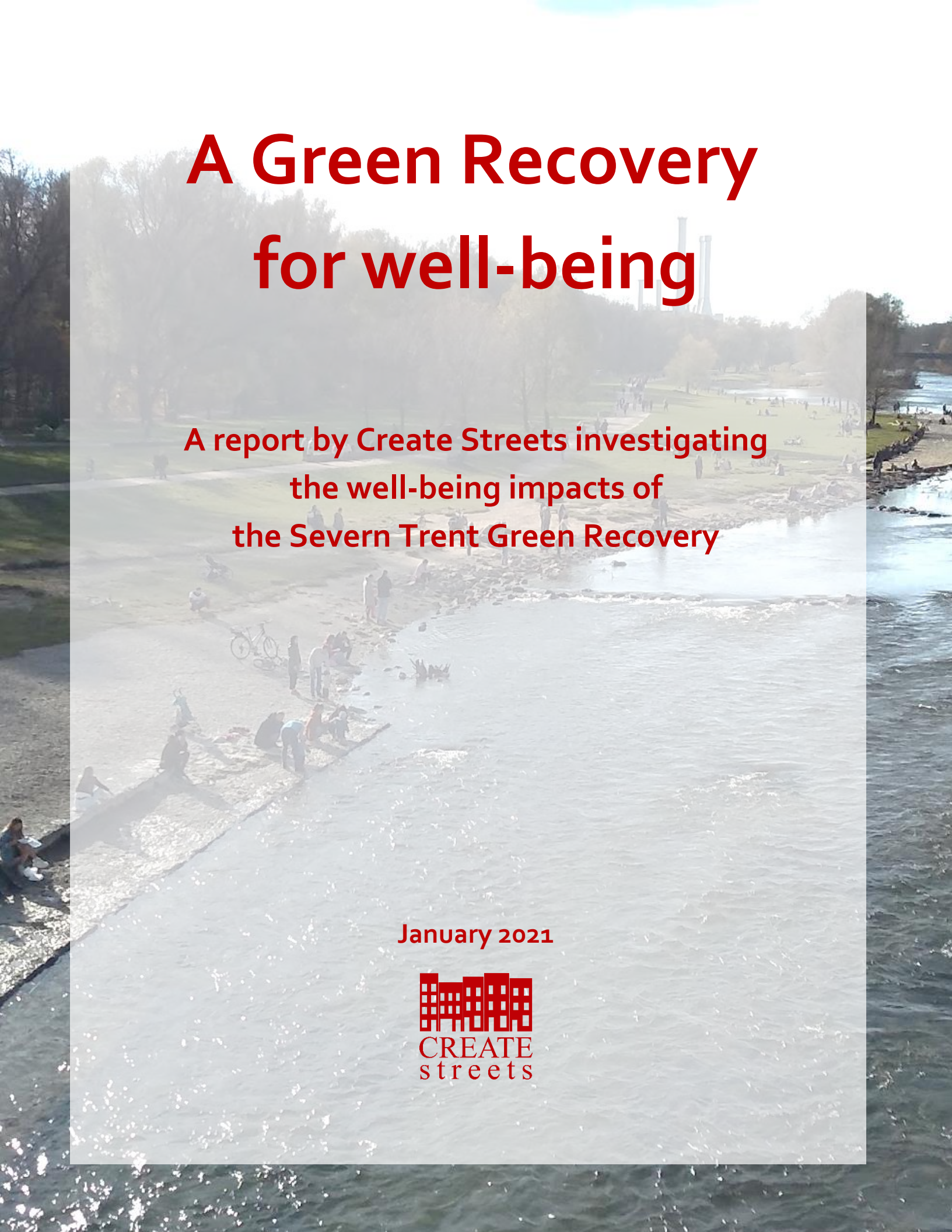

A Green Recovery for well-being

A report by Create Streets investigating the well-being impacts of the Severn Trent Green Recovery

January 2021

CREATE streets

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1.0 Unlocking the potential of UK rivers

Executive summary

Create Streets have been commissioned by Severn Trent to undertake an independent analysis of their Green Recovery strategy. This was to consider how their Green Recovery proposals would positively impact well-being and to suggest how to maximise these benefits.

River bathing brings multiple benefits for well-being via likely improvements to both mental and physical health. The benefits outlined in this report include:

1. *Improvements to mental health and a reduction in symptoms of depression;*
2. *Reductions in stress and restoration of well-being;*
3. *Improvements in happiness;*
4. *Improvements in physical health; and*
5. *Improvements to social relations and community.*

In parallel, the improvements to make the River Teme and the River Avon increasingly suitable and safe for bathing, exercise, and leisure will likely encourage more users. This will particularly be the case in the context of COVID-19 and for those living in deprived communities, close to the improved areas of the River Avon and Teme, with their inland location. By improving the quality of waters we hope to spread the physical and mental health well-being benefits widely.

