

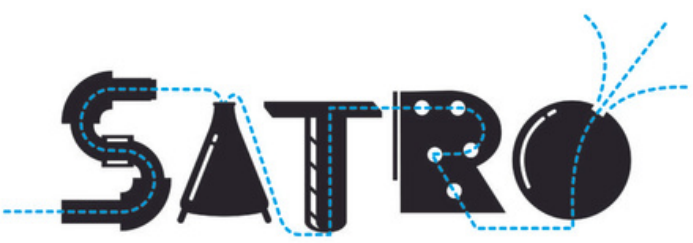
ECO FRIENDLY AND SUSTAINABLE GOLF COURSES

WATER CONSERVATION

PROJECT REPORT



Surrey
Wildlife Trust



● CONTENTS

PROJECT PLAN	01
EVALUATING THE APPROACHES	02
RISK ASSESSMENT	03
INTRODUCTION	06
THE IMPORTANCE OF WATER CONSERVATION FOR THE WIDER WORLD	07
THE ISSUES THAT STEM FROM WATER MISUSE	
WATER WITHDRAWALS	09
WATER CONSUMPTION	10
NATURE-BASED SOLUTIONS	
ALTERNATIVE WATER SOURCES	12
WATER HARVESTING	13
WATER COLLECTING	14
PERSONAL PROPOSAL	
PROPOSAL (DRAFT)	16
PROPOSAL (DEVELOPED)	17
PROJECT EVALUATION	20

● PROJECT PLAN

During this project, I spent 6 weeks on a virtual placement with SATRO and Surrey Wildlife Trust with the aim to explore ways to design an eco-friendlier and more sustainable golf course using nature-based solutions. The first week was an introductory week to the project and the mentors and produce an opening report to our project.

[1] My first response to this was to research the general layout of a golf course and its features. Next, I *created a table* by researching all the relevant issues with golf courses. I then researched various solutions to these problems. After completing the table, I soon realised that there were many methods to create eco-friendlier golf courses and due to time limitations, I felt that it was best to focus on one aspect. I simplified the aim to focus on a more specific area which was **'How to make golf courses eco-friendlier by conserving water using nature-based solutions'**

In the end, I finalised my project plan and set myself the following goals to complete the project. (See Table Above)

OBJECTIVES:

Make personal contributions by placing my own ideas into the research

Carry out relevant research to achieve the aim...

...whilst collecting data and statistics with references/links to the sources used

PROJECT GOAL	DEADLINE
Opening Report	29 July
Explain the importance of water conservation	5 August
Identify the relevant issues we have which stem from poor water conservation, worldwide and on golf courses	5 August
Deduced suitable and appropriate solutions to these existing problems	19 August
Designed a golf course layout that effectively conserves water	26 August
Final project editing to fit criteria	30 August

To aid in time management I created **a calendar** that included all the deadlines for the tasks that I had planned including the weekly meetings with the mentors. This allowed me to count the number of days I had until the due date.

Next, **I used an app** (Structured) which allowed me to decide how long a task would take and track how much time I would have left for other activities each day.

EVALUATING THE APPROACHES

Approach 1

Use the internet to gather all the relevant information on water conservation systems or water harvesting systems.

Positive Aspect Of The Method

Using the internet to collate information on these systems means I can conduct all the necessary information I need from home.

The internet also holds an abundance of information and data from around the world, meaning that I would be able to gather relevant information from foreign countries.

Negative Aspect Of The Method

It would be harder to get answers to specific questions I may have as information on the internet can be quite generic sometimes.

Some water conservation systems may be confusing, especially without deeper knowledge/qualifications in Engineering. This means that I would have to mainly use simplified diagrams to build on my understanding which can be less informative and accurate of how the system works. For example, a groundwater pump may have many components but a simplified diagram will break it down into a few key components, ultimately taking out extra information that may be relevant.

This was the approach I took in the end as there were too many difficulties in securing a tour at a golf course. The obstacles I encountered were:

- Letting my mentor know to reach out to golf courses too late in advance
- My mentor going on paternity leave

Approach 2

Visit a golf course in person to learn about water conservation systems and gather information in person.

Note: This method could be combined with Method 1 at some stages.

Positive Aspects Of The Method

In-person studies of the water conservation systems allow me to ask specific questions to the staff members on site. It also allows me to take photographs of specific parts of the system I need. This can act as primary research.

Negative Aspects Of The Method

It can be challenging to book a tour around a golf course without the right connections. However, tours may be arranged by getting in contact with my mentor who works with golf courses, although this is not guaranteed.

A golf course most likely does not have much different water conservation put in place, meaning I would have to visit multiple to gather information on the different types of systems.

As golf courses require a large amount of land, they tend to be away from urban and dense areas which means I would have to make long journeys and prepare travel arrangements.

Risks may be involved with this method. See the risk assessment attached on page 3

● APPROACH. 2 RISK ASSESSMENT



$P < 50 = 1$

$70 < P > 50 = 2$

$P > 70 = 3$

HAZARDS	RISKS	PRECAUTIONS	POSSIBILITY OF OCCURENCE
Long Use Of Public Transport	Risks of contracting Covid-19	<ul style="list-style-type: none"> • Face Masks On • Frequent Use Of Hand Sanitiser 	1
Loss Of Direction	Risks of being late to arranged visits and possibly danger from strangers.	<ul style="list-style-type: none"> • Prepare screenshots of the travel plan and itinerary incase mobile data is insufficient or in areas where signal is absent 	2
Loss Of Personal Possessions	Risks of losing items and being stranded/unable to travel back home	<ul style="list-style-type: none"> • Only bring key essentials in a zipped backpack • Wear backpack on the front 	2

Note: The possibility of occurrence is valid only when the precautions are taken. The possibility of occurrence is subjective

GOLF COURSES

NBS PROJECT

PROBLEMS	SOLUTIONS
<p>Loss of natural features, habitats and biodiversity: Loss of wetlands, woodlands and other natural features also means loss of habitats for countless wildlife species.</p>	<p>Methods: Grow plants that are native to the area</p> <p>Create nesting boxes for birds and selecting flowers that provide nectar for bees and butterflies</p> <p>Connect all the natural areas (woods, meadows, rivers) to improve wildlife movement and integration</p>
<p>Requires a large amount of space: The ideal space for a golf course is near forestation, deforestation tends to occur when building a new golf course.</p>	<p>Consider reusing old lands and renovating them into a golf course. For example, Trinity Forest Golf Club is a golf course built from a landfill https://trinityforestgc.com/</p>
<p>Use of chemicals: Courses use fertilisers and pesticides on their greenways to keep the grass looking green. The fertilisers runoff into bodies of water causing a state of nutrient over-enrichment called eutrophication which results in algal blooms that destroy ecosystems. They can also contaminate groundwater stores.</p>	<p>Alternatives:</p> <p>Zoysiagrass (pest-resistant), which means golf courses need fewer herbicides to maintain the grass.</p> <p>Boiling water/ natural foam cocktail to kill weeds.</p> <p>Dish soap to remove moss</p> <p>Microscopic worms to attack the turf-ruining grubs.</p>
<p>Water intensive: "Depending on the location of the golf course and the climate, an 18-hole course can use on average 2.08 billion gallons of water per day."</p> <p>https://www.twl-irrigation.com/how-much-water-does-a-golf-course-use/</p>	<p>Solutions: 'Grey Water' (recycled water) from rainstorms and run-off to water the grass.</p> <p>Buffalo Grass, requires less water than average.</p> <p>Paspalum tolerates salt water, making seawater a possible source of water.</p>
<p>Requires complex maintenance: Mowing, irrigation, and fertilization are top priorities to keep a golf course functional. These frequent activities make it challenging for the original ecosystem to recover.</p>	<p>Solutions: Designate areas near water hazards and irrigation lakes where synthetic fertilisers are not permitted to stop eutrophication.</p> <p>Grass Carp (algae eating fish), raise them in the water hazards or irrigation lakes incase eutrophication occurs</p>
<p>Uses a large amount of replaceable equipment: It can be very easy to lose a golf ball. Due to their low price most golfers don't care much if they lose a golf ball, this action leads to littering and eventually pollution when thousands of golfers follow suit.</p>	<p>Most golf balls are made with polyurethane (non biodegradable plastic) and with millions of lost balls being disregarded, this poses a threat to the wildlife in the area. The synthetic rubber core contains zinc, allowing the ball to release toxic materials when submerged.</p>



THE WIDER PURPOSE OF FRESH WATER CONSERVATION

RESEARCH TASK 1

● INTRODUCTION

Driest July in England since 1935 Met Office

By **Georgina Rannard**
BBC News Climate & Science

🕒 1 August

With global temperatures rising, animal species reducing, and consumption of natural resources increasing, we have ultimately damaged our ecosystems and environment. Most of us are still in the mindset that the Earth can provide for us and withstanding the damage we are doing to it for the next couple of generations or perhaps centuries which is not the case. We know that the animals are suffering but most of us give our sympathy and turn our backs, why? We know that some people are being tormented by extreme heat and weather temperatures, yet we still release greenhouse gases, why? Because we are not suffering the true repercussions yet. Most of us only realise the true severity when we are the ones who are suffering and by the time we realise, it could be too late.

Due to this ignorance, the consequences are slowly arriving at our doorstep, **[2]** For example, the Met Office has claimed that the start of 2022 has been the driest in England since 1976. With water levels running low, water companies have already

started placing restrictions to urge people to conserve water such as the hose pipe ban. It is crucial to make everyone aware of the consequences and the true severity of the declining health of our planet, we can do this by placing small changes in our daily routines or hobbies which can remind people that they are not excluded from suffering the repercussions. Changes can be made anywhere and an example is on golf courses.

So, what is golf course sustainability? It is the ability to maintain the good condition of something over time. In this case, it is to maximize the playing quality of the golf course whilst protecting the natural environment around it. My rationale for this project is to make persuasive arguments to encourage people (not just golf courses) to engage in water conservation and in the end hopefully devise a system that can help show golf courses that conserving water can be easier than it seems and that sometimes sacrifices such as paying extra money or going out of our way to conserve resources should be done for a better world.

"The most common reason cited for not using it was a *lack of an available source for recycled water* as indicated by 53 per cent of respondents"

-USGA [3]

[2] https://www.bbc.co.uk/news/science-environment-62382703?at_medium=RSS&at_campaign=KARANGA

[3] <https://www.usga.org/content/dam/usga/pdf/Water%20Resource%20Center/how-much-water-does-golf-use.pdf>

● IMPORTANCE OF CONSERVATION

[4] Freshwater habitats are home to:

40% of known fish species

10% of known animals

70% of our freshwater is used for agriculture

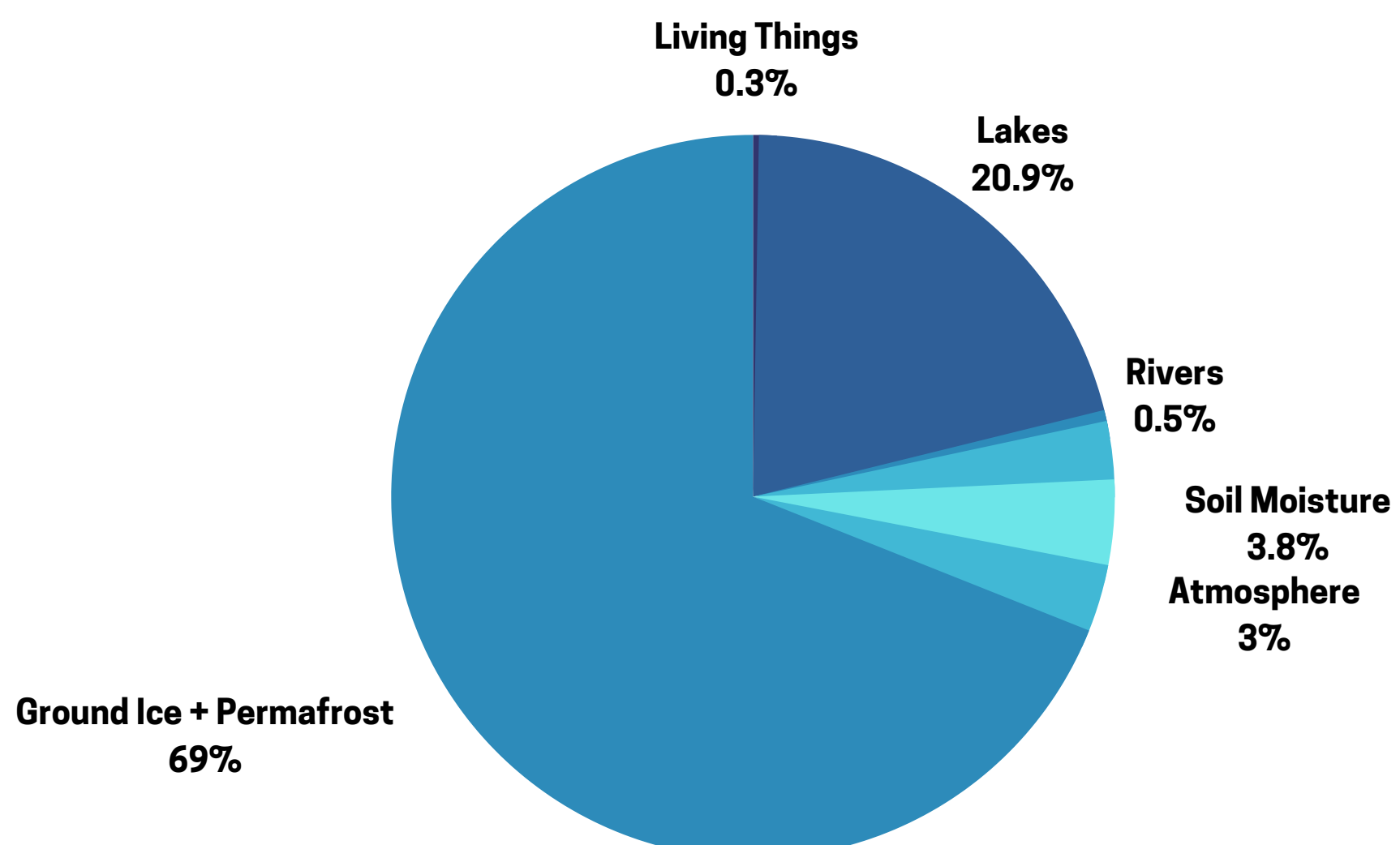
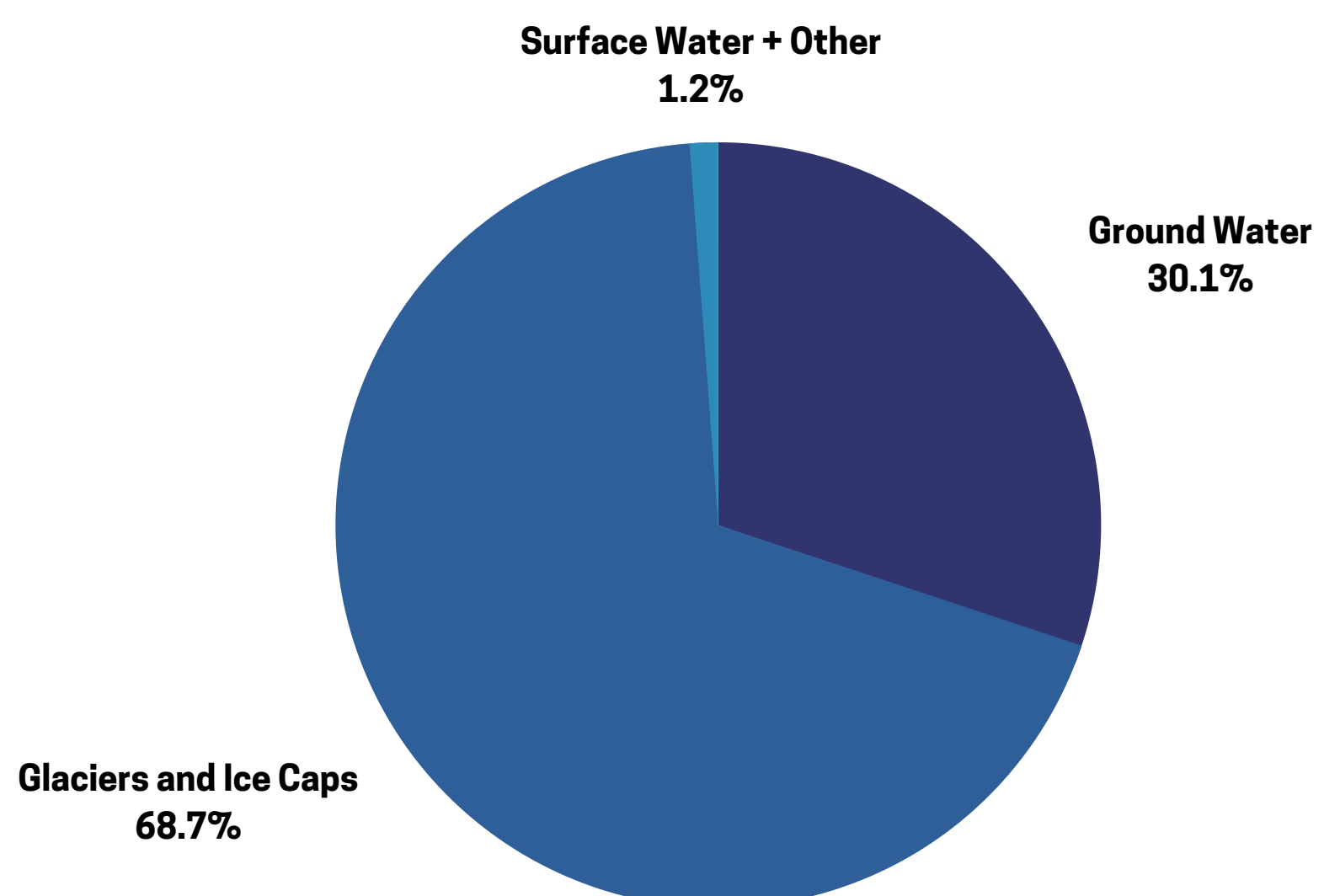
As our population grows, the demand for food rises

Using **less water means saving more money**

Despite the importance of fresh water, bodies of fresh water are **disappearing at an alarming rate**. eg; *The Bathtub ring around Lake Mead is the main water source for Las Vegas, which is showing clear evidence of water levels reducing.*



We know that 70% of our Earth is water, but only 3% of it is fresh. 1% of that fresh water is readily available as ground water and surface water, the rest is stored as glaciers.



[4] <https://www.usgs.gov/special-topics/water-science-school/science/freshwater-lakes-and-rivers-and-water-cycle>

[5] <https://courses.lumenlearning.com/suny-sustainability-a-comprehensive-foundation/chapter/water-cycle-and-fresh-water-supply/>



THE RELEVANT ISSUES DUE TO WATER MISUSE

RESEARCH TASK 2

WATER WITHDRAWALS

GLOBAL

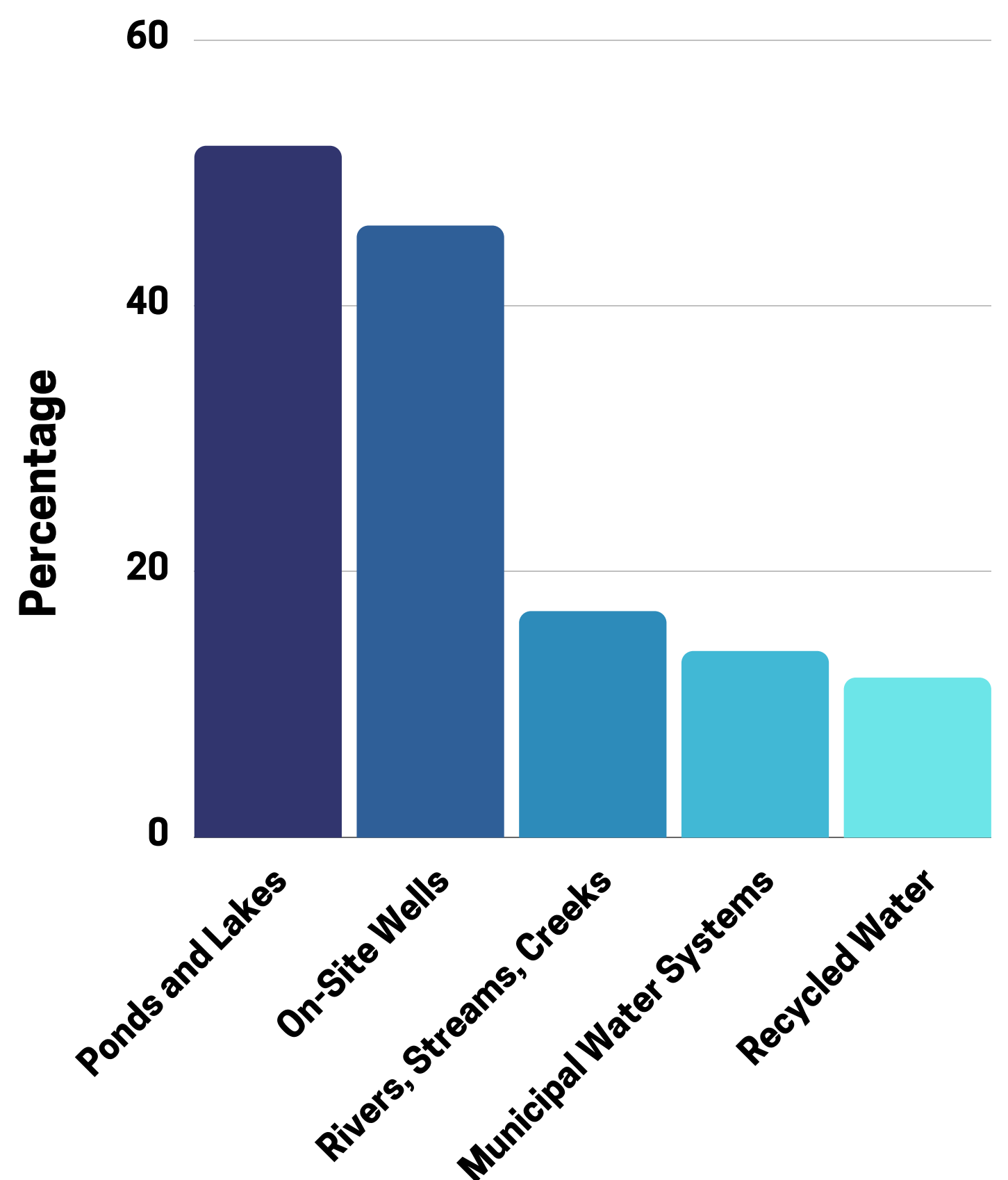
Water withdrawal is the total amount of water extracted from surface water or groundwater sources. [6] Already more than 1.4 billion people live in areas where water is being withdrawn faster than it is being replaced.

High water stress: is the withdrawal of excessive amounts of fresh water from natural sources compared to already available fresh water. If unmitigated, water stress can lead to water scarcity.

