Water Special Interest Group
Climate Change Action Plan

Introduction. Overall problem statement	The Water Special Interest Group (WaterSIG) note IChemE's position on climate change. The action plan presented here follows on from this statement and forms part of IChemE's delivery against several of the commitments set out, namely to develop detailed positions and action plans for economically sustainable and secure transitions to net zero carbon emissions, in all areas of chemical engineering practice and regions where members are active. It will also help underpin work on several other commitments, including: ■ provide policy advice to governments, based on chemical engineering experience, and expertise; ■ engage in public outreach activities with businesses and communities, to understand their concerns about the threats and uncertainties posed by climate change; ■ develop training courses and mandate CPD to provide the knowledge and skills to support members in the transition to a net zero carbon economy; ■ and in climate change adaptation encourage all regional members groups and special interest groups to hold webinars and seminars as part of the CPD programme; ■ to enhance skills and knowledge in pursuit of zero carbon futures and understanding of climate risks; ■ and to engage with the wider membership.
Specific problem statement	The World Health Organisation has identified water related illnesses as a significant cause of death within the 250,000 additional deaths predicted to occur each year between 2030 and 2050 due to the climate crisis[1]. Water related impacts of climate change with potential to cause loss of life and significant impact on health, economic security and migration include: ■ drought – resulting in permanent loss of fertile farmland, loss of livelihood, displacement, mass migration and loss of life through dehydration and water-borne disease; ■ source water quality deterioration – resulting in loss of available sources, for example by effects such as saline intrusion exacerbated by increasing rates of abstraction; ■ flooding and increased adverse weather events – resulting in drowning, destruction of property and other assets via events such as mud slides, loss of habitat, and water-borne disease such as cholera;

	■ conflict, both in terms of water wars fought between regions sharing rivers and aquifers, and as a result of overwhelming migration stemming from the above. The effects of the climate crisis will disproportionately affect people living in developing nations and their ability to access safe water supplies and sanitation. The climate crisis is contributing to the severity of droughts, floods and associated social and biodiversity crises on a daily basis. Decisions made by chemical engineers in the Water Sector: ■ influence the extent to which our urban and natural water cycles are impacted by climate crisis; ■ help limit the extent of the impact on the climate crisis by identifying opportunities to mitigate emissions and providing resilient adaptations to the global warming which we have already caused. Tangible, measurable climate mitigation and adaptation is lacking in the water sector. chemical engineers, while holding necessary skills to help develop and deliver the technical solutions that can address the crisis, are not yet adequately empowered with the knowledge required to use those skills to support effective action. IChemE's Water SIG provides a network for industry and academic professionals in the water sector. They employ systems thinking in the management of the urban water cycle including the design, construction, operation and decommissioning of water and wastewater treatment facilities. Water SIG members' actions within their professional roles and responsibilities significantly impact climate change and have the ability to direct progress towards both mitigation and adaptation. Examples of this include members working on progression to a circular economy, through resource recovery from the urban water cycle, through selection of new treatment infrastructure, operational efficiency and optimisation, and consideration of options for green infrastructure and nature-based solutions such as treatment wetlands.
What actions need to be taken to address the issue?	The water sector can and must take action to improve the sustainability of this essential resource. Many areas of action rely on the competence of technical professions such as chemical engineers. Specific actions include strategic approaches as well as specific technical applications: **Actions for a sustainable water industry:** ■ developing road maps to water industry transition from net carbonemitters to net carbon reducers, where these do not yet exist; ■ delivering source reduction in use of water, natural and human made resources, for example through using less water, efficiency in energy, and chemicals and reuse of nutrients in biosolids to offset human made fertiliser application; ■ production of circular economy products to realise value from water and wastewater (eg fertilisers, biopolymers, biochar); ■ implementation of nature based and carbon sequestration solutions to increase carbon sinks – for example though treatment wetland solutions and digestion of sludges allowing application of biosolids to land; ■ supporting the application of systems approaches, such as life cycle assessment, to support transition to a circular economy through empowering engineers with the technical tools require for and appreciation of the importance of lower-carbon and climate-safe design and decision making; ■ addressing issues of energy and resource efficiency in water and wastewater treatment and reuse;