Introduction

Evidence of the positive impacts of blue spaces and cold water swimming on well-being have been both clear and consistent for over 20 years (Hunt, 2019). From reduced stress to better social relations and economic well-being, the range of impacts are broad. A study looking at multiple urban river improvement schemes across Europe also shows that 'when planning the enhancement of urban rivers, the social and economic requirements of the adjacent urban areas are of major importance' (Tourbier et al 2004). Therefore, when looking at improving the quality of rivers for swimming, it is considered important to investigate how to maximise the health-enhancing (or salutogenic) benefits of blue spaces and cold water swimming to maximise those benefits. This document will;

1. *firstly, set the scene for the importance of outdoor recreation in a context of COVID-19;*
2. *look at the impacts of improved river water quality on visitor numbers;*
3. *consider the multiple positive well-being impacts of the increased number of visitors;*
4. *consider the positive impacts, specifically for more deprived communities; and*
5. *look at the design principles that would help to encourage usage, to maximise these benefits.*

The importance of outdoor recreation in a time of COVID-19

In the context of COVID-19, the benefits of access to blue spaces and clean waters for river bathing locally are particularly important. This is for two reasons;

1. recreation has been limited to local areas; and
2. recreation has been limited to outdoor spaces.

This means that people have needed to meet their leisure and social needs more locally and with greater reliance on outdoor activities. River swimming and riverside recreation became so popular following lockdown that steps were even taken to manage the demand (Wilson, 2020). The RSPB found that during lockdown, 71 percent of people felt that nature became *more* important to them (2020), presumably because people were spending more time outdoors. Of course, the situation is likely to change during 2021 but people's behaviour and feelings towards nature may continue.

For places that are inland and furthest from the coast, maximising the benefits and ensuring the safety of blue spaces such as rivers is therefore particularly important in the context of COVID-19. This is certainly true for the residents living along the River Avon between Coventry and Stratford where the nearest coastline is between 80 to 120 miles away. Similarly, along the River Teme, around Ludlow, the nearest coast is about 70 miles away. By improving the rivers' bathing quality and unlocking their potential, it will improve the equality of access to blue spaces, across the country, along with their associated well-being impacts. The proposed schemes would enable and encourage people living inland to safely undertake multiple outdoor activities, locally, including; bathing, swimming; kayaking; canoeing and paddle boarding. This is important to keeping both physically and mentally well during lockdown and afterwards.

Water quality improvement and recreational river usage

So how does water quality affect people's decision-making when it comes to swimming? Whilst it is obvious that people would not swim where water is visibly dirty, it is less obvious whether river swimming and use of rivers increases when reasonably clean water conditions are enhanced. At present, there is no direct research on this. However, research and data is available on what factors influence decisions on which coastal areas to visit. In 2013, research by Geldenhuys surveyed 600 beach visitors across six different beaches of varying quality on which factors most influenced their selection of a beach to visit. Factors associated with 'cleanliness' such as 'high-water quality' were chosen as the most important factor when it came to choosing a beach rather than factors such as 'safety and access' or 'landscape' (Geldenhuys, 2013). Cleanliness counts.

Factors associated with 'cleanliness' such as 'high-water quality' were chosen as the most important factor when it came to choosing a beach rather than factors such as 'safety and access' or 'landscape' (Geldenhuys, 2013).

The positive impacts of blue spaces and river swimming for well-being

Water quality improvements for the Rivers Teme and Avon are therefore clearly important. Safer rivers for swimming will encourage more visitors, share their benefits more widely and improve the well-being of the local population. This section will go on to examine the benefits for well-being of blue spaces and outdoor bathing in rivers that will be maximised by the improvement in water quality.

Maximising the positive impacts on mental health and depression. Research has found that blue spaces have two main mental health benefits. Firstly, just spending time near blue spaces has a positive effect on mental health. Research has shown that blue spaces, such as lakes, rivers and canals all have a positive impact on mental health (White et al, 2020). One survey by de Bell et al in 2017 showed that around 40 percent of respondents felt they had gained some form of psychological benefit from spending time around or using blue spaces (Environment Agency, 2020). Secondly, research has shown that swimming in cold water, such as wild river swimming, can alleviate depression. A study published in the *British Medical Journa*l in 2018 demonstrated that cold water swimming can be an effective treatment for depression (van Tulleken et al). The study suggested that, by inducing a fight-or-flight response, cold water swimming increased the stress threshold of the brain, making day-to-day stresses seem, comparably, less stressful. In the long-term this was suggested to reduce both chronic stress and depression, for increased well-being and mental health (van Tulleken, 2018).

A study published in the British Medical Journal in 2018 demonstrated that cold water swimming can be an effective treatment for depression (van Tulleken et al).

