GOLF COURSE 2030
GREAT BRITAIN & IRELAND

ACTION PLAN

WATER AS A LIMITED RESOURCE AND COPING WITH TOO MUCH

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STRI
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WATER AS A LIMITED RESOURCE AND COPING WITH TOO MUCH

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WATER AS A LIMITED RESOURCE AND COPING WITH TOO MUCH

1. INTRODUCTION

Water has two critical roles on the golf course. Firstly, it is essential for grass growth and maintaining grass health. Water is important to grass plants in the following ways:

- as a source of oxygen and hydrogen for the process of photosynthesis that uses the energy of the sun to combine carbon dioxide and water molecules to produce carbohydrates, which form the majority of structural components in the plant and energy storage molecules
- water is essential in keeping the cells in grass plant turgid (rigid), which allows them to stand upright. When water levels in the cells drop, cells become flaccid and the plant starts to droop or wilt
- water is the carrier of dissolved nutrients and compounds in the plant, without which plants would not be able to transport the required materials around themselves
- the soil microecosystem survives in water films around soil particles and in water filled pores. This is important to the grass plant, because it is the soil microecosystem that allows many plant nutrients to be made available, so without water the microecosystem is likely to become denuded, thereby reducing nutrient recycling, resulting in fewer plant nutrients being available when the grass plant needs them.

The second role of water on golf courses is that it directly affects the playability of a golf surface. If the turf is too dry, then it will become overly hard, and if a surface is too wet it will become too soft and receptive to incoming shots and more prone to wear damage.

A significant component of turf management is managing plant hydration and soil air: water balance. This can be in the form of irrigation to replace water that plants inevitably lose when they carry out gaseous exchange, or that is lost through evaporation from the soil, through to managing soil air: water balance through aeration, wetting agent application or drainage.

2. WHAT IS THE ISSUE?

The issues covered by this action plan relate to the complete overview of water management on golf courses. With changing climate patterns and greater demand for water two main issues can be identified:

- how can golf surfaces cope when water is in short supply?
- how can golf surfaces deal with wet weather, both intense but short storms and prolonged periods of rainfall leading to soil saturation?

Competition for water with other demands on supply is probably going to be the biggest challenge for golf. This needs to be spelt out clearly to golfers, clubs and golf industry professionals. The recent "Jaws of Death" statement by the Chairman of the Environment Agency highlighted the fact that, in the UK, we are going to reach the situation within 20-30 years where demand for water exceeds supply. At that point very tough priority decisions are going to be made, and it is likely that golf (perceived as a leisure activity) will rank below the priority given to domestic supply, the needs of industry and commerce, schools, hospitals, etc. This, and the need to find non-potable supplies for "non-essential" users will increase the cost of water, possibly beyond the means of current levels of usage in golf.
The variation and variability of rainfall is likely to be a key challenge to contend with, as climate projections for the UK and Ireland are that hot summers will become more common, that rainfall will become more variable both seasonally and geographically across Great Britain & Ireland. This poses significant challenges, which will be highlighted throughout this document, as it is likely to mean that golf courses are going to have to build into their resilience planning, how to cope with increased risk of hot dry summers and wetter winters and with a greater risk of extreme weather events.

A conceptual model for tackling the issues of water management (excess and scarcity) has been proposed, based on the action pathway golf courses are likely to have to follow:

**Assess**
The issues and needs of individual clubs, based on their own circumstances. Ensure turf and club managers understand and are confident to discuss these issues.

**Evolve**
The plan by assessing its level of success to ensure improved or continued resilience from water pressures.

**Support**
Clubs will need support at every stage to ensure success, with that support being tailored to their needs.

**Design**
Cost-effective and targeted solutions to address the issues at that club.

**Resolve**
The issues by implementing the agreed action plan for that club.

The intention is that this model can provide a structured pathway from issue identification to solution design and implementation to evolution of that plan for ongoing success. Critical to this is support at every stage. The nature and level of support will be specific to individual clubs. A one size fits all solution is unlikely to succeed with such a multifactorial issue such as water management. Therefore, solutions need to be tailored to individual club needs, based on their geographic climate, existing course conditions, governance and business model.

When consulting with the wider industry, it was felt that many of the technological and turf management solutions were available, but knowledge of their existence, capabilities, roles, benefits and drawbacks were not fully understood and information not located in a central place. It was felt that a significant part of the challenges associated with resolving resilience on golf courses to water scarcity and excess, lay in having a strategic plan, effective communication and education, provision of appropriate support to all levels of clubs and at different points of access within clubs and, finally, provision of resource (knowledge, advice or funding) to help carry out the targeted works needed.
# 3. THE CHALLENGES POSED BY THIS ISSUE