GOLF COURSES (USA)

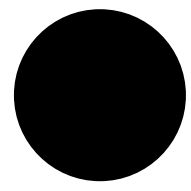
[7] Approx, 300-400 billion gallons of water are withdrawn per day, **0.5% of it is used for golf courses.** Only **12% of golf courses use recycled water**

Irrigation Water Sources In An Avg. USA Golf Course



[6] <https://blogs.agu.org/waterunderground/2017/06/26/difference-water-withdrawal-water-consumption-need-know>

[7] <https://www.usga.org/content/dam/usga/pdf/Water%20Resource%20Center/how-much-water-does-golf-use.pdf>

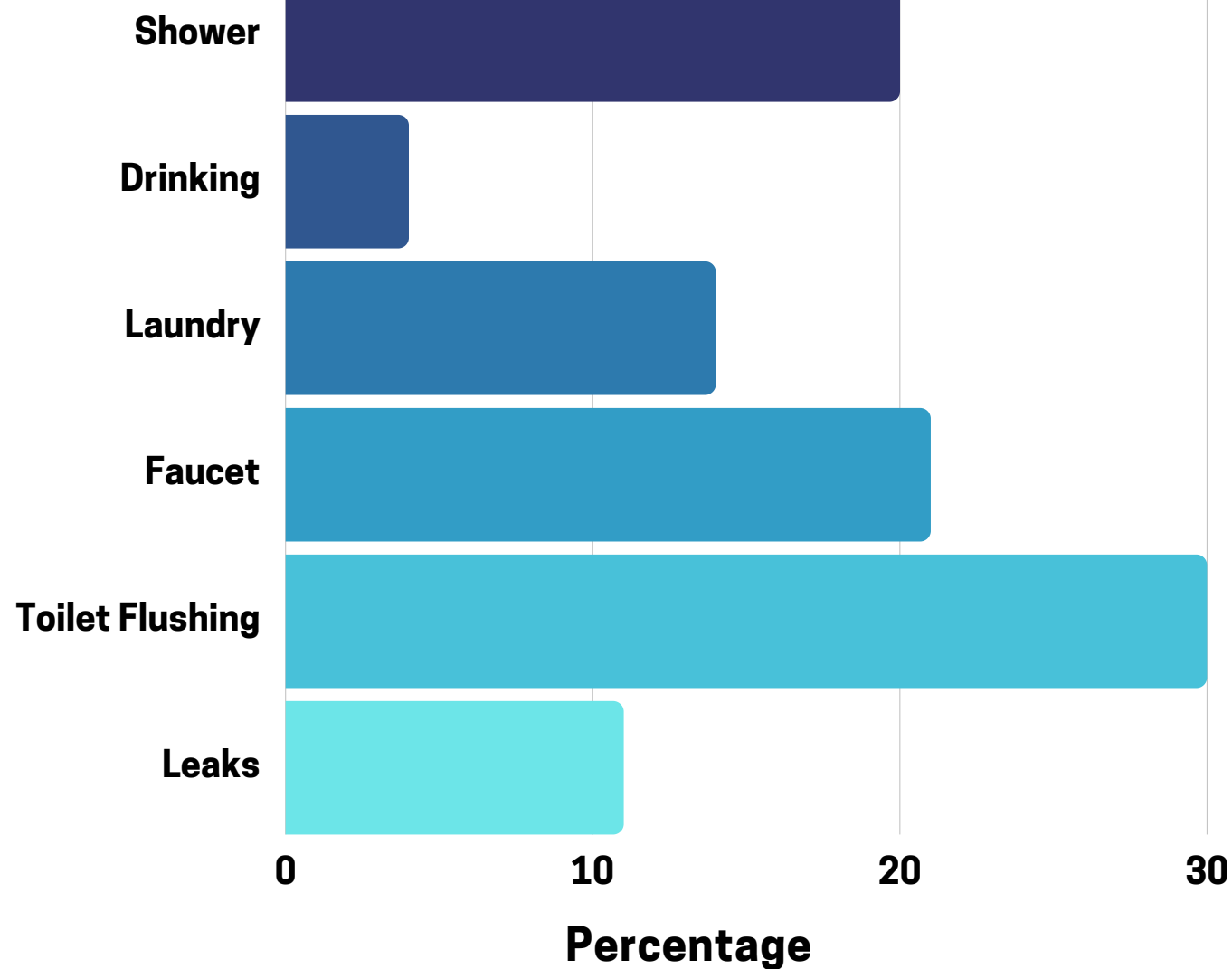


WATER CONSUMPTION

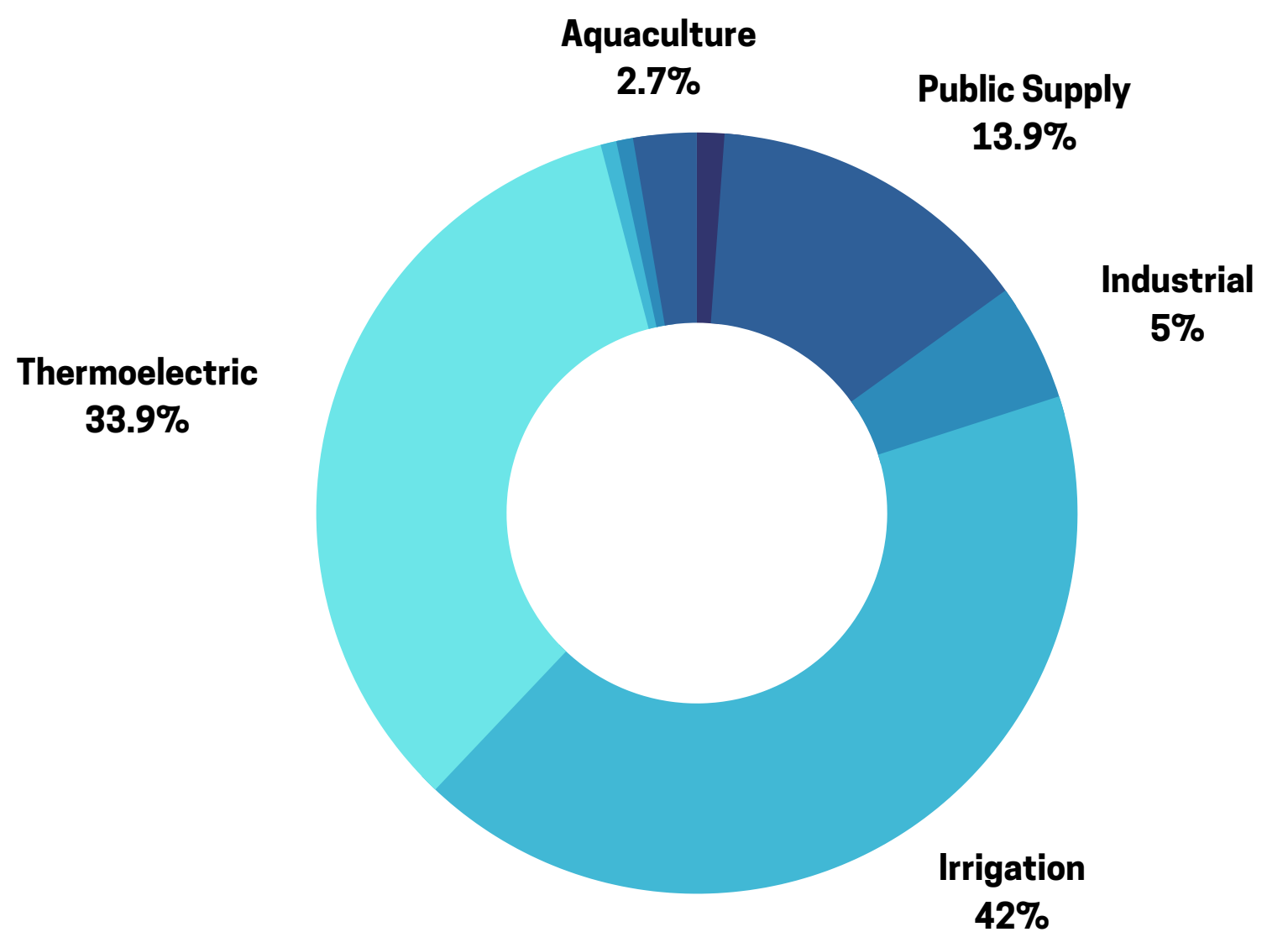
- [8] **On average, each person uses about 400 litres** of water per day including misuse of water such as leakage and splashes

In the Okanagan Basin alone, **5% of its water was used for golf courses**

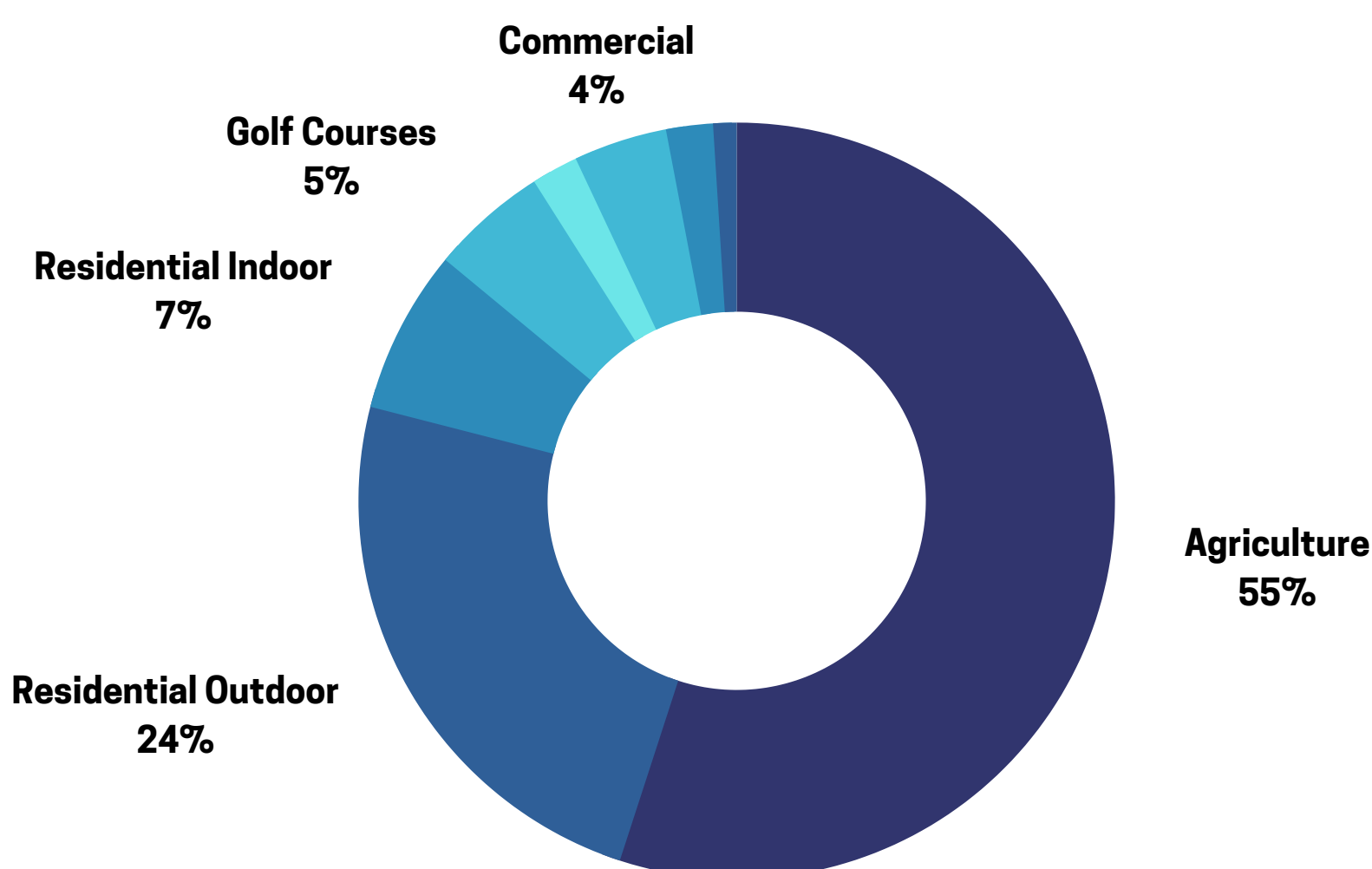
[9] Average Use of Water Per Person



USA Water Consumption



[10] Average Water Consumption In The Okanagan Basin 1966-2006



WATER CONSUMPTION

[11] Approx, 1.5 million acres of maintained turfgrass where 80% of it is irrigated. From 2003-2005, the avg amount of water used for irrigation was approx 2.3million acre-feet a year. During a survey conducted by the USGA, 53% of respondents claimed their reason for not using recycled water is due to a **"lack of availability of recycled water sources"**

WATER LOSS

Water can be lost or wasted through evaporation, runoffs into drainage pipes or leaky pipes

[8] <https://www.usga.org/content/dam/usga/pdf/Water%20Resource%20Center/how-much-water-does-golf-use.pdf>

[9] <https://www.usgs.gov/special-topics/water-science-school/science/freshwater-withdrawals-united-states>