Maximising the positive impacts on stress reduction and well-being restoration. Research has also linked just the exposure to blue space with both stress-reduction and the more general feeling of calmness. With improved water quality it will enable more people to safely access the benefits of stress reduction and restoration in this way, encouraging more people to use the rivers. As early as 1981 the effects of blue spaces on stress-reduction were demonstrated by Professor Roger Ulrich. By measuring neural oscillations whilst exposing subjects to both blue and green spaces, Professor Ulrich investigated how subjection to different environments affected stress. He demonstrated the positive effects of blue spaces on neural oscillations, concluding that subjects were less stressed when subject to blue spaces - even more so than when subjected to green spaces. A more recent study in 2020 by Vert et al demonstrated the effects of walking amongst blue spaces on office workers during their lunchtime. This study also showed an increase in subjective well-being and feelings of vitality by those exposed to blue spaces during their walk (White et al, 2020). This was compared to those who went on a purely urban walk or no walk at all (White et al, 2020). Other studies by Natural England, one in 2012 and one in 2013, also demonstrate the restorative effects of blue spaces on well-being, with between 30 and 40 percent of those who used blue spaces experiencing some sort of restorative effects (Environment Agency, 2020).

Image 1: Happy wild swimmer.

Maximising the positive impacts on happiness. In addition to negating the impacts of depression and stress upon well-being, evidence shows that there are clear links between blue spaces and positive effects upon happiness. A pilot study at the Queensland University of Technology, has found that 'Natural spaces with parks, gardens and areas with trees, or water, significantly contributed to people's happiness' (Pringle and Guaralda, 2018). Historic research suggests that this may be due to something which Edward Osborne Wilson coined as 'biophilia' (Wilson, 1984). Biophilia is usually understood to mean humans' innate and genetic affinity with natural environments. The concept has been used to understand why humans feel the 'urge to affiliate with other forms of life' since we are evolutionarily 'hard-wired to find particular scenes of nature calming and restorative'. (Wilson, 1984). This may explain why human happiness has been linked with natural environments (Iovene et al, 2019). Research undertaken in 2013 by MacKerron and Mourato also supports this. Through the use of GPS tracking data they measured the subjective well-being of participants in different locations, deriving that 'people's level of self-reported happiness increased substantially when they were in coastal or marine environments and also, to a lesser extent, when they were in a freshwater, wetland or floodplain location' (Environment Agency, 2020). In particular, the difference in happiness between when participants were in blue spaces and urban environments was substantial, as great as 'the difference between attending an exhibition and doing housework' (Hunt, 2012).

Image 2: Smiling wild swimmers in Norfolk.

Positive impact on physical health. Outdoor swimming and access to blue space has also been correlated with a positive impact on physical health (Environment Agency, 2020). The space that rivers (once safe for use) can provide for outdoor activities such as swimming and other water sports can encourage exercise and in turn improve physical health (Environment Agency, 2020). Studies have also shown that exercising in a natural environment is more restorative than exercise in an urban environment (Hartig et al, 2003). Data analysis by de Bell et al (2017) showed that 17 percent of people in a sample of 1,040 in the UK exercised using rivers, canals, and lakes as well as their immediate surroundings, including river paths, canal paths and lakeside walks. Research undertaken using surveys has also found that people are more likely to exercise for longer periods of time in blue spaces, compared to purely green spaces or in urban settings (Elliott et al, 2015). These blue spaces are also not treated with chlorine, chlorine dioxide, mineral salts or organic biocides in the same way that traditional swimming pools are, to ensure that they are pathogen free (Kircher, 2020). In rivers, the water is purified through physical and biological processes (Kircher, 2020). The improvement of rivers for bathing can, therefore, provide an important amenity for people to access physical activities.

17 percent of people in a sample of 1,040 in the UK exercised using rivers, canals, and lakes as well as their immediate surroundings, including river paths, canal paths and lakeside walks (de Bell et al, 2017).

Positive impact on social relations. Studies are increasingly showing the benefits of blue spaces, in particular, over green spaces for promoting positive social relations (White et al, 2020). A report in 2020 by White et al lists four qualitative studies in Germany, Iran, Ireland and the UK where evidence was found to suggest that blue spaces 'are ideal locations for people to spend high quality time with friends and family' (White et al, 2020). A study by de Bell et al in 2017 also found that a primary motivation to visit inland blue spaces was to socialise. The Rivers Teme and Avon already provide provision for these positive social relations. However, with improved conditions for bathing, these benefits for social well-being can be maximised.

Image 3: Wild swimmers.