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Pathways to address these challenges</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
</table>
| **Climate change** | • Understanding of what the likely consequences of climate change are, in terms of rainfall and temperatures, not only at national scales, but also regionally around Great Britain & Ireland in as much spatial detail as possible.  
• Characterisation of temporal variability in rainfall and temperature, i.e. will conditions be consistently warmer and wetter, or will there be greater seasonality or extreme weather events.  
• Translation of climate change impacts (which are based on probabilistic models) on golf course management and how that will affect surface playability. | • Review and characterise current understanding of implications of climate change, both nationally and regionally.  
• Carry out risk analysis of how climate change will affect water scarcity and excess on all playing surfaces at golf clubs.  
• Communication of review and what this means for short, medium and long-term golf surface management.  
• Use these findings to target optimal solutions that could be used by clubs to build greater resilience to water scarcity or excess. | Key stakeholders will include:  
• Climate scientists  
• Regulators such as EA, SEPA etc.  
• R&A and National governing bodies  
• Industry bodies, such as BiGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Golfers  
Requirements will include:  
• Participating in reviews and risk analyses  
• Communication activities  
• Training |
| **Water supply** | • How will climate change affect water availability in particular?  
• How will competing pressures for potentially scarcer water resources be regulated?  
• How will regulation and resource competition impact golf courses? | • As part of review on impacts climate change, water availability should be included.  
• Review water requirements (usage and supply) on golf courses and consult with water regulators to establish current and longer-term potential issues. | Key stakeholders will include:  
• Regulators such as EA, SEPA etc.  
• Water suppliers  
• R&A and National governing bodies  
• Industry bodies, such as BiGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials |
<table>
<thead>
<tr>
<th>Legislation &amp; Regulation</th>
<th>Problem identification</th>
<th>Requirements will include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What is the perception of water regulatory bodies to water usage on golf courses?</td>
<td>• What are the specific issues experienced at individual clubs that affect water management?</td>
<td>• Participating in reviews and communication activities and training</td>
</tr>
<tr>
<td>• How will legislation and regulations change in light of latest climate change predictions, and how will this affect golf course water use?</td>
<td>• Are clubs able to identify and review water related issues at their clubs and how much help do they need?</td>
<td>Key stakeholders will include:</td>
</tr>
<tr>
<td>• How will the regulatory landscape change or react to:</td>
<td></td>
<td>• Regulators such as EA, SEPA etc.</td>
</tr>
<tr>
<td>o water scarcity?</td>
<td>o Clubs will need to review their water assets and demands now and for the future, to ensure they have sufficient supply or can implement appropriate schemes to mitigate if demand outstrips potential supply.</td>
<td>• Water suppliers</td>
</tr>
<tr>
<td>o increased drainage from golf courses, i.e. increased water volumes entering drainage networks?</td>
<td>• Clubs should pinpoint drainage issues on course and how they could be exacerbated if there is more rainfall and/or more extreme weather events</td>
<td>• R&amp;A and National governing bodies</td>
</tr>
<tr>
<td>o use of recycled water on turf?</td>
<td>• Clubs will need to have a targeted approach to help prioritise need and</td>
<td>• Industry bodies, such as BiGGA, GCSAI, BASIS etc.</td>
</tr>
<tr>
<td>• As part of water supply review, it is essential that water regulatory bodies such as EA and SEPA are engaged.</td>
<td></td>
<td>• Agronomists and turf managers</td>
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<tr>
<td>• It will be critical to look at water prioritisation under scarcity conditions and what the implications will be for golf courses.</td>
<td></td>
<td>• Club owners, managers &amp; officials</td>
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<tr>
<td>• Discuss with regulators, as part of water availability review, what will be likely changes to legislation and how they will affect golf courses.</td>
<td>Requirements will include:</td>
<td>Requirements will include:</td>
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<tr>
<td></td>
<td>• Reviews, communication and training</td>
<td>• Regulators such as EA, SEPA etc.</td>
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<td>• Water suppliers</td>
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<td></td>
<td>• R&amp;A and National governing bodies</td>
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<td>• Industry bodies, such as BiGGA, GCSAI, BASIS etc.</td>
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<td></td>
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<td>• Agronomists and turf managers</td>
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<td></td>
<td></td>
<td>• Club owners, managers &amp; officials</td>
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<tr>
<td>Solution feasibility</td>
<td>Sustainability</td>
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<td>--------------------------------------------------------------------------------------</td>
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<td>• What are the available solutions, how best to utilise them and how costly are they to implement and maintain?</td>
<td>• Solutions have to be sustainable from both an environmental and business point of view.</td>
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<tr>
<td>• What is best practice guidance for managing turf under conditions of either water scarcity or water excess?</td>
<td>• If surface water storage is utilised to harvest drainage and rain water, is there a risk that these environments will become ecologically sensitive, thereby restricting abstraction.</td>
<td></td>
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<tr>
<td>• What are the environmental impacts of implementing these solutions?</td>
<td>• When technological or management solutions are put forward, they should not jeopardise either environmental or business sustainability goals.</td>
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<td></td>
<td>• Encourage innovative solutions that remove sustainability issues through technological or design solutions.</td>
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<td></td>
<td>Will they need to be supported in this endeavour.</td>
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<td></td>
<td>• Training should be provided to club to help staff recognise potential issues and how to prioritise need.</td>
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<tr>
<td></td>
<td>• Participating in reviews, communication activities and training.</td>
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<tr>
<td></td>
<td>• Best practice guidance advice and toolkit production.</td>
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</tbody>
</table>

Key stakeholders will include:
- R&A and National governing bodies
- Industry bodies, such as BIGGA, GCSAI, BASIS etc.
- Agronomists and turf managers
- Club owners, managers & officials
- Product manufacturers