[10] <https://www.ccwater.org.uk/households/using-water-wisely/averagewateruse/>

[11] <https://www.obwb.ca/wsd/key-findings/water-use>



NATURE BASED SOLUTIONS

RESEARCH TASK 2

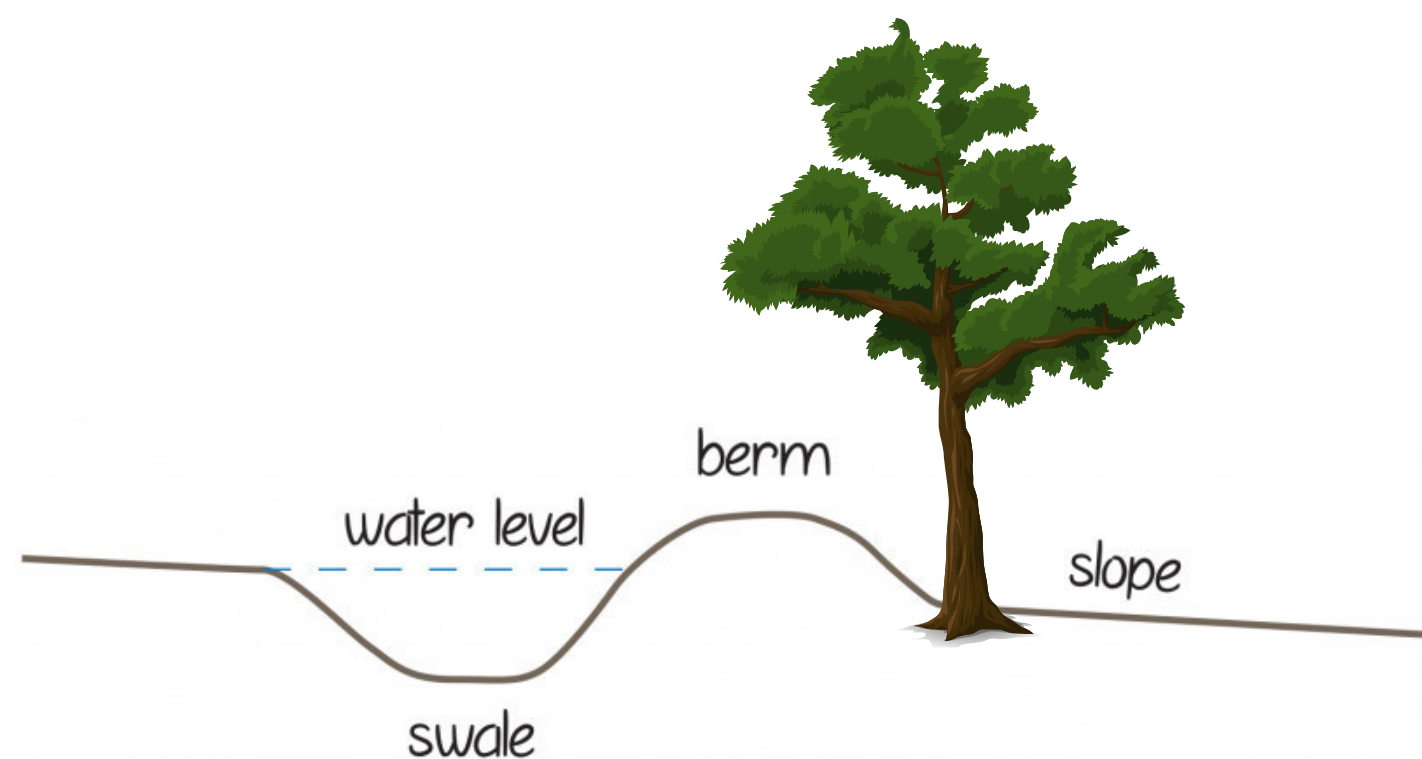
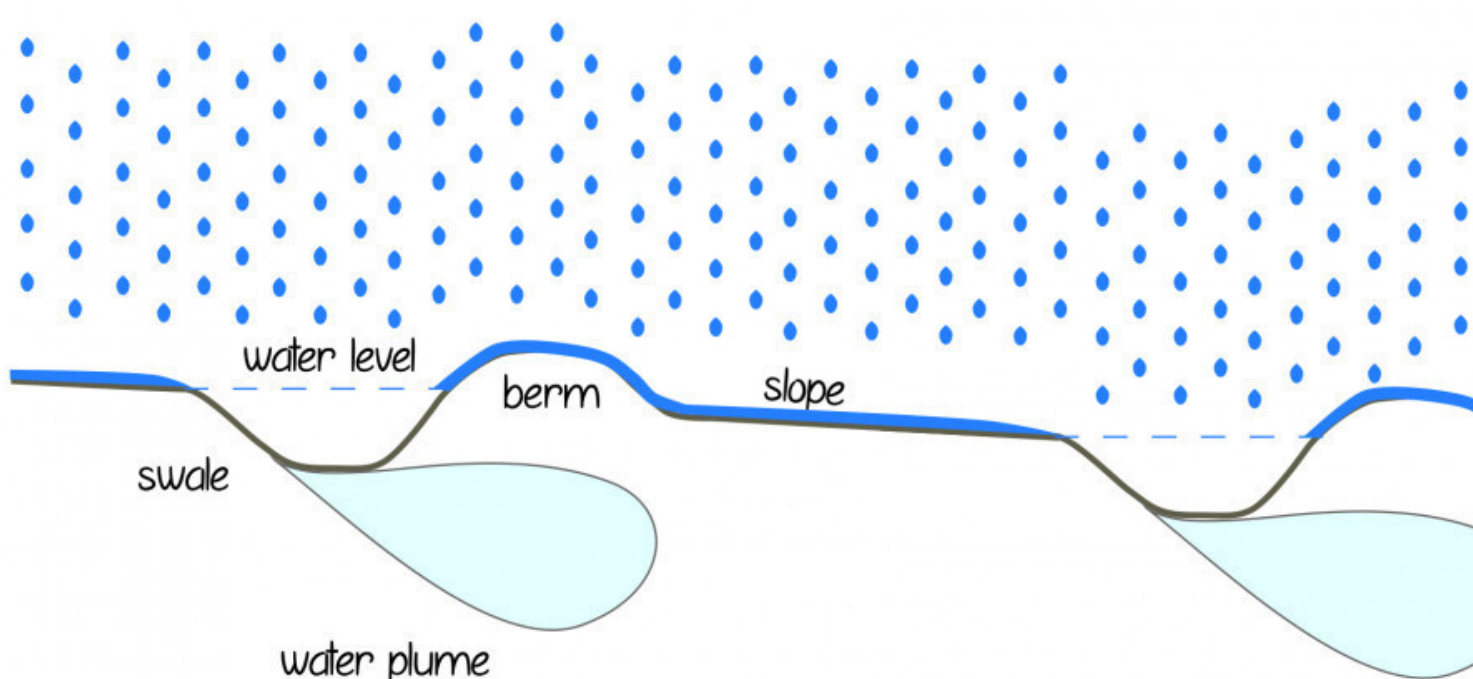
● SOLUTION 1

[12] Swales:

Are ditches that catch rainwater and soak it into the soil which can reduce the need to hand water the soil. They can act as bodies of grey water which helps to reduce the usage of fresh water.

Swales are a perfect method to use on golf courses as the slopes and curves needed perfectly match the shape of the greens. They can also be extended into river swales which can then be multi-use and serve as a water hazard for the golf course too as long as they are the right size

A requirement for a swale is that it must be perfectly levelled, this is to ensure water soaks in evenly. If one end is lower than the other, all the water will run down to the lower end like a slide. Desirable dimensions for a swale are to have it twice as wide as it is deep.



Trees along the berm and slope will have better access to water. These can be grown to provide homes for birds that can potentially be introduced to golf courses

Solutions that are similar to swales can be regular ponds which can also double as a water hazard.

● SOLUTION 2

"The most common reason cited for not using it was a lack of an available source for recycled water as indicated by 53 per cent of respondents"
-USGA [3]

In response to this concerning statement, I decided to research different ways of obtaining gey water.

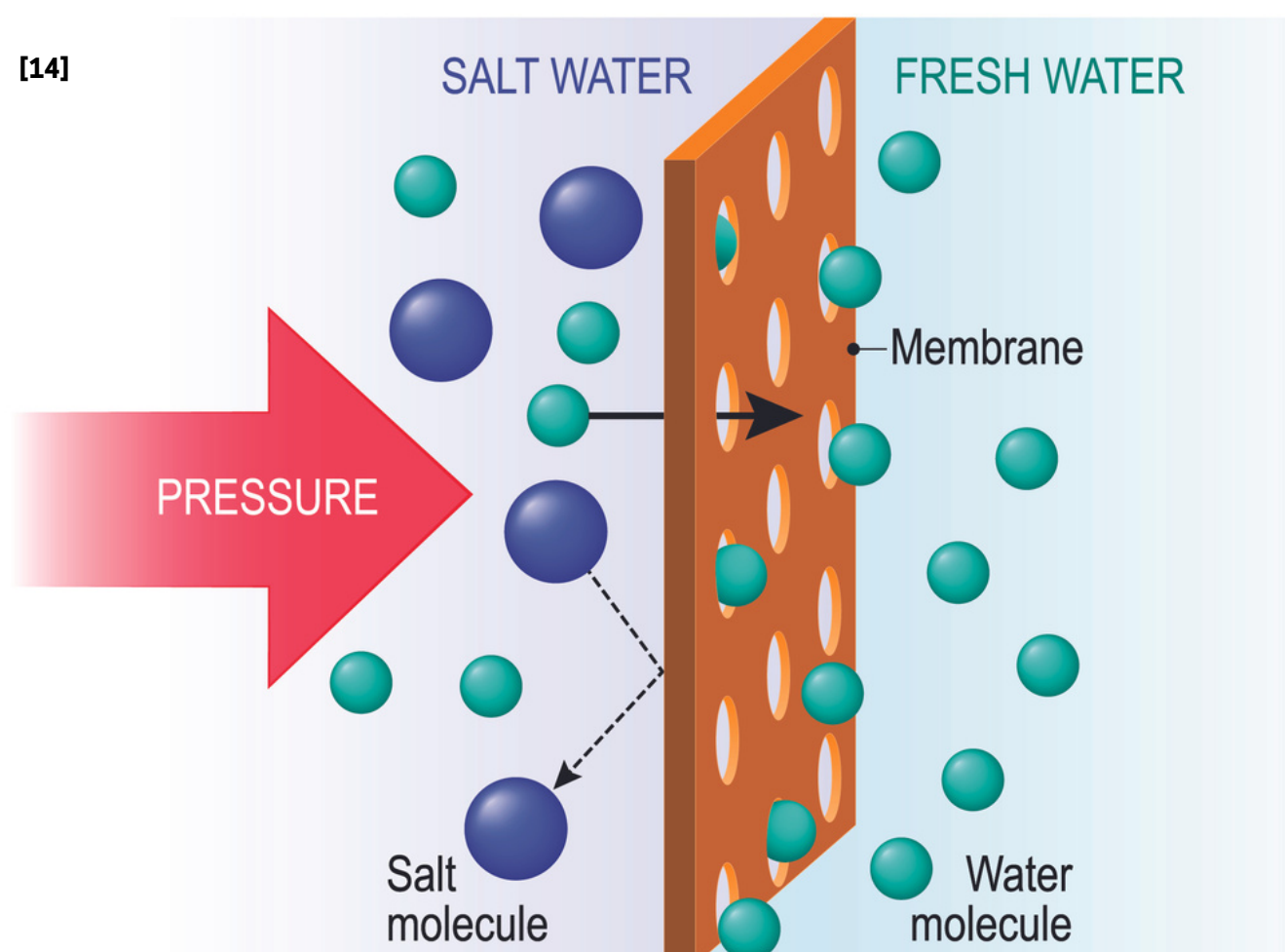
[13] A scientific way of conserving fresh water is through desalination. This is an alternative to pure fresh water.

Desalinated Water:

Desalination is simply the removal of other components such as salt molecules in saline water. There are two methods to desalinate saline water.

Reverse Osmosis:

Is when saline water is put through a membrane at high pressures. The membrane will allow water molecules to pass through but not other molecules that were dissolved in the saline water.