The benefits of blue spaces and the 'levelling up' agenda

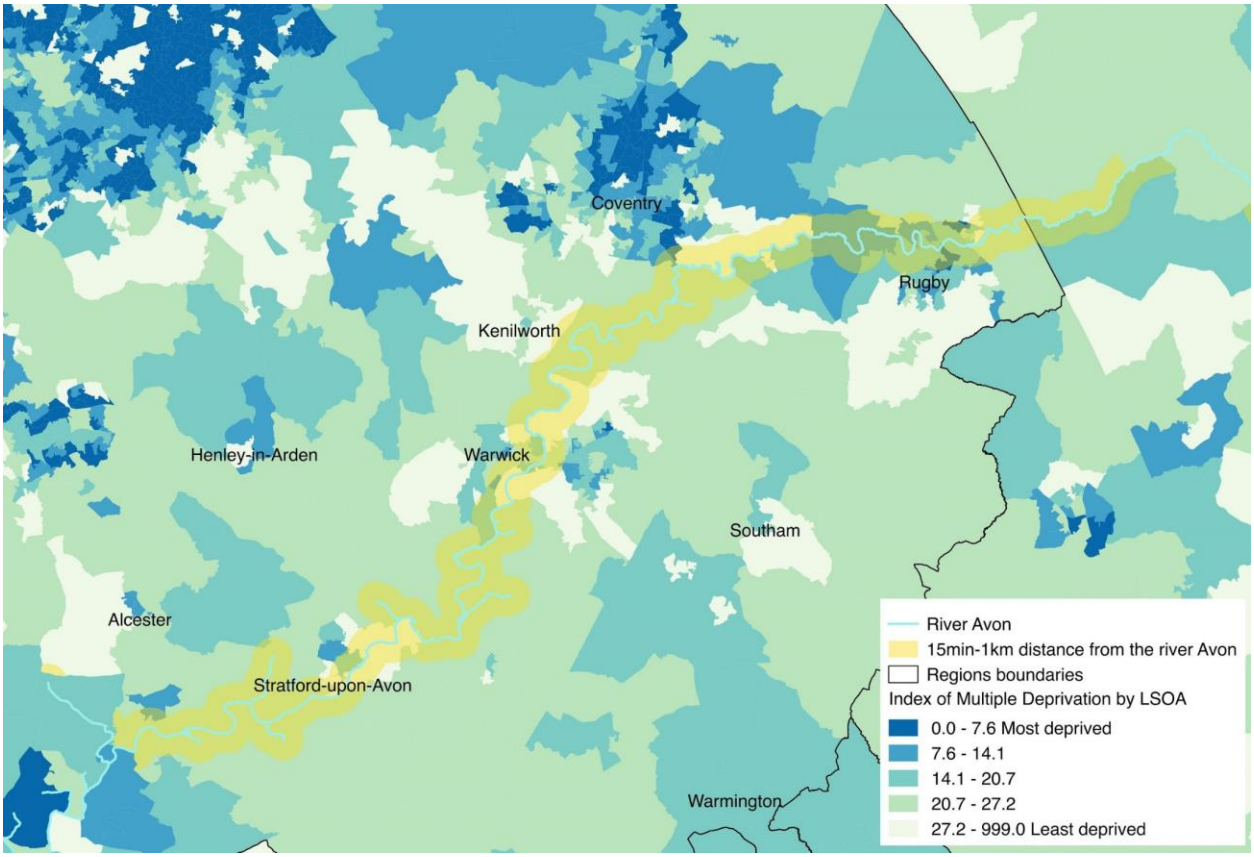
As part of the 'levelling up' agenda in the UK, the well-being benefits of blue spaces and outdoor swimming should be maximised for those in more deprived areas - especially considering their low cost. Compared to the free cost of swimming in local rivers, the average cost for an organised swimming session nearby is £7, with costs ranging from £6 to £10 per session. Ten examples of local swimming prices, per person, per swim, are listed below.

Compared to the free cost of swimming in local rivers, the average cost for an organised swimming session nearby is £7

- Compton Verney - £10 (£8 when booking a block of 5)
- Lenches - £9.50 (1 hour time slot)
- Dostill Quarry - £8 (1 hour slot)
- Cliff Lakes - £7 (including parking and 1 free hot drink)
- Chasewater - £7
- Colwick Lake Nottingham - £6 per session + membership
- Stanton Lakes - £6 (1 hour time slot)
- Midlands open water centre - £6
- Market Bosworth - £5
- Lavender patch - £5