Requirements will include:
- Participating in reviews and communication activities and training.
- Guidance and toolkit production.
- Best practice advice production, communication activities and training.
| Business impacts | • What are the impact and risk assessments of a) water scarcity and b) poor drainage and greater flood risk and what does this mean to individual golf courses?  
• How will resourcing and funding of improvement works be implemented?  
• How will impacts (physically and costs) of mitigation works or programmes be perceived by club management and players? | • Look to produce assessment tools/guidance to help clubs identify impacts to business of water management issues and costs and maintenance requirements of mitigation solutions.  
• This will need to go hand in hand with an education/communication programme to help ensure a minimum baseline of understanding is in place.  
• Communicate the “do nothing” option and the impacts this will have. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include:  
• Participating in reviews, guidance advice production, communication activities and training. |
| Communication & education | • What are the perceptions of the golf industry to impacts of climate change on water resources, both in terms of water scarcity and excess water?  
• What level of understanding is there of water management issues (both excess and scarcity) and risks and effects this can have on golf course playability?  
• What are the key messages that need to be communicated?  
• What will be the best way to present the issues and risks caused by water under or over availability?  
• What audiences need to be targeting? | • Need to raise awareness of issues, not just with turf managers, but with players and golf club management.  
• Need to have an integrated strategy for delivering a scientifically robust message of impacts and solutions in a format that is easily understood with realistically actionable outcomes.  
• Multichannel communication (traditional press, social media, presentations) to engage as wide an audience as possible. However, will need to tailor message to audience, such as overview of issues and solutions for players/members, technical for turf managers and business/cost implications for club management. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include:  
• Communication activities and training, including the production of standardised materials for them. |
<table>
<thead>
<tr>
<th>Implementation</th>
<th>Support</th>
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</table>
| - What are the optimum technical and best practice maintenance solutions for managing water scarcity or water excess?  
  - How will best practice advice be communicated, and optimum solutions recommended and who is best placed to deliver this?  
  - How will solutions recommended, and best practice advice given be tailored to course needs and resource availability (space, time, money).  
  - How can the solutions available be made cost effective and clubs made aware of the options that suit their operational business model? | - Support to industry partners assisting clubs, turf managers and club managers will be critical to success to ensure programmes are kept on track and message on water use and management is kept fresh and current.  
  - Level of support needed by clubs needs to be gauged on a case by case basis, but if support is not provided for clubs implementing | - Education is critical to success, as there is a need to build up not only technical knowledge but also understanding of business and wider environmental impacts.  
  - Clear guidance on solutions to tackle water scarcity and excess, and what happens if no action is taken.  
  - Need to have a strategic approach to implementing policies and actions on making golf courses more resilient to water scarcity or excess.  
  - Use of standardised toolkit or guidance to help ensure consistent and effective messaging.  
  - Need to engage appropriate organisations/bodies for effective delivery as supporting clubs through the process of “assess, design, resolve and evolve” is critical. |
| Key stakeholders will include:  
  - R&A and National governing bodies  
  - Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
  - Agronomists and turf managers  
  - Club owners, managers & officials  
  - Product manufacturers | Key stakeholders will include:  
  - R&A and National governing bodies  
  - Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
  - Agronomists and turf managers  
  - Club owners, managers & officials |
| Requirements will include:  
  - Participating in reviews and communication activities and training.  
  - Guidance and toolkit production. | Requirements will include:  
  - Participating in reviews and communication activities and training.  
  - Guidance and toolkit production. |
| Resourcing & funding | • Funding of projects will be critical, as clubs with tighter budgets will undoubtedly need assistance. Where will this funding come from, how will it be made available and how will cost-effectiveness be monitored and assessed?  
• Need to produce funding strategy following a review of available funding streams.  
• Possibility of a loan scheme specifically to help with water management projects.  
• Need to establish cost-benefit of technical and management solutions.  
• Enable clubs to investigate resource availability and issues in their clubs.  
• Provision of technical and business support to be available for clubs to assist with decision making. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials | Requirements will include:  
• Participating in reviews, advice production, communication activities and training. |
| Prioritisation | • How will external resourcing, such as advice and support services, as well as funding be prioritised for clubs?  
• How will clubs prioritise works required to improve their resilience to water scarcity and/or drainage issues?  
• Need to prioritise technical or management programmes for tackling water scarcity or excess on each course based on requirements and feasibility that solution will provide cost-effective solution.  
• Regional priorities based on review of impacts of climate change on precipitation.  
• Need to prioritise resourcing to clubs, but a system to achieve this will need to be devised, along with a transparent process for doing this. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Financial institutions | Requirements will include: |
### Player expectation

- What do players expect of golf courses when there is either prolonged dry weather or persistent wet weather?
- Can player exceptions be met following remedial activities or does there have to be a degree of realignment of player expectations considering the reality of the on-course situation?
- Player feedback about what they value about playing surfaces, how they would feel about changes forced by water scarcity or excess
- Communication with members and players regarding water resilience issues to highlight scale, need and what can be done.
- Assess ability of players to change expectations based on quality of turf during hot and dry periods?
- Will those who market directly to players be willing to include water sustainability messages in their offerings?