- addressing the issues of sustainable desalination. Desalination is the most energy-intensive form of water production, yet likely to become an increasingly necessary mitigation of the effects of climate change;
- addressing the issues of sustainable wastewater reuse, including the chemical engineering challenges associated with direct potable reuse and the associated public perception and acceptability challenges;
- minimising energy consumption in water and wastewater treatment, including taking a holistic view when revising effluent discharge consents;
- protecting and valuing existing natural capital and creating nature-based solutions (eg constructed wetlands) where appropriate, as well as protecting natural carbon sinks (eg oceanic plankton);
- implementing low emissions technologies in water and wastewater treatment such as those which utilise methane and do not generate nitrous oxide;
- proactively working to reduce methane and nitrous oxide emissions from existing wastewater treatment assets;
- developing and promoting decentralised water and wastewater treatment technologies that reduce the need to pump water and wastewater significant distances when used in appropriate contexts. Examples of this would be rainwater treatment, local ground water treatment and aquifer-recharge, composting toilets, greywater reuse;
- engaging and interfacing with the changes in the wider economy's production, transmission and use of energy, particularly the emergence of hydrogen.

Action on water efficiency:

- developing water foot-print calculation tools, building on existing models and making these more widely available, including evaluation of the 'cost' of water for new projects to enable comparison between options at feasibility stage;
- promoting more widely water efficiency in networks and homes, including digitisation, reducing non-revenue water and leakage;
- exploring and assessing options around circular water, including decentralisation, greywater, agricultural and industrial reuse.

Action on decarbonising energy:

- collaborating on sustainable energy sources including hydro-electric and solar power options;
- enhancing effectiveness of biogas generation from wastewater sludges;
- developing hydrogen generation from water sources, utilisation of photo-voltaic cells in and electrolysis of water;
- accelerating innovation and commercial deployment of energy storage technology, to enable use of renewable energy sources.

Action on decarbonising heating:

- assisting with water-heating options and extracting heat from wastewater to support projects developing local district heat networks.

Action for sustainable food:

- determining sustainable means of reducing and meeting irrigation demands;
- reducing the use of carbon intensive fertilisers and consequently the impact of these on global water resources, for example by utilisation of biosolids and nutrients from wastewater.

Action on decarbonising construction:

- recognising that, particularly in developing countries, there is a need for construction of new water industry assets (including treatment and distribution);

	■ supporting development of low carbon emission construction methods for new assets; ■ promoting the adoption of more sustainable methods to produce concrete, steel and other construction materials. **Action on carbon draw down:** ■ delivering nature-based solutions for water and wastewater treatment; ■ supporting negative carbon emissions technologies and research initiatives; ■ developing sustainable carbon sequestering technologies and processes. **Action on economics:** ■ developing mechanisms for economic assessment of options; ■ exploring variety of end-to-end financial mechanisms; ■ developing tools or strategies for management of uncertainty and variability (including spatial and seasonal). **Action on influencing:** ■ lobbying and influencing policy makers such, as government, on matters such as the science behind storm overflows and water demand management through white goods standards.
What skills, training gap or facilitation requirements need to be addressed?	**1. The Future Water Sector Workforce** The water sector needs process engineers with the specific skills sets that are unique to those trained in the Chemical Engineering discipline, including a firm grounding in mathematics and engineering principles, and this need will only increase as the effects of climate change intensify. The water industry lacks many chemical engineering core competencies, such as analytical and problem-solving skills, and would benefit from engineers in other industries bringing those transferrable skills with them. The water sector should be inclusive and welcome process engineers from other sectors. There is an opportunity to provide resources to support the rapid reskilling of experienced process engineers who would like to join and assist the water industry. This could be complemented by a peer-to-peer mentoring programme to support workers as they make this transition. **2. For Workers Outside the Water Sector** Water is fundamental to daily life at home and in industry. Chemical engineers in all sectors require a fundamental understanding of process water cycles, and the ability to optimally reuse and recycle water as a valuable commodity. Water footprint calculations should be promoted as best practice alongside carbon footprint calculations across all industries, to enable meaningful comparison of choices and options. Minimising demand for water, including process water, is critical in the drive to a net zero future. Optimisation of unit processes and techniques should be shared across all sectors. **3. For Members Already in the Water Sector** There are many areas in which we can improve the skills of the people who are already working in the water sector. Examples of some of these are, emerging and innovative technologies (better able to combat or reverse the effects of climate change), for example nature-based solutions, chemical free treatment and more efficient digital solutions for the design and operation of processes. Microbiological systems and how to maximise use of green build options. Renewable energy options (involving collaboration with Clean Energy Special Interest Group): ■ best practice ecological approaches to provide holistic solutions – in collaboration with other IChemE groups – understanding and employing life cycle assessment and circular economy approaches which deliver