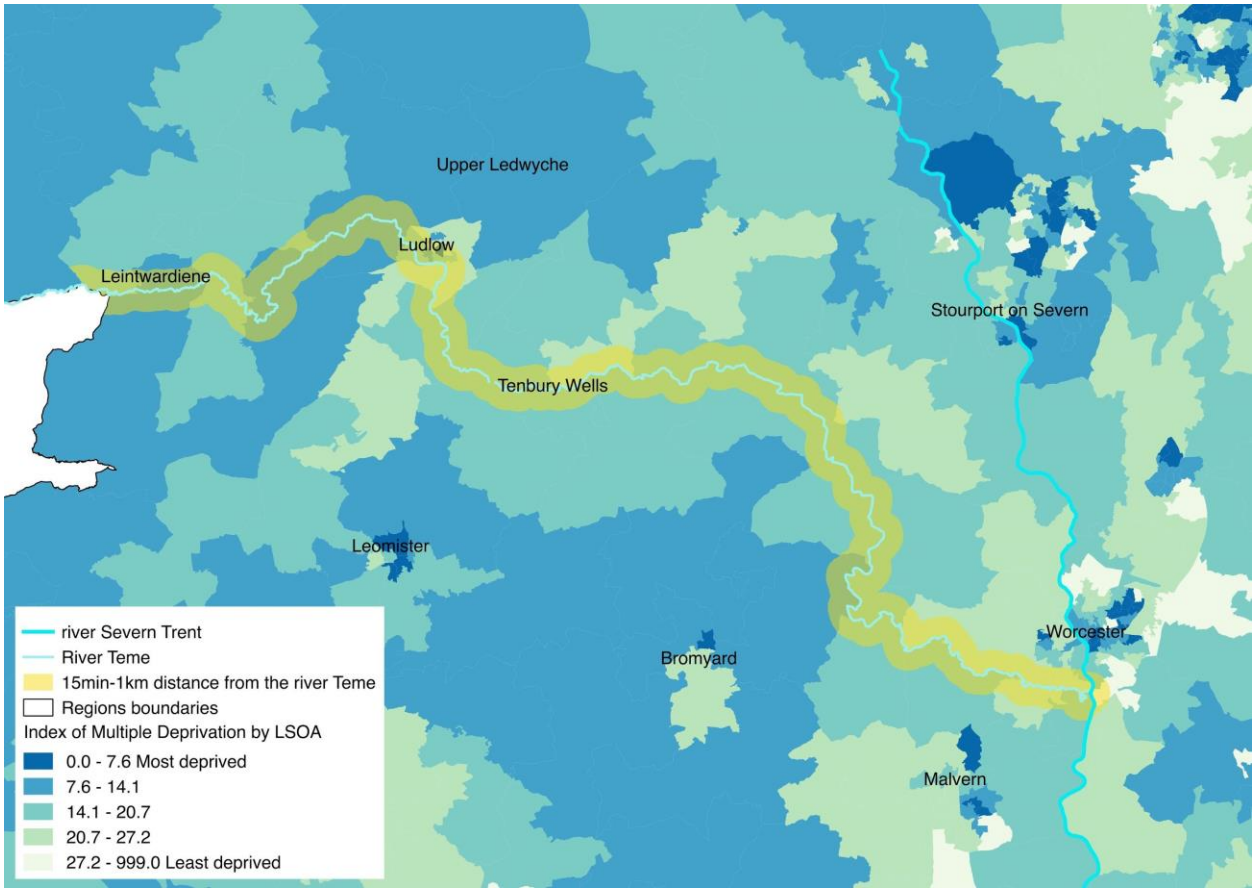
Some of these sessions would also require additional costs such as memberships and have time limits of one hour. However, many do also offer modestly discounted passes for multiple sessions. For example, Dostill Quarry had a ten-session pass for £60. However, these are all a lot more than no cost at all - the cost of swimming in the Avon or the Teme. River swimming is most accessible.

To see how improvements in water quality in the River Teme and River Avon will affect those in the most deprived areas, by providing them with access to clean rivers in which to swim, we have mapped deprivation in the surrounding areas and overlaid this with a 15-minute walking radius. This travel mode and distance have been chosen since those living in more deprived areas often do not own a car, and thus more frequently rely on walking and public transport (Lucas et al, 2019).



Map 1 - River Avon and Index of Multiple Deprivation

Map 1 shows the areas within a 15 minute-walking distance from the River Avon (light yellow buffer area) and the distribution of Index of Multiple Deprivation within these catchment areas. The Index of Multiple Deprivation is measured as a rank from 1 to 1000, where 1 is the lowest (least deprived areas) and 1,000 is the highest (most deprived areas). Along the River Avon, and within a 15-minute walking distance, we can see that there are many areas which are in the top 20 percent of the most deprived areas in the country. The main areas include neighbourhoods in Warwick, Stratford-upon-Avon, areas to the South East of Coventry and areas in Rugby. Some are in the top 10 percent of most deprived neighbourhoods.



Map 2 - River Teme and Index of Multiple Deprivation

Map 2 also shows the areas within a 15 minute-walking distance, except this time from the River Teme between the areas where water quality improvements will be made (light yellow buffer area). Again, this is overlaid with the distribution of Index of Multiple Deprivation within these catchment areas. Along the River Teme we can see that areas West of and in Leintwardine are in the top 20 percent of most deprived areas in England and are also within a 15-minute walking distance of the river. Areas in the top 10 percent most deprived and 20 percent most deprived are also just outside of the 15-walking radius in Malvern and Worcester (Worcester also being in the catchment area of the Avon).

These maps, together, show how the improvements to both the River Avon and the River Teme will help to maximise the well-being benefits of river bathing and blue spaces to communities in the top 20 and 10 percent of the most deprived areas in England. These improvements could thereby play an important role in the 'levelling-up' agenda in the UK.

Design principles to maximise the benefits of river bathing

It is known that blue spaces and rivers for swimming have many positive effects on well-being. So how can the benefits of cleaner and safer rivers be maximised for local people? This section sets out two principles that have been shown to maximise the potential of bathable rivers, and therefore maximise the well-being benefits of river bathing. The evidence on these principles is outlined below.

Some wilderness, but not too much. It is well known that both green and blue spaces offer positive impacts on human well-being. But what kind of green and blue environments do people prefer? Research shows that where greenery is too thick or dense it can cause feelings of fear and lack of safety concerns (Kuo and Sullivan, 2001). Research has also shown that people prefer being in green places that are 'coherent' and 'spatially defined' (Iovene et al, 2019). However, research in Munich shows that people do seem to prefer wilderness over artificial developments.