### Key stakeholders will include:

- R&A and National governing bodies
- Industry bodies, such as BiGGA, GCSAI, BASIS etc.
- Agronomists and turf managers
- Club owners, managers & officials
- Players

### Requirements will include:

- Player feedback survey and review, communication activities and training.

### 4. THE OPPORTUNITIES MADE AVAILABLE BY THIS ISSUE

<table>
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<tr>
<th>Opportunities</th>
<th>Pathways opportunities to address these actions</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
</table>
| Increased playing surface resilience | • Courses will become more robust to extremes of weather.  
• Courses, as businesses, will be better able to cope with external challenges.  
• Greater revenue generation potential as courses can sustain more days of play or more rounds.  
• Capture knowledge and communicate this to industry to enable others to gain benefit.  
• Communication with golf clubs, at both a technical and a golf club management level to ensure they understand benefits. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BiGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include: |
| Improved playing qualities | • Better playing surfaces for golfers that resist wear. | • By carrying out strategies to deal with water scarcity and/or excess, the playability of surfaces will be improved under a wider range of weather conditions. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include:  
• Communication and training. |
| --- | --- | --- | --- |
| Sustainability on courses | • Potential reduction in water requirements if water saving technologies or management strategies are employed. | • Collate relevant information and strategies for golf courses.  
• Communication opportunities to integrate functional and ecological aspect of mitigation solutions.  
• Funding for research to demonstrate the advantages or methods of good water management. | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Golfers  
Requirements will include:  
• Advice production, communication activities and training.  
• Research to demonstrate effective methods. |
| Botanical composition | • Driver for development of more resilient grass species or cultivars to reduce water need.  
• Driver to look at different grass species in regions where they are | • Consultation with golfing bodies in drought affected regions.  
• Consultation with grass breeders to identify new species or cultivar that | Key stakeholders will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc. |
| Innovation | • Potential to initiate integrated water management schemes, such as harvesting and reuse of water or even use of locally treated water coming from club house.  
• Evaluation of new technologies or new ways of integrating existing technologies onto golf courses. For example, is it possible to decentralise irrigation systems by having local harvesting and storage solutions or use sub-surface irrigation to reduce water losses?  
• Are there ways to better manage and monitor water need across golf courses or use different grasses? | • Evaluation and review of new technologies and management techniques that could be used to help mitigate water scarcity and/or excess.  
• Important not to be constrained by existing preconceptions or understanding. There should be licence to explore “left field” or novel approaches.  
• Investigate funding opportunities to facilitate early adopters of new technologies.  
• Research and demonstration trials to prove and show efficacy of these systems. | • Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include:  
• Advice production, communication activities and training.  
| Knowledge gain and best practice review | • Expanding understanding and knowledge of interrelationships between climate, soil and golf playing surfaces.  
• Opportunity to enhance best practice advice for dealing with extremes in weather conditions. | • As part of implementation strategy, the knowledge that will be gained needs to be gathered together, summarised and communicated. | • The R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
Requirements will include:  
• Participating in reviews, best practice guidance advice and communication activities and training. |
### 5. EXISTING KNOWLEDGE AND GAPS IN KNOWLEDGE

<table>
<thead>
<tr>
<th>Gaps in knowledge</th>
<th>Pathways to address these gaps</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>• Review currently available data to identify if possible or necessary to refine resolution further.</td>
<td>Key stakeholders involved with all of the knowledge gap areas will include:</td>
</tr>
<tr>
<td>• Translation of climate change impacts to smaller geographic scale, i.e. golf course scale.</td>
<td>• Review available solutions, evaluate and compare with existing options in test installation as part of research programme.</td>
<td>• R&amp;A and National governing bodies</td>
</tr>
<tr>
<td>• What are the alternative solutions, how do they compare to current solutions and how can they best be used?</td>
<td>• Communicate output to key stakeholders and feed information into best practice guidance.</td>
<td>• Industry bodies, such as BIGGA, GCSAI, BASIS etc.</td>
</tr>
<tr>
<td>Drainage solutions</td>
<td></td>
<td>• Agronomists and turf managers</td>
</tr>
<tr>
<td>Irrigation solutions</td>
<td>• Review available solutions, evaluate and compare with existing options in test installation as part of research programme.</td>
<td>• Club owners, managers &amp; officials</td>
</tr>
<tr>
<td>• What are the alternative solutions, how do they compare to current solutions and how can they best be used?</td>
<td>• Communicate output to key stakeholders and feed information into best practice guidance.</td>
<td>• Product manufacturers</td>
</tr>
<tr>
<td>Capture solutions</td>
<td>• Review available solutions, evaluate and compare with existing options in test installation as part of research programme.</td>
<td>Requirements will include:</td>
</tr>
<tr>
<td>• What are the practical and realistic options for harvesting and storage of water on the course?</td>
<td>• Communicate output to key stakeholders and feed information into best practice guidance.</td>
<td>• Assisting with review activities.</td>
</tr>
<tr>
<td>• Are there options to environmental and ecological solutions that can help with water storage?</td>
<td></td>
<td>• Planning of appropriate desk based and field studies to gather the required knowledge.</td>
</tr>
<tr>
<td>Integration of solutions</td>
<td>• Review available solutions, evaluate and compare with existing options in test installation as part of research programme.</td>
<td>• Field research will tend towards demonstration and case study type work, rather than small plot work.</td>
</tr>
<tr>
<td>• What are the most relevant and compatible solutions, how can they be integrated, and do they give added value? For example, a system that captures and stores drainage water, recycles it for use through</td>
<td></td>
<td>• Preparation of best practice advice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Preparation and participation in communication activities and training.</td>
</tr>
</tbody>
</table>
| Future/novel technologies | • What future or novel technology is being developed for golf or used in other industries that will assist with water management?  
• Grass species/variety development – what is on the horizon and would they be of use on golf courses? | • Communicate output to key stakeholders and feed information into best practice guidance.  
• Engage with solution providers to establish what technologies are relevant and show promise.  
• Review available solutions, evaluate and compare with existing options in test installation as part of research programme.  
• Pilot schemes to trial and demonstrate feasibility (case study type approach).  
• Player engagement to empower them to proactively support new technologies to aid with water management. |