Thermal Desalination:

Is when the saline water is heated at high temperatures, allowing the water to evaporate. The evaporated water can be collected and when condensed becomes liquid again without the salt molecules.

Both methods of desalination **require high amounts of energy**. This higher energy requirement means that desalination can be more expensive to conduct. It can also produce more greenhouse gases.

Municipal Water:

[15] Municipal water is commonly referred to as 'tap water'. Most of this water is used for cleaning and watering gardens. It is sent to many different industries and homes through underground pipes. It is chemically treated before being distributed for public use.

With 14% of USA golf courses using water from municipal water systems, they can use also water from municipal sewage treatment facilities. Although the quality of the water may be up for discussion.

This recycled water still provides nutrients and moisture whilst allowing the municipal facilities to avoid discarding their water into streams.

[13] <https://www.bbc.co.uk/bitesize/guides/zvxvgdm/revision/5>

[14] <https://uconn-today-universityofconn.netdna-ssl.com/wp-content/uploads/2018/07/GettyImages-694238198-reverseosmosisillustration.jpg>

[15] <https://sensorex.com/2020/03/10/municipal-water-treatment-applications/>

● SOLUTION 3

Rain water off course as golf club blamed for floods woe ^[16]

HOMEOWNERS living by a city golf club claim their properties have been repeatedly flooded by water being drained directly off one of the course's greens.

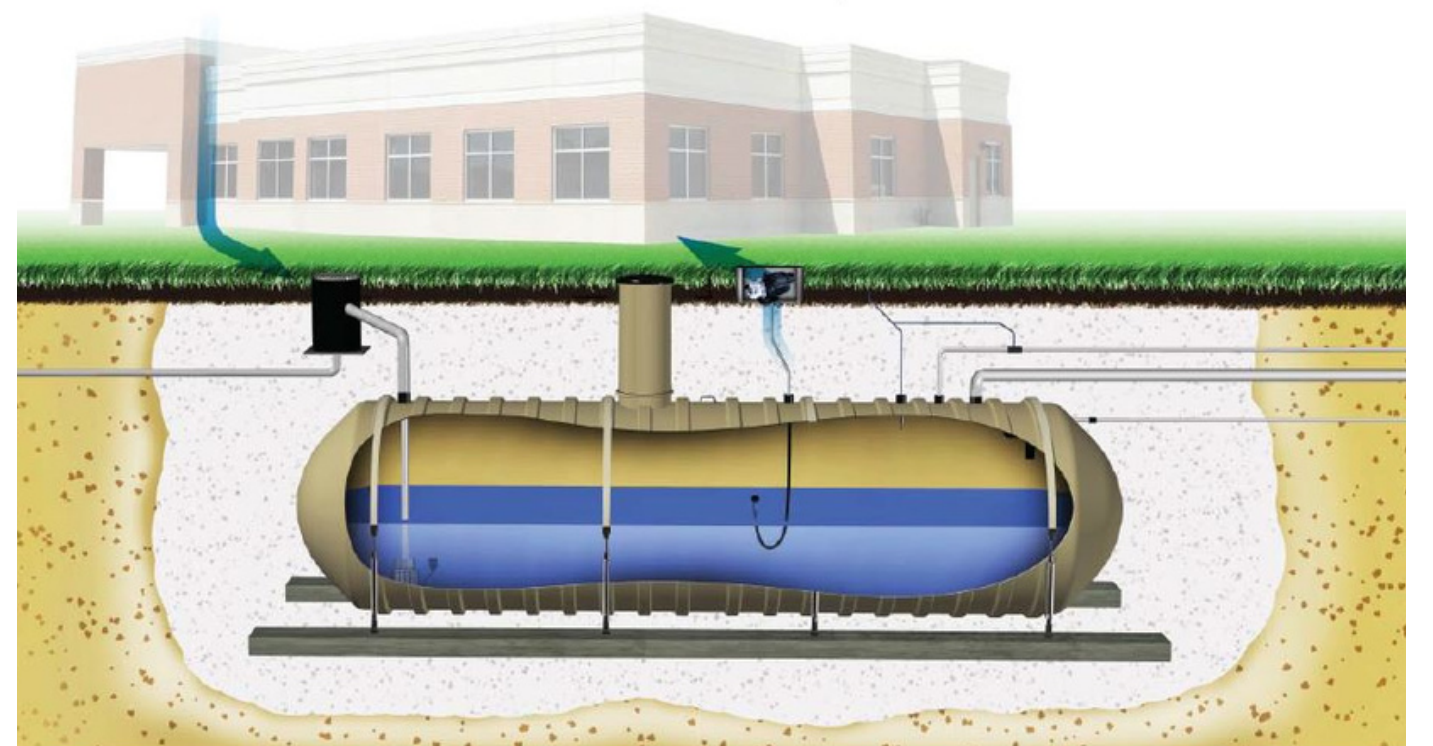
By The Newsroom

Friday, 13th July 2012, 1:00 pm

Further, into the project, I realised that bodies of water out in the open like ponds and swales can be useful but also cause trouble. Especially for typically rainy countries, bodies of water can overflow off the boundaries and start running off into areas that are supposed to be dry. Overwatering the turf and damaging it can also become a possibility. A way of storing large volumes of water is in a large container to avoid run-offs.

Taankas (Rainwater Collecting Bins)

[17] A very old method of storing rainwater was by using Taankas in places such as Rajasthan, India. These were underground storage tanks for collecting rain water.



However, in the modern day, a more durable and longer-lasting container will be needed.

The advantage of an underground storage tank is that it's out of sight and protected from extreme weather conditions. However, the disadvantages are the difficulties in installing it as well as the high price that comes with it. In some cases, there could be cracks in the pipes causing leakages. When left undetected and unrepaired, golf courses can accidentally use more water than they thought and therefore cause bills to skyrocket. Once a problem develops on the surface of the water tank such as chips and cracks, it may be difficult to repair it back to its original condition. quality.

[16] <https://www.edinburghnews.scotsman.com/news/rain-water-course-golf-club-blamed-floods-woe-1618014>

[17] <https://en.wikipedia.org/wiki/Taanka>

[18] <https://rainharvestingsupplies.com/fiberglass-tanks/>

● SOLUTION 4

One of the most efficient ways of conserving water is to **avoid using it when possible**. This can be done in a variety of ways on golf courses. For example, reducing the area of turfgrass that requires irrigation and keeping the number of large water hazards to a minimum, this so golf courses do not need to refill it when the water levels are running low due to evaporation or require changing when the water becomes dirty.

The main consumer of water on golf courses is the turfgrass, **switching to grass species that require less water will aid in conservation**.

However, multiple different species will be needed to provide biodiversity. Without biodiversity, risks the death of the grass species if a disease was to arrive and spread. New species of grasses are regularly being cultivated by scientists through hybridisation to combine the positive aspects of common species.

Seashore Paspalum

[19] A saline water/grey water tolerant grass means that seawater is a possible source of water. It is also tolerant to low-quality water and soil which reduces the intensiveness of the maintenance. Seashore paspalum only requires small amounts of fertiliser. This is a benefit as using less fertiliser reduces the severity of eutrophication. However, a weakness this type of grass has is the lack of resistance to diseases. It can also struggle to survive alongside other types of grass species such as Bermudagrass.

Empire Zoysiagrass

[20] A warm season grass that is drought and herbicide-resistant. Another benefit of using this grass is its ability to withstand high temperatures but also cooler temperatures. Ideal temperatures for zoysiagrass is 75F (Apprx. 24C)

Although it browns during the winter, it can remain green for longer than other warm-season grasses such as the Bermudagrass. To achieve a four-season green turf, ryegrass can be planted along with it.

Celebration Bermudagrass

A dark blue-green colour grass species that is warm climate tolerant and therefore most commonly used in Florida. It is extremely drought resistant meaning it requires less water. However, it requires an abundance of sunlight to thrive which would make it a less suitable choice for countries that experience less sunshine such as the UK.

Fine Fescue

[21] A drought-resistant, cold-season grass and prone to regularly rainy weather. Due to its deep roots, it has great access to underground moisture. Fescue grass is also low maintenance meaning that it can be a suitable choice for fairways. It is also quick to germinate, new blades can appear after two weeks after sowing. However, a disadvantage to this grass is that it is not very resistant to diseases and pests. It also has a rough and bristly texture.

[19] https://thebackyardpros.com/seashore-paspalum-what-it-is-and-how-to-grow-it/#Pros_and_Cons_of_Seashore_Paspalum

[20] <https://www.lawnandpetal.com/zoysia-grass-pros-and-cons-plus-expert-tips-for-growing-a-healthy-zoysia-lawn/>

[21] <https://www.mckaysgrassseeds.com.au/pros-cons-fescue-grass/>

● DRAFT PROPOSAL

At this point, I started to look at different ways to incorporate the 4 solutions described above to create a course that successfully conserves water.

As the first step, I took inspiration from the Taankas and designed my own version of an underground storage tank. I felt that the concept of having it underground was beneficial for golf courses as it allows for large tanks to be concealed to avoid disrupting the aesthetics of the course.

My proposal was to have pipes attached to the roof of the golf club's main building. These roofs should be sloping for maximum effect. These pipes will then run down the wall and underground towards the storage tank. However, having one source is unreliable, especially for places that rarely experience rain.

Another source of water to fill these tanks can be water treatment factories. Underground pipes can be constructed that allow water to flow and be supplied to the golf courses.

Connected to the storage tanks are mini sprinklers which are used to irrigate the areas of the course that require it. Since this would be a large area, the tanks will need to be large and able to cover the entire surface area of the irrigated turf. However, after this stage, I will need to devise a system that will allow these sprinklers to successfully cover as much area as possible.

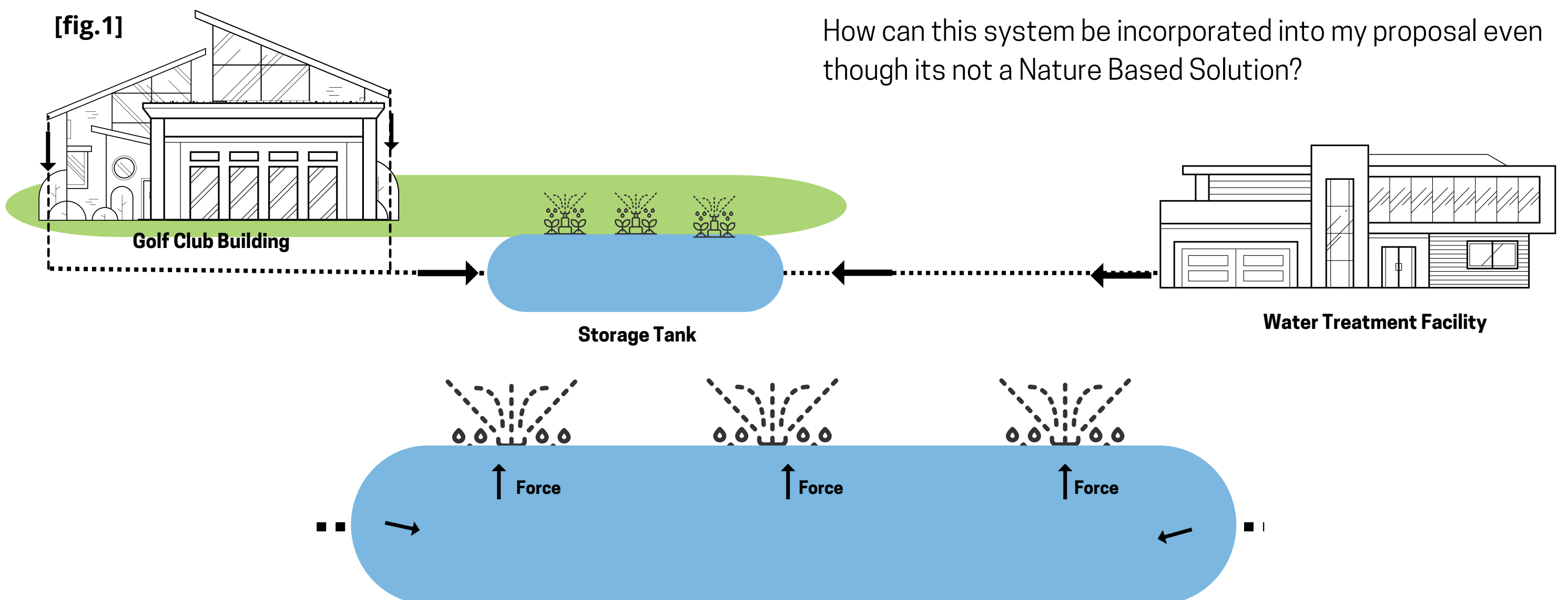
The storage tank/sprinkler system would be installed strictly in areas that require it. Soil moisture sensors can be installed and placed in the soil to measure how much moisture is present. This can greatly help with conserving water as it allows for the sprinkler to be used only when strictly necessary and therefore conserving water.