During the 1980s, Munich residents struggled to find the city's River Isar attractive, due to early twentieth century taming efforts and artificial canal-like development since the 1950s. They initially opposed the restoration of the dams, due to their attachment to the wilderness of the river (IOER & TU Dresden 2004). However, thanks to the 2000-2011 Isar Plan, parts of the river within the urban boundaries have been re-naturalized. Today, they are again very popular with visitors (Benítez et al, 2017). In this case, at least, people seem to prefer a wilder river. Additionally, according to a series of empirical surveys conducted in 1998 to inform the rehabilitation programme, nearly seven percent of people surveyed said that their favourite activity was swimming in the river. River swimming, as well as other activities such as sunbathing, walking, picnicking and resting, was often linked to landscape elements with a specifically wild character, such as gravel banks and gravel islands (Nohl, 1998).

Sloping banks and places to sit are important. Currently there is no academic research on the sorts of wild swimming environments that people prefer. However, a desk study done in 2020 as part of this independent review examined 32 different locations across the UK that are popular for wild freshwater swimming. Clear common trends emerged. 30 out of 32 had sloping banks or rocks for easy access. The only two which did not, provided a pontoon to enter the river. 23 of the 32 locations also had wide banks or areas by the river on which people could sit and linger. The remaining nine sites were particularly secluded and private, almost exclusive in feel. Other common features were bridges (six instances) and waterfalls (seven instances).

Common feature	Wide banks for sitting	Slopes for easy access	Bridge	Waterfall
Number of rivers in the study with these features	23	30	6	7

The number of each 'common feature' found at 32 different popular for wild swimming locations [1]

1.Research conducted by Create Streets, November 2020

Image 4: A river with easy access and wide banks, Coltishall, Norfolk.

Image 5: Sloping banks on the River Isar, Munich.

Conclusion

This research has shown the multiple benefits of river bathing upon both mental and physical well-being. The benefits outlined in this report include; a reduction in stress and anxiety, reduced symptoms of depression (of cold-water swimming itself); increased physical well-being; and increased happiness. In parallel, the research suggests that the improvements to make the River Teme and the River Avon increasingly suitable and safe for bathing, exercise, and leisure will likely encourage more users. This may be enhanced by the events of 2020 and the heightened awareness of nature and of outdoor recreation.

This research not only emphasises the importance of river quality improvement for existing users, it also emphasises the value in spreading these well-being benefits to new users who may, at present, experience limited outdoor recreation and, being inland, have little access to blue spaces. By improving the quality of the river Avon and Teme in the stretches outlined, it is expected that the well-being of the local population, including those who live in the most deprived 10 and 20 percent of areas in the UK, will be improved. To maximise these benefits this report also identifies two key design principles for maximising the use of rivers for river bathing. These include; ensuring that the river has sloping banks or another form of easy access; and ensuring that there are wide banks that are wild, but not too wild.

In conclusion, this report suggests that by improving the river quality in these stretches of the Teme and Avon and by increasing the numbers of their users (especially among those living in more deprived areas) that there will be multiple benefits for both the physical and mental well-being of nearby populations.

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Image 5: Maddalena Iovene, Create Streets

2.0 Decarbonising water resources

Executive summary

Create Streets have been commissioned by Severn Trent to undertake an independent analysis of their Green Recovery strategy. This was to consider how their Green Recovery proposals would positively impact well-being and to suggest how to maximise these benefits.

Increasing water storage capacity, whilst introducing natural reed bed treatment systems will not only reduce Severn Trent's carbon emissions throughout the treatment process and increase flood and drought resilience, but will also provide multiple well-being impacts, by:

1. *Providing a new blue space for water sports and recreation at a repurposed quarry;*
2. *Introducing reed-beds for the natural filtering of water at Church Wilne and Witches Oak Water sites;*
3. *Potentially creating a new centre for education and wild swimming; and*
4. *Potentially covering new water treatment buildings with creeping green walls.*

Introduction

Increasing water supplies whilst reducing carbon emissions may primarily be for climate mitigation and resilience. However, these steps can also have an important secondary benefit on the well-being of local people. This can be done by considering how the currently proposed schemes for new water treatment plants, natural process treatment plants and flood reserves can be designed to achieve this as part of a wider holistic strategy for a Green Recovery. This document sets out how this will be done at a repurposed quarry and at Church Wilne water treatment works, considering the multiple factors that positively impact well-being.

Providing new blue spaces for recreation and leisure

The purchase of a former quarry could provide a new blue space for recreation and leisure, whilst also enhancing the existing visitor area.