### 6. PROPOSED ACTIONS TO ADDRESS THE CHALLENGES

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Actions to address challenges</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
</table>
| Climate change | • Based on the available data, characterise the implications of climate change on precipitation and temperatures, both nationally and regionally.  
• Review the potential impacts of climate change, according to the various projections for emission levels, on water scarcity and rainfall patterns.  
• Carry out a risk analysis of the impact of climate change on golf course water resources (scarcity and excess).  
• Summarise these outputs and communicate to the relevant stakeholders to raise awareness of the issues and the implications for golf surface playing quality.  
• Feed the information from this section of work into the evaluation of possible solutions to tackle the effects of water scarcity and water excess. | Key stakeholders taking part in these actions will include:  
• Climate scientists  
• Regulators such as EA, SEPA etc.  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials |
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<tr>
<th>Water supply</th>
<th>Key stakeholders taking part in these actions will include:</th>
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</thead>
<tbody>
<tr>
<td>• As part of climate change review, assess the impacts resulting from climate change on water availability.</td>
<td>• Water suppliers and regulators such as EA, SEPA etc.</td>
</tr>
<tr>
<td>• Carry out a review of water requirements on golf courses, assess potential issues in supply and feed this into the review on potential solutions to mitigate water scarcity and water excess.</td>
<td>• Government who may be able to leverage the actions of the water suppliersR&amp;A and National governing bodies</td>
</tr>
<tr>
<td>• Consult with water suppliers and regulators on short and long-term implications on water accessibility.</td>
<td>• Industry bodies, such as BiGGA, GCSAI, BASIS etc.</td>
</tr>
<tr>
<td>legislation &amp; regulation</td>
<td>• Agronomists and turf managers</td>
</tr>
<tr>
<td>• Engage with water/environmental regulators to discuss current and likely future changes to water regulations (water availability, abstraction, storage and drainage).</td>
<td>• Club owners, managers &amp; officials</td>
</tr>
<tr>
<td>• Identify current and future water availability prioritisation within the hierarchy of water users. Establish how golf courses will be affected under projections from climate change models.</td>
<td></td>
</tr>
<tr>
<td>• Assess current legislative measures on adaption to water scarcity to see how they will impact golf courses.</td>
<td></td>
</tr>
<tr>
<td>Problem identification</td>
<td>Key stakeholders taking part in these actions will include:</td>
</tr>
<tr>
<td>• Provide guidance information to assist clubs with undertaking the following:</td>
<td>• R&amp;A and National governing bodies</td>
</tr>
<tr>
<td>o review of water assets and demands and how this matches supply</td>
<td></td>
</tr>
</tbody>
</table>
| Solution feasibility | • Review available solutions to mitigate water scarcity and water excess  
• Create a strategy and supporting best practice guidance on mitigation solutions, their cost effectiveness, how to best employ them and how to assess the feasibility of their use.  
• Create education and training programme and tools to help communicate best practice advice to clubs.  
• Put in place a support programme from first point of contact right the way through to solution design, implementation and review. | Key stakeholders taking part in these actions will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Government, with golf’s actions supporting its case with regards to regulation |
| Sustainability | • Review sustainability of mitigation solutions for golf club use and put together guidance notes. | Key stakeholders taking part in these actions will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Government, with golf’s actions supporting its case with regards to regulation |
| Business impacts | • Create best practice guidance to outline the impacts of water scarcity and excess on golf course business operations. It will be important to stress the financial impacts of climate change and cost effectiveness of the various solutions | Key stakeholders taking part in these actions will include:  
• R&A and National governing bodies  
• Industry bodies, such as BIGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Government, with golf’s actions supporting its case with regards to regulation |
| Communication & education | available, so that the overall impact on the business versus the mitigation gain can be assessed.  
• Create tools and guidance to help clubs identify business risks resulting from water management issues, as well as the costs of solutions and ongoing upkeep.  
• Devise education and communication programme to deliver best practice guidance. This could be in the form of seminars, one to one presentations, webinars etc. It is important to contextualise the mitigation options presented against the “do noting” scenario. | Key stakeholders taking part in these actions will include:  
• Industry bodies, such as BiGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials |
| Implementation | • Develop strategy for implementation of mitigation solutions and the resources that will be needed to communicate and deliver these solutions.  
• Create clear guidance on what the available solutions are, what they do and how to select the optimal solution.  
• Devise a communication plan to impart this knowledge to the full range of stakeholders that will find this information useful. This will include engaging the appropriate organisations to ensure that delivery is effective and advice clear and consistent.  
• Produce a standardised toolkit/resource set that will support effective communication. | Key stakeholders taking part in these actions will include:  
• R&A and National governing bodies  
• Industry bodies, such as BiGGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Product manufacturers |
| Support | • Establish a support plan, which should include organisations best placed to support clubs, how staff from these organisations will be trained and how support should be rolled out to clubs. | Key stakeholders taking part in these actions will include:  
• R&A and National governing bodies |
| **Resourcing & funding** | • Provide materials and resources to aid in club support and promote clear and consistent advice and communication to clubs.  
• There must be a recognition that the level and nature of support needs to be gauged on a club by club basis, but resources and solution finders should be produced to help guide clubs. Support tools need to be capable of putting clubs in contact with the relevant technical support, so that they can guide them through the solution selection and mitigation stages.  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials | **Key stakeholders taking part in these actions will include:**  
• R&A and National governing bodies  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials  
• Financial institutions |
|---|
| **Prioritisation** | • Essential to review funding sources and put together a funding and resource requirement strategy/plan.  
• Carry out cost-benefit appraisal of the various mitigation solutions, whether they be technical installations or turf management approaches.  
• Based on climate change and water supply reviews, gauge club requirements and with the cost-benefit analysis of mitigation measures, establish likely resource and funding requirements of clubs.  
• Produce simple and clear funding/resourcing information for clubs.  
• Create prioritisation policy, which must be clear, transparent and fair, to enable funding, support and resources to be targeted.  
• Assist clubs with how to prioritise work on their course to mitigate water scarcity and water excess, based on their own individual circumstances.  
• Key stakeholders taking part in these actions will include:**  
• R&A and National governing bodies  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials | **Key stakeholders taking part in these actions will include:**  
• R&A and National governing bodies  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers  
• Club owners, managers & officials |
| **Player expectation** | • Carry out feedback survey of players to gauge what they value about playing surfaces, their awareness of climate change and water resource issues, how they would feel about changes in their surfaces forced by either water scarcity or excess and what they would tolerate in terms of mitigation solutions or changes in their playing surfaces.  
• Key stakeholders taking part in these actions will include:**  
• R&A and National governing bodies  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers | **Key stakeholders taking part in these actions will include:**  
• R&A and National governing bodies  
• Industry bodies, such as BigGA, GCSAI, BASIS etc.  
• Agronomists and turf managers |
7. PROPOSED ACTIONS TO TAKE ADVANTAGE OF THE OPPORTUNITIES