	maximum climate change mitigation opportunities and can progress towards social justice, nature positive solutions and achieve tangible progress on the UN SDGs; ■ climate literacy including economics and financing for climate action, to support chemical engineers identifying novel ways of meeting the cost of necessary investment and to develop innovative business models to decarbonise our sector; ■ softer skills, such as diplomacy, to smooth the transition through this challenging time.
What actions should the SIG and its members take to support delivery of the above actions?	We will take the below actions and will encourage SIG members to come forward to support this from within and outside the existing SIG committee. We recognise progress may be challenging in some areas, but believe bold action is required to address the Climate Crisis. We will seek to collaborate widely, including with other SIG and members groups and other organisations representing the international Water sector eg IW, RSC etc: **1. Communication and Education** IChemE's Water SIG will publicise the climate crisis, deepening knowledge and understanding of the challenges, the strategies and the solutions that are necessary to address it. We currently do this through public access webinars, open access articles on our web pages, submissions to other publications, via social media and through IChemE's media centre. Within the water industry, our members are actively quantifying and mitigating carbon emissions, developing lower carbon treatment processes, implementing circular economy, taking action to reduce water and energy usage and promoting water re-use. We will engage with external stakeholders to work towards an inclusive water industry that delivers systems decarbonisation, while recognising work already being done at sector level (eg Water UK 2030 route map). We will support the growth of professional knowledge among our members to enable them to make the right decisions at the necessary pace to achieve global climate action goals. In collaboration with other IChemE stakeholder groups (eg SIGs and MGs) we will be part of improving IChemE member knowledge sufficiently to enable decision making at the pace necessary to meet global climate action goals, recognising the need for systems thinking beyond water. It is critical that this thinking is done across sectors and across disciplines. **2. Water Climate Call to Action** As IChemE's Water SIG we recognise that most climate actions that are needed will require whole-sector participation. We will drive cross-sector collaboration prioritising water climate issues in a hierarchy, developing a Water Climate Call to Action and employing a variety of means to encourage our members and others to take action. We will empower members of the Water SIG with knowledge so they can advocate for lower carbon solutions, to achieve mitigation, and for adaptation, to build resilience, in all decision making in their day-to-day professional roles; aligned with their professional obligations. Our early work in this area has identified the actions listed above, that need to be taken by the water sector, we will prioritise these with the wider water community and continue to deliver online events and other collaborative initiatives to raise awareness, promote innovation and help influence their delivery. **3. Helping the Chemical Engineering Profession adopt science-based targets.** We can contribute to informing science-based targets, aligned with national carbon budgets and the Paris Agreement by:

	■ sharing information on water-climate impacts and good practice to inform focus for members and their companies to reduce their greenhouse gas emissions; ■ supporting members and their organisations in their journey towards science-based targets and accreditations, providing advice on water and wastewater reuse, demand reduction and waste to energy options; ■ actively promoting our strategies to address the water Climate Crisis in our outreach programmes to raise awareness of what net zero and science-based targets mean from a Water Industry perspective and why these are imperative; ■ the Water SIG will contribute to the wider development of IChemE work on the topic of climate change adaptation and mitigation; ■ we will also proactively engage in the development of bold and ambitious position statements that seek to embed leading good practice such as science-based targets. **4. Training** We will support IChemE in the development and production of a training resources to provide certification to experienced chemical engineers moving into low carbon sectors/areas. **5. Events** We will continue to develop online, globally available, cross-sector and multi-organisational knowledge and expertise sharing events, such as the water climate discussions, a series of COP26 preparatory events that we have led thisyear.
What actions will you encourage others to take?	We will encourage our Water SIG members to embed climate action at the heart of their professional activities, recognising the existential threat it provides for security of safe water and livelihoods for humanity. We will encourage and support IChemE activities to raise awareness, provide key member awareness and skills training and promote required climate action as aligned with their purpose to advance chemical engineering's contribution for the benefit of society and the key principles set out in the IChemE position on climate change. We will encourage and support IChemE in updating their governance process to ensure climate action is embedded in the activities of all chemical engineers. In particular, we will encourage IChemE to include a requirement for members to demonstrate knowledge of the Climate Crisis and to be able to show evidence of their active engagement in climate mitigation and adaptation as an IChemE member. We encourage IChemE to include this requirement explicitly for membership applications at all levels and to clarify member obligations to society in this area. We will encourage and support IChemE in the development of a climate action route map for chemical engineers which highlights key areas of impact and opportunity for maximum climate ction impact for our IChemE members. This would raise awareness and support members in discharging their professional obligations across all sectors, recognising these are highly inter-connected and cannot be siloed. We will encourage and support IChemE to work closely with government, other institutions and influential industry bodies, to develop a transition plan to help the transition of skilled workers into low carbon, green economy sectors. We will expect IChemE to visibly and strongly support all government measures that will drive down energy and water wastage in the general population, including behaviour change and regulatory changes.

Next steps	By the end of 2021 we will work with IChemE and similar organisations across the water sector to complete the water climate discussion series; delivering a *Water Climate Call to Action* and enabling water professionals of every discipline around the world to come together around an array of climate innovations and initiatives. The action that we can deliver is dependent on the volunteer time and expertise available, from within the Water SIG and wider IChemE community, but our ambition is to achieve the following: ■ in the next 12 months, we will contribute to work that will support delivery of the commitments made in IChemE's 2020 position on climate change, recognising the greatest contributions to climate change being made based on global and national inventory reporting and where greatest emissions reduction can be effected by chemical engineers within and across sectors through measures and policy action, recognising professional obligations, SIG and MG specific inputs as well as key cross-sector, cross disciplinary opportunities with other professional institutions; ■ in the next 12 months we will also work with IChemE to highlight the links between Sustainability and climate action, and to support and develop, as a SIG, key understanding of wider issues including the biodiversity crisis and net positive nature solutions, inclusion and diversity and social justice and the link between Circular Economy concepts and climate action. We will support member engagement and understanding in these key areas in which progress is fundamental to meeting Grand Challenges,UN SDGs and thus achieving the aims of Strategy 2024. By 2024 in line with the IChemE Strategy 2024, we will achieve the following in alignment with the strategy aims and climate action: ■ aim 1: support Water SIG members technical awareness competence, and action with respect to water sector impacts on the climate crisis and climate crisis impacts on the water sector; ■ aim 2: have developed and rolled out transition training with IChemE support to develop new skills for emerging and future needs for the low carbon water sector; ■ aim 3: support this aim for recognition of IChemE as a vibrant learned society, materially impacting on the Grand Challenges and UN SDGs in particular with regard to climate change mitigation and adaptation, supporting IChemE in empowering its members to effect material action and sharing achievements as a result of the IChemE climate action Route Map for chemical engineers; ■ aim 4 support AIM 3: provide recognised peer group leadership *in Climate Action* through contribution to an IChemE climate action Framework for chemical engineers across all SIGs and MGs – supporting relevant sector and country policy and improved societal understanding of how chemical engineers deliver climate action; ■ aim 5 support AIM 4: lever digital solutions to create an environment forengagement with IChemE membership delivering meaningful, science-based climate action. Beyond 2024, we will support IChemE in continuation of their Climate Action Route Map for chemical engineers, contributing SIG specific inputs and supporting this as a science-based global best practice approach for leading Professional Institution. Note: Any opinions are those of the authors and do not necessarily represent those of IChemE.