[redacted]

The positive impacts of blue spaces on mental well-being. Research has shown that blue spaces, such as lakes, rivers and canals, all have a positive impact on mental health (White et al, 2020). One survey by de Bell et al in 2017 showed that around 40 percent of respondents felt they had gained some form of psychological benefit from spending time around or using blue spaces (Environment Agency, 2020). A summary by White (2020) lists multiple studies (by MacKerronand and Mourato in 2013, White et al in 2013, Korpela et al in 2010 and Vaeztavakoli et al in 2018) all of which conclude that positive emotional states seem to be particularly enhanced in blue space settings, compared to green. Wetlands can also be designed as multifunctional spaces, as they have been in Weiliu Wetland Park, Xianyang, China (Holmes, 2019). In Bellwood quarry in Georgia (USA), an old-disused quarry was repurposed into a reservoir in the face of water shortages in nearby Atlanta (McCandless, and Whiston Spirn, 2013). One study (by the Massachusetts Institute of Technology, MIT) found that 'visitors are astounded by the natural beauty of the quarry and the potential benefits and historic value it will provide for the city' (McCandless, and Whiston Spirn, 2013). [redacted]

Positive emotional states seem to be particularly enhanced in blue space settings, compared to green (White et al, 2020).

The positive impact of blue spaces on physical well-being. Blue spaces can also provide spaces for recreational activities and exercise that can have their own positive impacts on physical well-being (Environment Agency, 2020). Studies have shown that exercising in a natural environment is more restorative than exercising outdoors in an urban environment (Hartig et al,2003). Research by Barton and Pretty (2010) suggests that exercise in waterside habitats has the most positive impact on well-being, by improving self-esteem and mood, even more so than in green spaces. Data analysis by de Bell et al (2017) showed that 17 percent of people in a sample of 1,040 in the UK exercised through the use of blue spaces (Environment Agency, 2020). The re-use of an old quarry could therefore provide an important amenity for people to access physical activities.

The 'rehabilitation of quarries can yield so many positive social, economic, and environmental benefits that it only makes sense that they should be reintroduced into society after their resources are depleted' (McCandless, and Whiston Spirn, 2013).

A research report by McCandless, and Whiston Spirn (2013) at MIT looked at five case studies on the re-use of quarries and their environment together with well-being impacts. Overall, the report concluded that the 'rehabilitation of quarries can yield so many positive social, economic, and environmental benefits that it only makes sense that they should be reintroduced into society after their resources are depleted' (McCandless, and Whiston Spirn, 2013). The report also concluded that although costly, 'the costs will be outweighed by benefits, and adaptive re-use should be undertaken as measures to make our cities more ecologically healthy and aesthetically pleasing' (McCandless, and Whiston Spirn, 2013). One example given was a disused quarry in Connecticut, United States, now Brownstone Exploration and Discovery Park, where a disused quarry was converted into an adventure park with cliff-jumping, rock climbing, camping, educational programmes, swimming, kayaking, scuba diving, climbing and rappelling, wakeboarding, rope-swings, 750-foot zip-lining, a 100-foot water slide and inflatable water

toys (McCandless, and Whiston Spirn, 2013). The park now has 500,000 visitors annually, has created local jobs and improved the area's safety. The authors of the report stated that the park 'stimulates outdoor activities that bring people out of their homes and into nature thus supporting healthy and enjoyable activities for all ages' (McCandless, and Whiston Spirn, 2013).

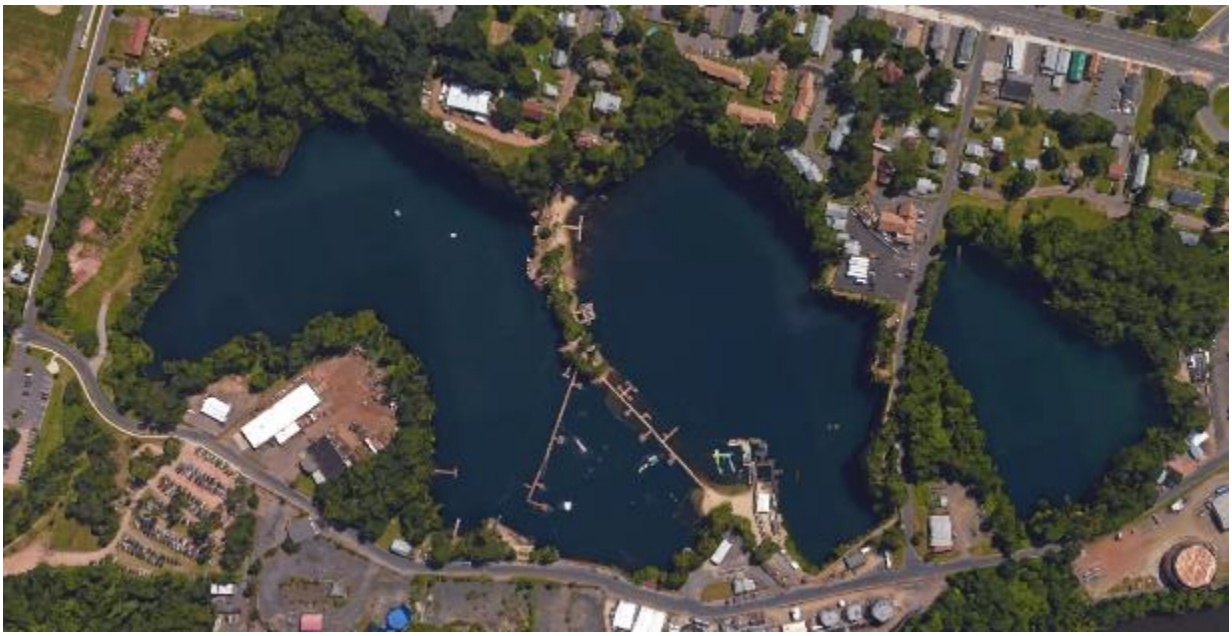

Image 3: Brownstone Exploration and Discovery Park.