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Actions to address opportunities</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
</table>
| Increased playing surface resilience and improvement to playing quality       | • Collate and summarise how improvements in playing surface resilience benefits the game of golf and golfers.  
                             | • Communicate these findings to golf club management and golfers.                                 | Key stakeholders taking part in these actions will include:                               |
|                                                                              |                                                                                                    | • R&A and National governing bodies                                                       |
|                                                                              |                                                                                                    | • Industry bodies, such as BIGGA, GCSAI, BASIS etc.                                       |
|                                                                              |                                                                                                    | • Agronomists and turf managers                                                            |
|                                                                              |                                                                                                    | • Club owners, managers & officials                                                        |
|                                                                              |                                                                                                    | • Players                                                                                 |
| Sustainability on courses                                                    | • Collate and summarise how the potential reductions in water use benefit, not only golf clubs, but also the wider environment.  
                             | • Review and communicate the opportunities to integrate functional and ecological benefits into water resource mitigation solutions  
                             | • Potential to run demonstration trials to these benefits or establish optimal method to achieve this. | Key stakeholders taking part in these actions will include:                               |
|                                                                              |                                                                                                    | • R&A and National governing bodies                                                       |
|                                                                              |                                                                                                    | • Industry bodies, such as BIGGA, GCSAI, BASIS etc.                                       |
|                                                                              |                                                                                                    | • Agronomists and turf managers                                                            |
|                                                                              |                                                                                                    | • Club owners, managers & officials                                                        |
|                                                                              |                                                                                                    | • Players                                                                                 |
| Botanical composition                                                        | • Review solutions from naturally droughty regions where golf is played. Look for potential crossover into UK conditions based on projected climate conditions.  
                             | • Review optimal grass species under climate change scenarios and engage with grass breeders to look at what germplasm might be useful under projected conditions of either water scarcity or excess. | Key stakeholders taking part in these actions will include:                               |
|                                                                              |                                                                                                    | • R&A and National governing bodies                                                       |
|                                                                              |                                                                                                    | • Industry bodies, such as BIGGA, GCSAI, BASIS etc.                                       |
|                                                                              |                                                                                                    | • Agronomists and turf managers                                                            |


### Innovation
- Review and evaluate new and emerging technologies or management techniques, from the golf industry or other industries, that could be useful to mitigate either water scarcity or water excess.
- Investigate how solutions can be integrated to give added value to golf courses to enhance playing surfaces or their management.
- Investigate funding opportunities to develop new technologies or help early adopters utilise new solutions.
- Carry out research and demonstration trials to evaluate and show efficacy of these new solutions.

