By analyzing the current fields we can look at important things to consider with the of the planning new field
7. Though Occidental has already implemented a number of tactics to reduce water use for the fields, there is still more that can be done. In Los Angeles efficiently irrigated turf typically requires approximately 1,500 HCF per acre a year- Currently Occidental's turf's use approximately 3, 811 HCF per acre a year- Now we do need to keep in mind that our sports fields receive a considerable amount of traffic and use, which contributes to the lawns need for water. But by changing some of our current methods we might be able to reduce both the amount of water used and the overall maintenance costs.
8. Currently the amount of money allocated to water the turf at Occidental is approximately $140,000 per year.
9. For this project I looked at how the following techniques should help Occidental reduce the amount of water and Maitenance expenditures. The following areas offer different techniques and methods to aid in conservation. Watering techniques, soil types, different grass types, mowing techniques, fertilizers, and aeration. Today I am just going to discus the sprinkler system and the different soil

types at Occidental, as I have determined that these two factors have the largest impact on how much water is used at OXY.

10. In 1997 Occidental switched to a computerized sprinkler system, which has been applied to four of the five fields. The system was designed by researchers at Cal Tech to be used as an instrument to cut water costs. Occidental is currently working as a partner with Cal Tech, as we are helping to research the effects of this new system. Previously Occidental had a sprinkler system which was not computer operated.
11. The benefits of the new system: 1. First it saves labor costs in that the regulating of turning on and off all the sprinklers is done by computer. This also helps in that now the sprinklers are programmed to water in the middle of the night, when the weather is the coolest and there is the least amount of water evaporation. 2. It waters in accordance to weather patterns . The program works in conjunction with a weather satellite which sits near Keck theater. This monitors the temperature and rainfall. When it does rain the computers stop all watering and let the clouds water for us. The satellite also monitors the rate at which water is being evaporated. These things are all taken into account and the computer waters the lawns accordingly. 3.Finally, this program ensures that excessive water is not used. Normally sprinklers are just set on timers, which will still turn on if it's raining. And if lawns are watered manually there is often times when water is wasted because of spillage, or people accidentally leaving the sprinklers on too long.
12. Now this program has great potential. It has not quite been proven that it does save water. This chart shows the amount of water used in HCF's for 1994, 97, 98. Remember that 1998 was the first full year that the system was in place. Since the implementation of the new system we can see that :For the Soccer field slightly more water was used, and for the football field, slightly less was used. Last year we were affected by El Ninio, so there should have been a more drastic reduction in water use. But after we look at how much water this new system uses over a period of time, we will be able to make a better assessment. Also now that we have all the technology in place, it will not be too difficult to reprogram to water at a lesser rate.
13. Part of the inefficiency might be for the following reason. The current system assesses the need to water on a daily basis, yet the lawn institute of America states that the healthiest lawns are produced when they are watered heavily at infrequent intervals. This means that the combination of both rain and irrigation should supply a lawn with one inch of water per week when temperatures range between 45-85 degrees, 1 and a half inches when it is 85-90 degrees, and two inches per week when temperatures exceed 90 degrees.
14. So now I am going to move to talk about the different types of soil used for the fields and how this affects water needs of the different lawns.
15. When doing this research I primarily looked at the soccer fields and the Football field. This is because the softball field will most likely be moved, and the Baseball field is watered by a meter that is connected to nearby dorms, so it is hard to determine exactly how much water they are using. The

football fields soil is primarily composed of clay. The two soccer fields are grown on a mixture of granite and decomposed granite.

16. I equated how many gallons are used per square feet for the football field and then for the soccer fields. What I found is that the soccer fields use roughly twice as much water. This graph shows water needs of the two fields measured by gallon per square foot for 94, 97, and 98. This discrepancy in water use is largely due to the soil types.
17. Decomposed granite does not lend itself very well to grass production. It has very poor absorption so when the soil does receive water it either passes quickly through the soil and just falls down to the base rock. Or if the soil is too compacted water can not penetrate into the soil, so puddles and soil erosion occur easily. When the water just falls to the base rock the roots do not have the opportunity to absorb the water; henceforth you need to over water in order to provide the lawn with the amount that it needs. Clay has a much better absorption rate, which is why the football field uses so much less water. But even so clay has the tendency to compact easily which stunts absorption, and is therefor not the optimal solution.
18. So as per my research, talking with outside contractors, and Jerry Hinahosa of Occidentals grounds maintenance department, I came up with what I think would provide the optimal soil conditions for a field. Most importantly sand would be the major soil component. Sand absorbs water, and it does not easily compact. Secondly you would grate your base rock on a slight slope so that the water that is not used by the grass is able to run off. Finally you would seal the base rock off with a layer of oil and plastic. This is key because when a field receives a lot of impaction, as do our sports field, the soil pushes into the base rock causing it to crack, break apart, and eventually mix with the soil. Since you want the sand to stay pure, this plastic seal will keep the soil and base rock separated indefinitely. Unfortunately to change the existing fields to this condition would cost approximately $150,000 dollars per field.
19. But keep in mind the extraordinary difference in cost to water the two fields which are of almost the same square area. The cost to totally redo the soccer fields would probably be made back in 7-8 years. Also, just removing the granite and replacing it with sand might cost considerably less and still save a lot of money and water.
20. But when environmental issues are considered in the original planning, conservation of things such as water can be assured much more easily. The new baseball field is intending to use sand as their primary soil type, so Occidental is currently working in the right direction to enviromentally safe guard their future playing fields
21. That will bring us to the end of today's presentation.

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