Some questions that arose when I got to this stage were:

How are these sprinklers going to cover the most surface area to ensure every inch can be watered by just watering once?

How can these sprinklers be designed so that we can control which sprinklers should operate and which shouldn't to avoid over watering a specific area?

How can this system be incorporated into my proposal even though its not a Nature Based Solution?



[fig.2]

● DRAFT PROPOSAL

These sprinklers will need to be evenly spaced out. The area each sprinkler can cover needs to be large so fewer sprinklers will need to be used. The force that pushes the volumes of water upwards also needs to be large to ensure water can successfully shoot out high enough but not too high so it can still disperse over a greater horizontal distance.

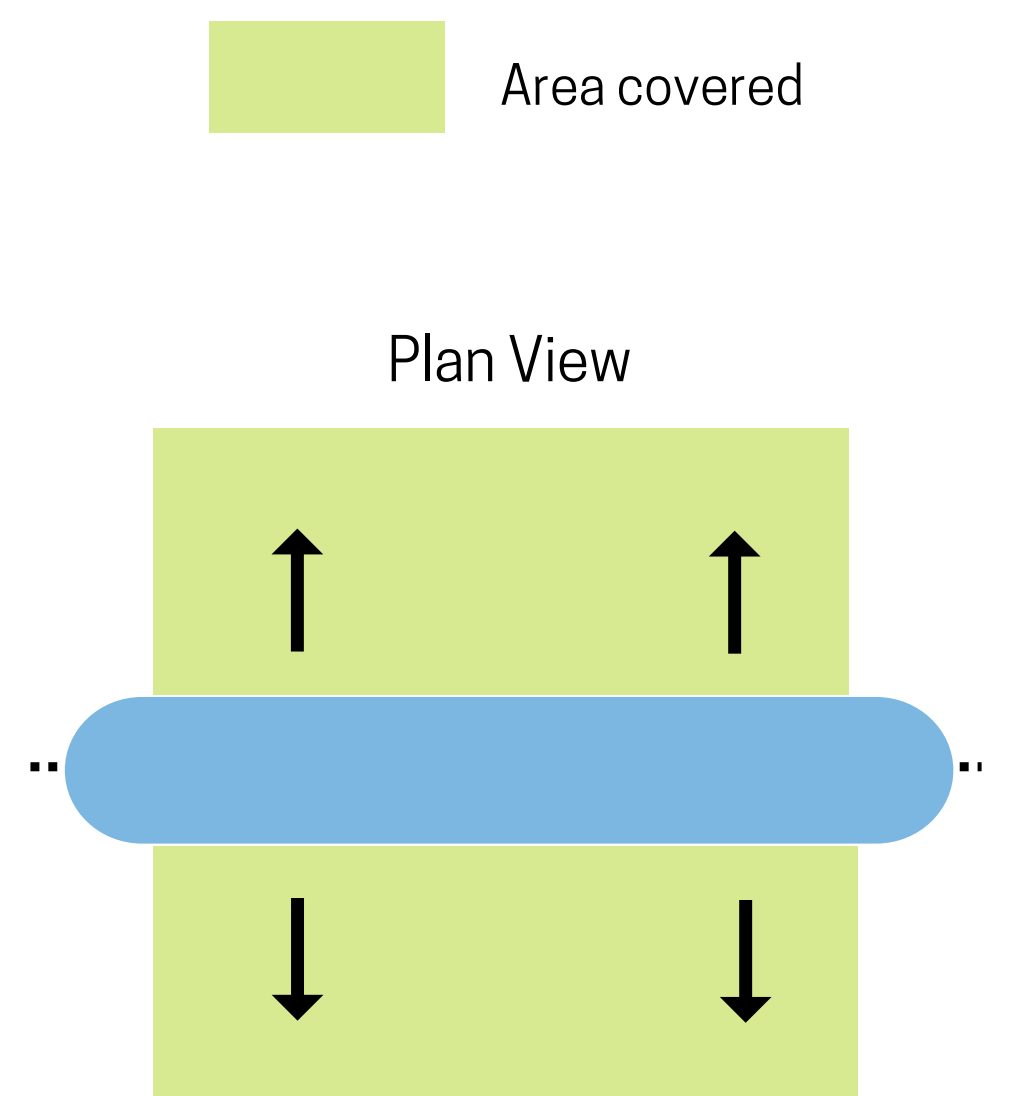
To cover even more distance, the sprinklers should be able to rotate like such:

[22] Half Rotation On The Vertical Plane



This type of sprinkler will need to have pivots on the ends that allow it to rotate through 180 degrees.

The force pushing the water out also needs to be high to allow the water to jet out and therefore reach a greater distance.

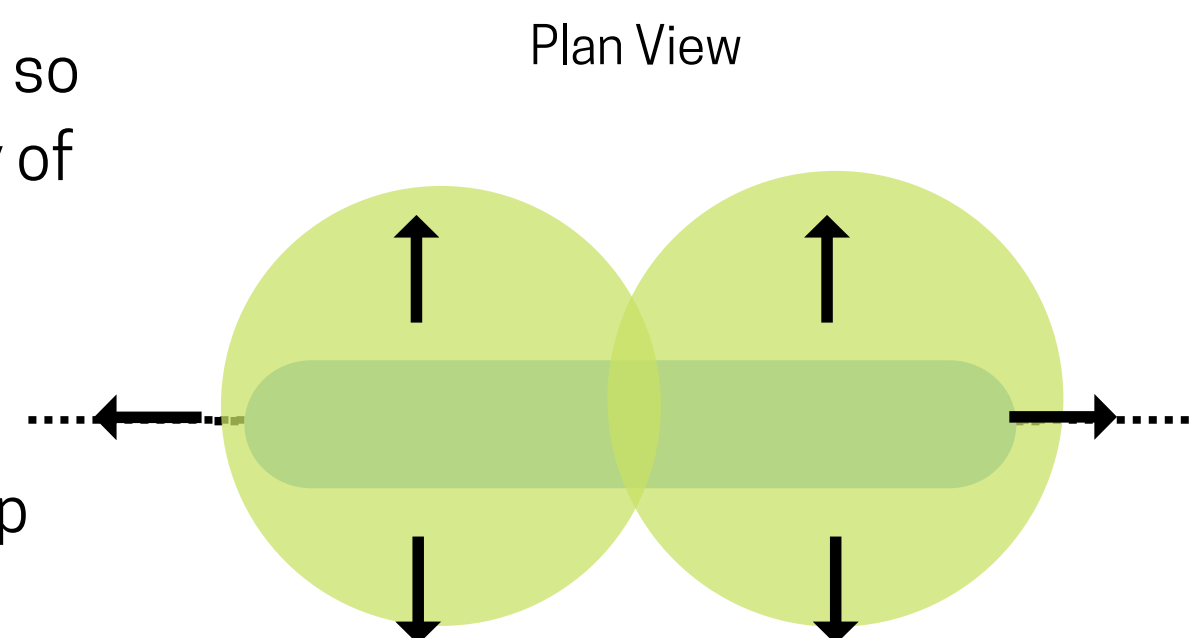


[23] Full Rotation On The Horizontal Plane



When designing this type of sprinkler, I'll have to make sure that it does not protrude too much out of the ground, this is so it doesn't obstruct the journey of the golf balls travelling past.

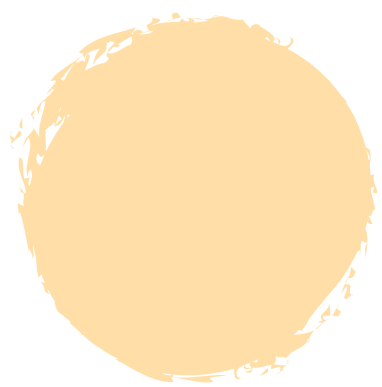
A better idea for this is to give the sprinkler the ability to go up and down. It can go all the way down when not in use and all the way up when in use.



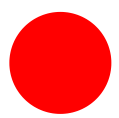
[22] <https://www.walmart.com/ip/Lawn-Sprinkler-ABS-Plastic-Automatic-Rotating-3-Way-Adjustment-Garden-Water-Sprinklers-Irrigation-System-Covering-Large-Area/856579196>

[23] <https://www.aliexpress.com/item/Garden-Greenhouse-Three-Arm-Automatic-360-Degree-Rotary-Spray-Head-Garden-Lawn-Sprinkler-Irrigation-Watering-Supplies/32764080487.html?src=bing&albslr=202445061&isdl=y>

DEVELOPED PROPOSAL



Area Covered



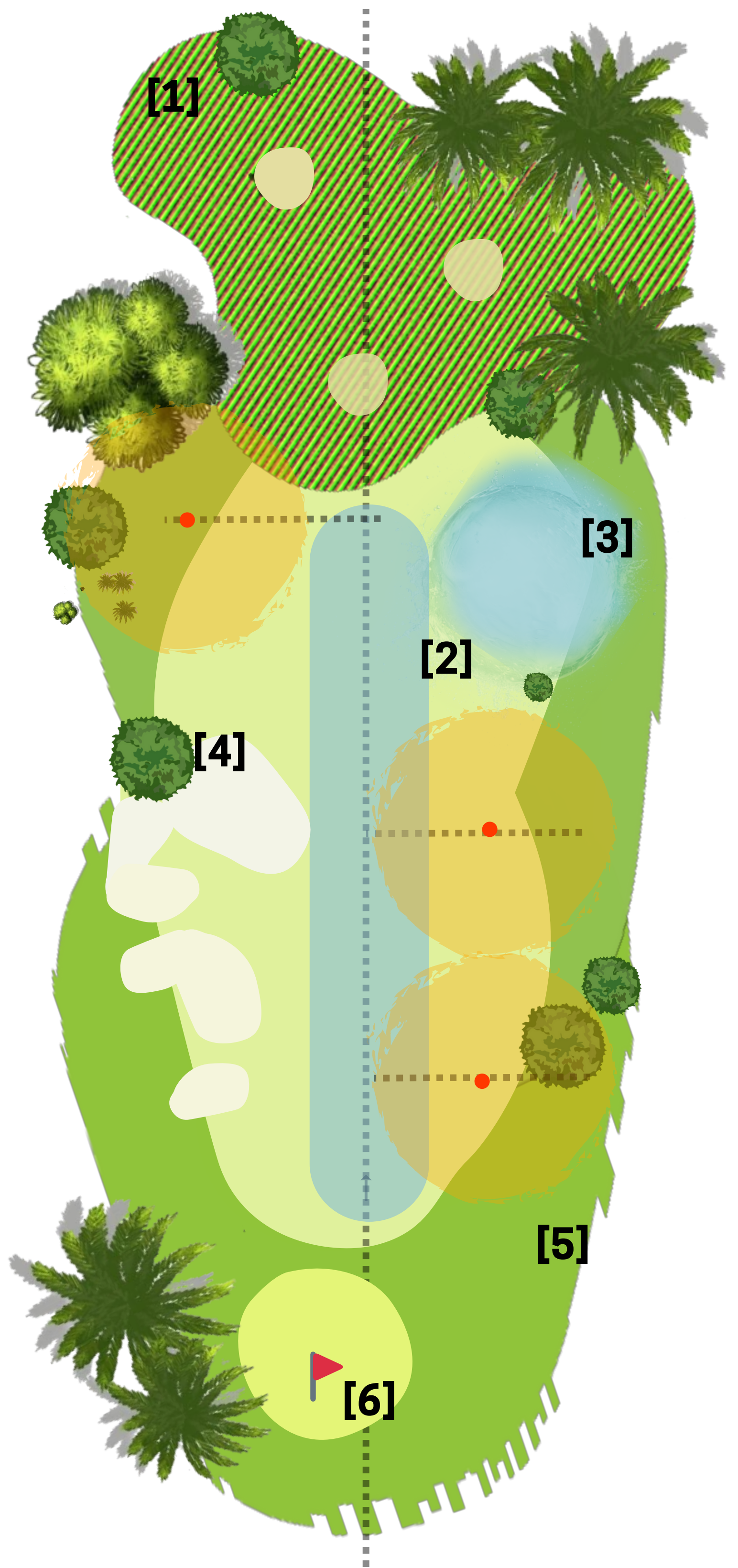
Sprinkler Location

The pump that can extract the water out of these pipes can be inbuilt into the rotary sprinkler. Since there will be soil moisture sensors installed, the number of sprinklers needed will be reduced and only placed in areas that need them. I decided to place them in the fairways, this is because the fairway makes up the largest amount of the course and therefore has more turf. Smaller areas of such as the teeing grounds can be hand-watered if necessary.