Key stakeholders taking part in these actions will include:
- R&A and National governing bodies
- Industry bodies, such as BIGGA, GCSAI, BASIS etc.
- Agronomists and turf managers
- Club owners, managers & officials
- Product manufacturers

### Knowledge gain and best practice review
- Review all knowledge gained during enactment of action plan to refine best practice guidance and communicate this to the golf industry.

Key stakeholders taking part in these actions will include:
- R&A and National governing bodies
- Industry bodies, such as BIGGA, GCSAI, BASIS etc.
- Agronomists and turf managers
- Club owners, managers & officials
- Product manufacturers

## 8. PROPOSED ACTIONS TO RAISE AWARENESS OF EXISTING KNOWLEDGE AND PLUGS GAPS IN KNOWLEDGE

<table>
<thead>
<tr>
<th>Gaps</th>
<th>Actions to address gaps</th>
<th>Stakeholder requirements</th>
</tr>
</thead>
</table>
| Climate change            | • Assess how fine a resolution is possible with the latest climate change model data.  
                            | • Is possible or necessary to translate climate change model data to be similar to the geographic scale of typical golf courses? | Key stakeholders involved with all of the knowledge gap areas will include: |
|                           |                                                                                                             | • R&A and National governing bodies                            |
| Drainage/irrigation/water capture and storage solutions and how they can be integrated | • Review available solutions, evaluate and compare with existing options in test installation as part of research programme.  
• Evaluation potential and added value benefits from combining or integration solutions.  
• Communicate output to key stakeholders and feed information into best practice guidance. |
| Future/novel technologies | • Engage with solution providers both in the golf industry and other industries to identify potentially relevant and beneficial technologies and examine how their use would benefit golf turf under conditions of water scarcity or excess.  
• Review available solutions, investigate new or near market solutions and compare benefits and projected costs.  
• Trial and demonstrate new technologies, possibly in a case study type approach, to provide confidence in their effect and an understanding of how to optimise their use. |
| Industry bodies, such as BIGGA, GCSAI, BASIS etc. | • Agronomists and turf managers  
• Club owners, managers & officials  
• Product manufacturers |
9. WHAT MAY BE REQUIRED OF STAKEHOLDERS

- Development of SMART objectives and a strategy to guide reviews, knowledge capture, production of best practice advice, support documentation to support providers and clubs, communication and training activities.

- Involvement of all key stakeholders to identify a structure capable to deliver the objectives derived in the strategic vision, devise a programme for delivery and measures to monitor progress with meeting objectives, thereby enabling success to be measured.

- For a broad and multifactorial problem such as water resource management, whether it is complete or temporary water scarcity or dealing with excess water, it is critical to have buy-in from industry and stakeholders. The maxim “we are stronger together when we act in unity” is certainly true in this case.

- It is important to get engagement and active involvement from a broad cross section of stakeholders and the golf industry, to address the issues highlighted at all levels in industry and within the different management spheres of influence in golf clubs.

- To effectively put in place mitigation plans and make headway with tackling this issue, a one size fits all solution will not work. The solutions will inevitably need to be tailored to meet the needs and challenges faced at individual clubs. As such, the advice and support provided to clubs, whether this is initial guidance, detailed feasibility and design work, ongoing monitoring and support, will need to be targeted and focused on club specific circumstances.

- Whilst discussing this issue with a broad cross-section of the industry, getting the right people talking and acting together both in international/national bodies, industry organisations and within clubs is critical.

- To be successful, in the whole endeavour, clubs will need support providing at every stage, such as outlining issues, advice on what technical or turf management options are available, resource and funding identification.

- Training and education to give confidence to those both giving support to clubs and staff at clubs is vital, so that they are competent to and feel empowered to make optimal best practice decisions. Together, we can give a powerful message, whereas alone, as individual organisations the message significantly loses power.

10. FUNDING OR OTHER SUPPORT REQUIRED TO IMPLEMENT RECOMMENDATIONS

- Education, communication and awareness of both staff from industry bodies visiting clubs (e.g. home union representatives, agronomists, industry representatives) and staff within clubs, including technical staff (greenkeepers/course managers) and club management (club managers, club officials) is vital, and funding to carry out these activities will need to be found.

- There undoubtedly is a need for funding activities in clubs relating to water management and this will need to be based on priority, whether that is based on prioritising activities or venues based on geographic location and conditions, or based on available resource in clubs to deal with issues that threaten the operation of that club. Timescale over which issues will impact clubs will also need to be factored into the prioritisation process.

- Funding sources will need to be investigated as part of the implementation of the action plan to see what might be leveraged from government, non-governmental or
private sources. A funding plan will need to be created and policies put in place to
govern appropriate and efficacious use of the available funding.

- Physical resource and funding to cover the costs and therefore enable conferences,
seminars, training events and communication activities to take place.

- There is a requirement to actively support clubs to develop plans, implement them
and monitor success. This is likely to be from a diverse range of organisations that
have regular contact with clubs such as The R&A, home unions, industry bodies,
agronomists.