Despite not being a nature-based solution, the sprinkler system can still be included by including the 4 nature-based solutions within the design. Grass species that require less water can be put in place where the water sprinkling is less intense. Swales that are manually built but naturally filled (by the rain) can be used instead of a man-made and man-filled water hazard.

FEATURES

- [1] Teeing box with 3 teeing grounds
- [2] The Fairway
- [3] Water hazard (Swale)
- [4] Dry Hazards (Sand Bunker)
- [5] The Roughs
- [6] The Hole



DEVELOPED PROPOSAL

Cold Climate Golf Course

Fewer sprinklers will be needed for rainy areas. Grass species will need to be cold resistant and not brown during the winter.

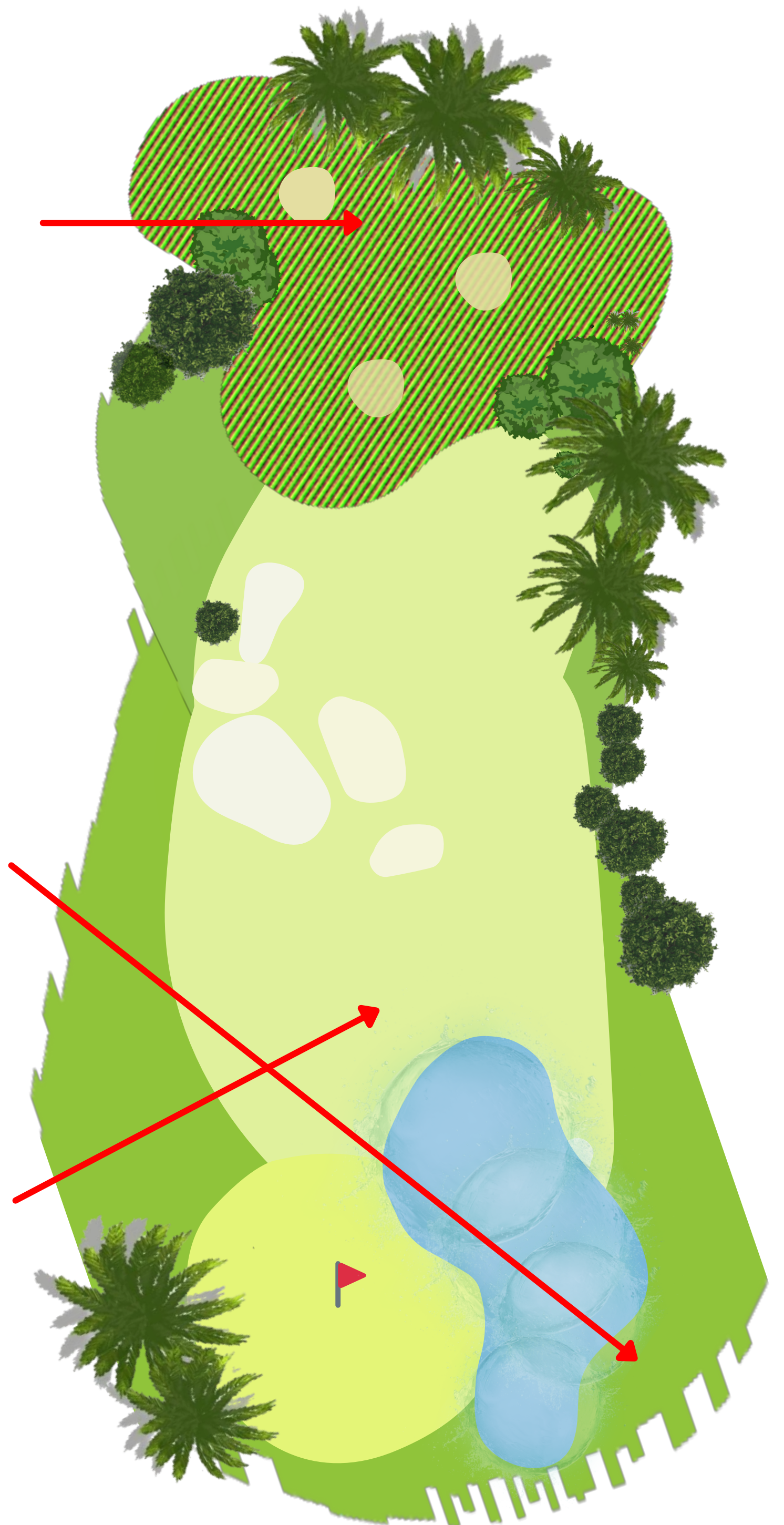
[24] A tee that uses Latitude 36 Bermudagrass

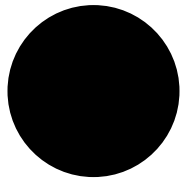


Teeing grounds require smooth surfaces and low-cut grass. Bermudagrass can be cut low without stressing the grass. Although Bermudagrass tends to die in cold weather, Latitude 36 is a cold-resistant type of bermudagrass which is ideal for general UK weather climates.

There are fewer trees around the water hazard to reduce competition for water between the trees and the grass in the fairway. To further reduce competition, **root-pruned trees** can be planted however there must be a range of species of root-pruned trees to introduce biodiversity amongst plants.

Fairways also need to be neatly kept and well mown. **Bentgrass** is a common grass which thrives in colder conditions and can grow thickly without needing a lot of water. Other grasses such as Poa Annuua, fescue and perennial ryegrass can be incorporated to add diversity. However, Poa Annual has shallow roots and is often hand watered.





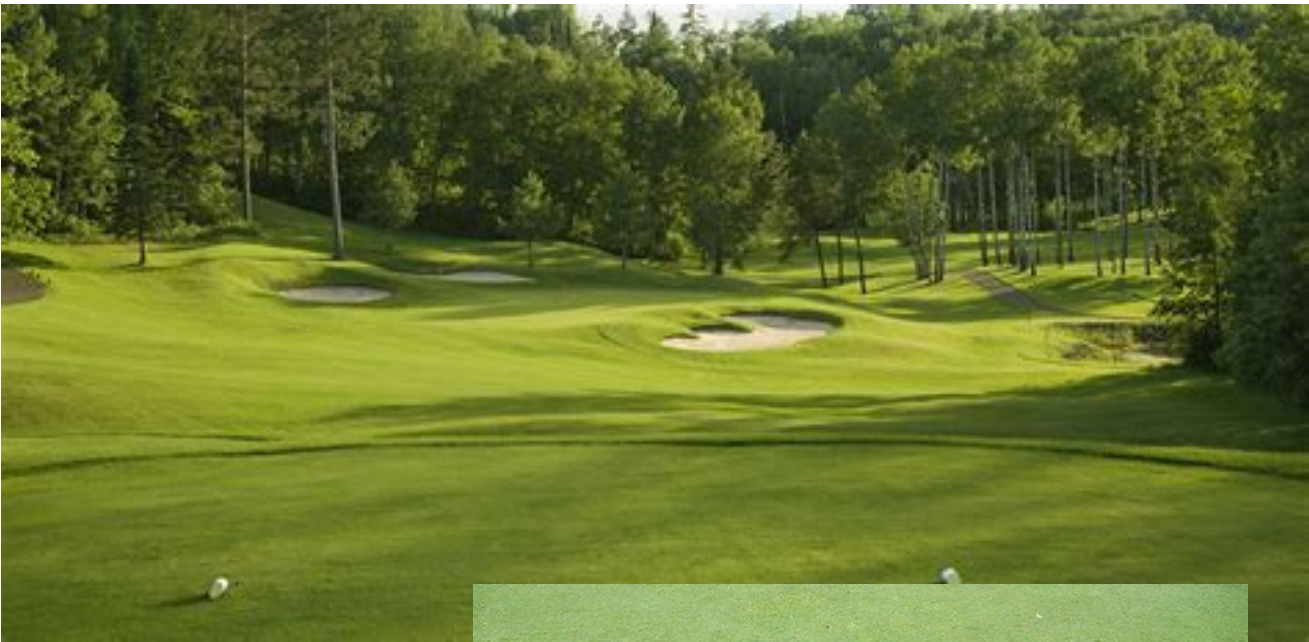
DEVELOPED PROPOSAL

Grass Samples

[25]



[26]



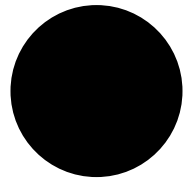
[27]



[25] <https://kingranchfl turfgrass.com/services/latitude-36-bermudagrass/>

[26] <https://turfmerchants.com/grass-seed-variety/bentgrass/>

[27] <https://www.kmgcgolfconsultant.com/2010/01/how-to-grow-great-poa-annua-golf-greens.html>



DEVELOPED PROPOSAL

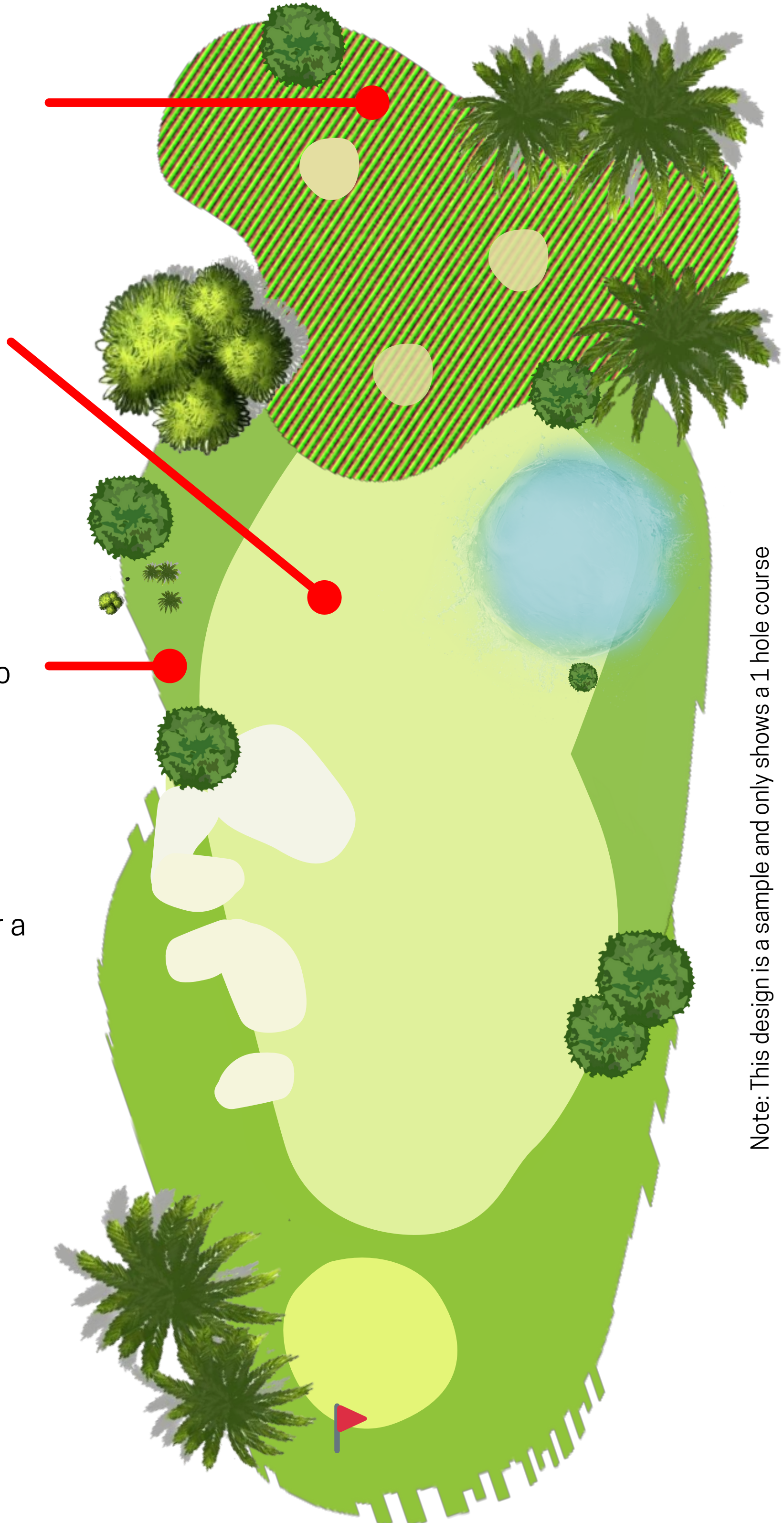
Warm Climate Golf Course

Celebration Bermudagrass can be used for the teeing grounds instead of Latitude 36 due to its ability to tolerate warm climates.

The fairways consist of Empire Zoysiagrass and Kentucky Bluegrass. This is because Empire Zoysiagrass tolerates high heat and Kentucky Bluegrass is durable and tolerates stress. Zoysiagrass tends to be found on Teeing Grounds and Fairways.

The rough can be Bluegrass or Ryegrass as they do better when longer.

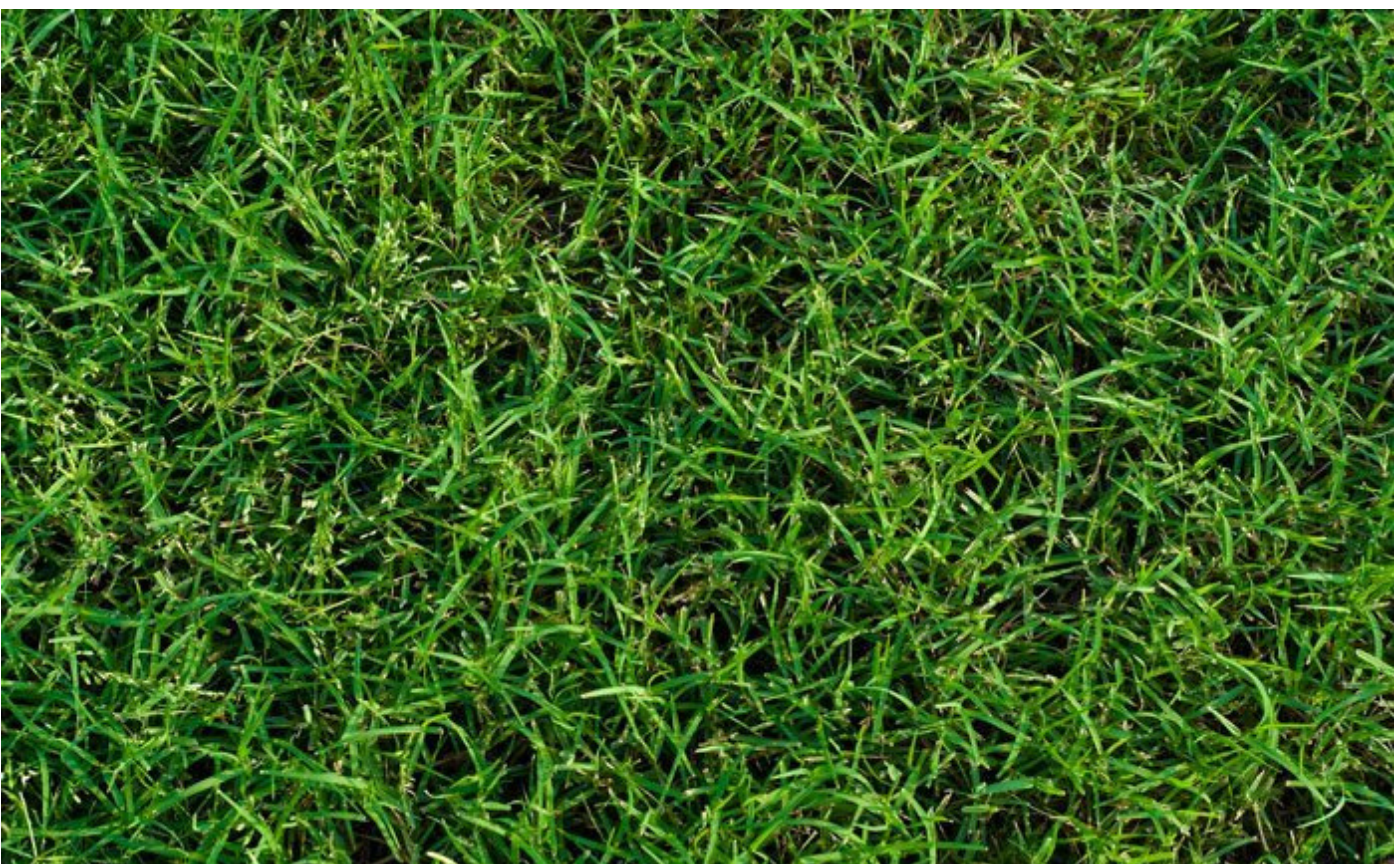
Many courses in Florida and Georgia, USA use Bermudagrass. This can be used on the Greens for a smooth low cut surface.



Note: This design is a sample and only shows a 1 hole course

DEVELOPED PROPOSAL

Grass Samples



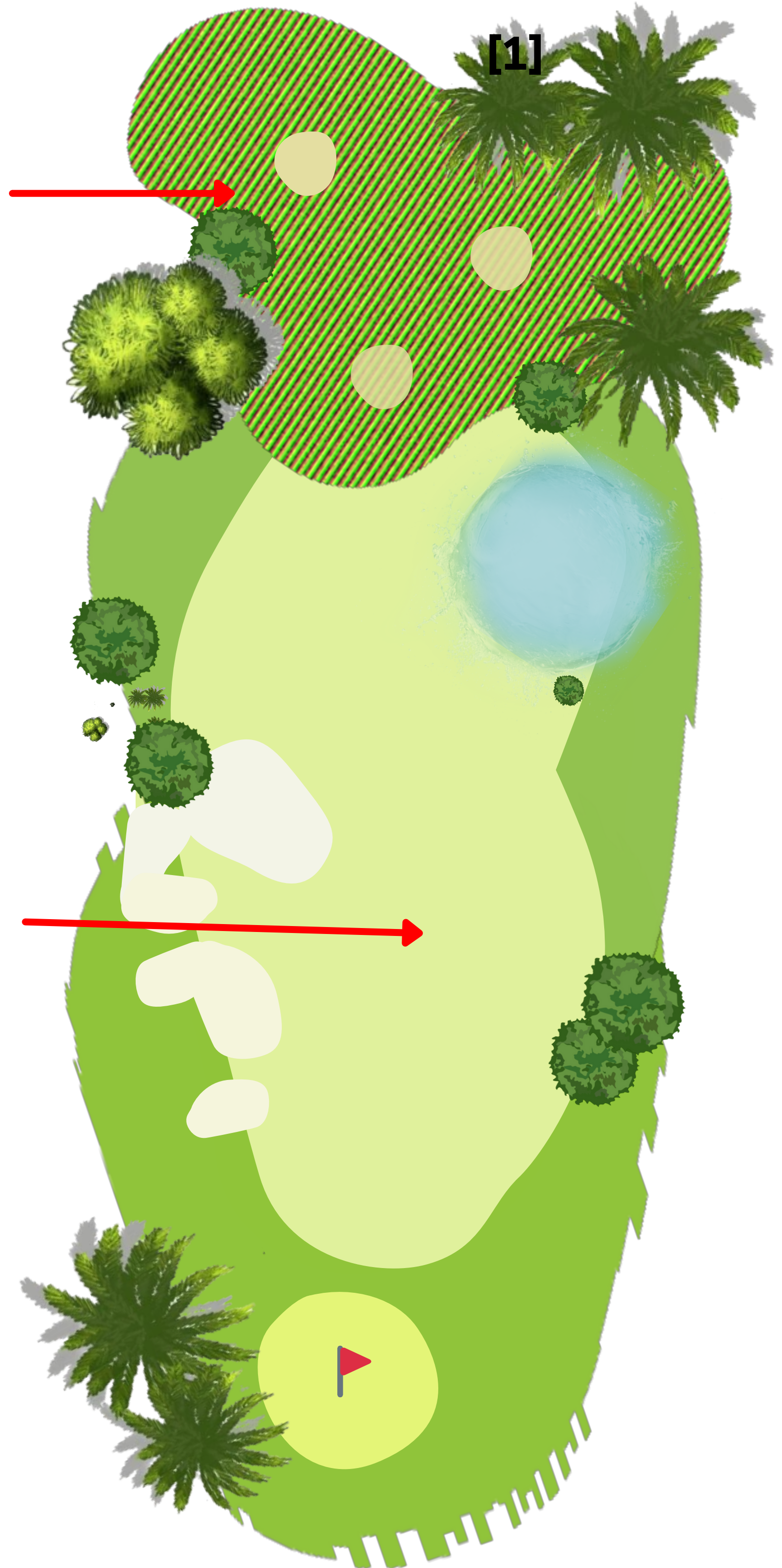
[28]



[29]



[30]



[28] <https://www.nimmerturf.com/celebration-bermudagrass/>
[29] <https://hanceysturf.com.au/product/empire-zoysia-grass/>
[30] <https://sportingvalleyturf.com/our-sod/kentucky-bluegrass/>

PROJECT EVALUATION

POSITIVE

The system which I designed for this project involved the contribution of both golf courses and water treatment facilities. It helps water treatment facilities to avoid disposing of their excess water that doesn't get distributed. This helps two organisations to conserve large volumes of water, if more golf courses were in partnership with water treatment facilities, larger amounts of water could be conserved nationwide.

NEGATIVE

In my opinion, the start of my proposal did not successfully reflect the aim of '**Using nature-based solutions**'. The storage/sprinkler tank I envisioned was a human-made solution. To get back on track, I decided to research suitable ways of bringing nature into my proposal that can also aid in water conservation. This meant that my proposal had a combination of human technology and nature.

Another downside to this project was the science behind the irrigation system. Without deeper knowledge in engineering, it was a lot harder to investigate and deduce a system that could physically work. With time constraints, I found it harder to start learning about the mechanics of irrigation systems from scratch.

Another thought I had later on in this project was that irrigation systems have already been long-term concepts and there already exists efficient and clever systems.

During this project, I developed key skills such as team/group work and how to effectively communicate with various people to ensure the project flows smoothly whilst maintaining friendly and professional relationships with other team members.

Initially, I wanted to design a golf course that was suitable for the UK and its weather climates however the information on golf courses in the USA was a lot easier to find. Although the research was still relevant to golf courses worldwide, most of the key research involving data only applied to the USA. This left me with two options: *conduct further research relevant to the UK and add that to the existing research* or design a golf course suitable for both. I decided that option 2 was better as I could design a course for cold climates and another for warm climates, making them relevant for multiple places on Earth.

Throughout the 6 weeks, I have noticed that I rarely have questions to ask during the weekly meetings but a lot after. This problem was solved by simply emailing my list of questions after the meetings. A large proportion of the time was spent on deciding on the main focus of the project, if I had decided on a focus sooner, researching would have run a lot smoother as I would have known exactly what to research into.

If I was to redo this project, I would conduct a survey for golf players and superintendents, asking for their opinion on the level of sustainability and eco-friendliness of golf course maintenance along with their suggestions to improve the quality of the maintenance. This would allow me to include some primary research in my project.