- Essential to the success of this action plan will be the creation of a communication
and support network for clubs and relevant support organisations.

11. RECOMMENDED ACTIONS

Establish a working group representing the broad spectrum of stakeholders to establish an
integrated, and co-ordinate strategy for dealing with water scarcity and excess water impacts
on golf courses. The aim will be to ensure that all activities, carried out as part of the resultant
GC 2030 Water programme, will be co-ordinated, effective and relevant to golf courses.

The following reviews should be carried out to collate existing knowledge and current
understanding of water resource management issues (excess and scarcity) and, importantly,
to inform strategy for tackling these issues:

- **climate change impacts.** What will be the scale and extent of impacts and how will
they affect golf courses regionally across Great Britain & Ireland. Central to this will be
summarising the local effects to highlight priority areas for certain types of mitigation
works, for example areas where rainfall will significantly increase or where water
supplies will be under pressure due to low rainfall during summer months

- **technical solution and turf maintenance practice review.** This should look to
identify and establish how available technical solutions and current best practice
guidance should be used and integrated into golf course management. Integral to this
review will be the evaluation of innovative technologies and strategies for dealing with
course drainage, water capture and re-use and irrigation

- **review of legislation, policies (current and projected) and resource availability
concerning water supply and usage.** It is critical to understand the regulatory
framework in which golf clubs are operating and the variances in approaches used
across Great Britain & Ireland. Central to this will be engagement and consultation
with regulatory bodies governing both water supply and drainage outflow. This will be
to ensure that the recommendations to golf clubs will be specific to their regulatory
region and ensure that they meet future regulatory requirements.

Surveys of turf managers, golf club managers and players to establish awareness,
understanding of issues, current and future trends and impacts on their courses. This will help
target communication and training requirements.

Once the outcomes of the reviews are known, and it is possible to produce best practice
guidance advice and any other relevant tools to help organisations providing support to
clubs, it will be critical to set up training programmes for staff of those organisations. Hand-
in-hand with this, must go a communication campaign to highlight issues, risks and solutions
to clubs across Great Britain & Ireland.
It will essential to establish a standardised and integrated support network that clubs can
access general, business/operational and technical advice. This will need to include the
relevant organisations best placed to deliver this support, not only from a technical
perspective, but who would also be able to resource such a service effectively.

It will also be necessary within this period, to identify research needs to fill gaps in knowledge,
or to construct technology demonstration areas to provide clubs with case study and
practical evidence to build confidence in proposed solutions.

12. SUCCESSFUL OUTCOMES FOR THIS ACTION PLAN

In the view of the author, if three out of the following four actions came to fruition, then that
would be a clear marker of success for the action plan and the resultant work programme.

- Publication of a strategy of how the golf industry is adapting to climate change. It
  must be acknowledged that this is a dynamic process and climate change models
  and water usage predictions evolve over time, therefore the strategic roadmap to deal
  with water management on golf courses must also change and evolve over time.

- Creation of best practice guidelines that are freely available and utilised by the
  majority of golf course where there are water resource issues. A strong measure of
  success would be if guidance coming from this programme was to have a measurable
  and visible practical impact on turf and/or golf club business practices.

- The establishment and ongoing demand for an education and training programme of
  support organisation staff and golf courses in all matters relating to water resource
  management.

- The staging of a climate change in golf conference, which could be held during BTME,
  that brought together key stakeholders. The objectives would be to assess the current
  impacts and risks of climate change, what that meant for golf clubs, how mitigation
  measures were working and what are the challenges we are facing as climate models
  and weather patterns evolve.

13. CONCLUDING COMMENTS

The intention of this action plan has been to highlight the key challenges, opportunities and
gaps in understanding regarding water resource management. Whilst carrying out the
preparation and production of this action plan, the scale and scope of the problems being
faced are enormous and highly complex. Without water or continually with too much water,
playing surfaces on golf courses will be severely challenged, to the point that golf courses will
be jeopardy if action is not taken.

The key aim of any programme to tackle water resource management on golf courses must
be to establish cost-effective, practical solutions to make golf surfaces more resilient to
extremes of weather, whether they are short-term or long-term climate changes. The
following key messages have come out of the production of this action plan:

- the need to establish what will happen to water sources and rainfall, as a result of
cclimate change and the pressure that will come to bear as competition for water
increases
• the need to engage with regulators, water suppliers, as well as the broad cross-section of organisations operating within the golf industry
• the need to review current understanding of the implications of climate change, the impacts on golf courses and the current and future solutions that could be used to mitigate these effects
• the critical need to produce best practice guidance that can be effectively communicated within the golf industry to trigger change, and form the basis for action to ensure change is effective
• support to clubs and training of those delivering support, as well as turf and business managers with clubs is essential for success
• finally, for any initiative to be successful it needs to be co-ordinated and be created from the start to deliver integrated solutions.

14. ACKNOWLEDGMENTS

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Rowan Rumball – STRI (Sustainability perspective)
Dr Tom Young – STRI (Technology and solution delivery perspective)
Steve Gingell – STRI (Agronomy perspective)

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   https://www.metoffice.gov.uk/research/collaboration/ukcp