Image 4: Brownstone Exploration and Discovery Park.

Introducing reed-beds and wetlands for the natural filtering of water

Another Severn Trent strategy for improving carbon neutrality, whilst also providing water resilience, is to use natural process treatments for water using reed beds. This will not only reduce both the chemicals needed and the energy consumed in the treatment process, thus reducing carbon emissions, but also act to off-set carbon emissions made elsewhere in the process by absorbing carbon from the atmosphere. Reed-beds will also provide new habitats and ecosystems, supporting increased biodiversity, as part of a broader Green Recovery. Reed beds can also, less-obviously, support human well-being. They can do this in two ways;

1. By providing green spaces for leisure and recreation activities such as walking, cycling, running, photography and bird watching (whose positive benefits have already been explored); and
2. By providing increased biodiversity for health and well-being.

[map redacted]

Image 5: Map showing the proposed sites for reed bed water filtration.

The two sites which are being proposed for reed bed treatment are [redacted] between Derby and Loughborough. These sites are outlined in image 5. The benefits of biodiversity, in addition to the benefits of green spaces, on well-being are outlined below.

The benefits of biodiverse green spaces on well-being. Reed beds are very biodiverse green spaces, with habitats for many different plant species, fungi, invertebrates, insects, fish, bugs, butterflies, and beetles. Research published in the *International Journal of Ecol*ogy looking at water treatment reed beds concluded that specially designed reed beds for water treatment 'may be at least as biodiverse as naturally occurring reed beds and will add to the overall biodiversity' (Feest et al, 2011).

Biodiversity, in addition to being a major part of the Green Recovery, also provides numerous benefits for human well-being. Research has shown that a decrease in biodiversity causes a loss of microbiota, found on skin, which protects against inflammatory-based illnesses such as asthma, cardiovascular disease (CVD), some cancers, potentially some neurodegenerative diseases, type 2 diabetes, inflammatory-associated depression, and some presentations of obesity (Haahtela et al, 2013). A report by Sandifera et al (2015) concluded that 'stronger biodiversity conservation would have overall positive effects on human well-being'. Not only does biodiversity have well-being impacts for health but also for anxiety, stress, and depression' (Winch et al, 2020). Green spaces with a higher diversity and richness of species has been linked with increased effects for positive well-being (Winch et al, 2020). Overall, more biodiverse spaces result in more benefits for well-being (Sandifera et al, 2015).

Biodiversity, in addition to being a major part of the Green Recovery, also provides numerous benefits for human well-being. Research has shown that a decrease in biodiversity causes a loss of microbiota, found on skin, which protects against inflammatory-based illnesses such as asthma, cardiovascular disease (CVD), some cancers, potentially some neurodegenerative diseases, type 2 diabetes, inflammatory-associated depression, and some presentations of obesity (Haahtela et al, 2013).

Maximising the benefits of reed bed water treatment for well-being. These benefits of green spaces and biodiversity could also be maximised through the extension of paths at [redacted] as well as the creation of an education and visitor centre at [redacted], just 4 miles from the closest train station at [redacted]. This could encourage visitors to enjoy the green spaces for relaxing, bird watching, wild swimming, wildlife spotting, walking, cycling and running. Some might also take the opportunity to learn about the process of reed bed filtration, which is a sustainable technology. At the Centre of Alternative Technology (CAT) in Wales, courses are offered in reed bed creation and management, as well as many other water treatment courses (2020). A similar scheme at [redacted] might encourage people to reduce unnecessary consumption for increased and long-term resilience.

[map redacted]

Image 6: Map showing deprivation levels and a one-hour public transport or cycling radius, and a 15-minute walking radius around the areas surrounding [redacted].

Maximising the benefits for communities in more deprived areas. Benefits would be especially maximised for those local people who face high levels of deprivation. Image 6 shows these levels of deprivation, as measured by the Index of Multiple Deprivation (IMD), in areas within a one hour public transport or cycling radius and a 15-minute walking distance of both [redacted and redacted]. These distances have been chosen since people who face increased levels of deprivation often do not own a car and more frequently rely on walking, cycling or public transport (Lucas et al, 2019). The Index of Multiple Deprivation is measured as a rank from 1 to 1000, where 1 is the lowest (least deprived areas) and 1,000 is the highest (most deprived areas). This map shows that there are multiple areas with a 7.6 or lower IMD rating, or areas with high deprivation levels. These are concentrated in Nottingham, Derby, Burton-upon-Trent, Mansfield and Loughborough. Areas within a 15-minute walking radius [redacted], the site with the closest train station and of a proposed station on the HS2 line.

Create 'creeping' green walls on new water treatment buildings

There are two new proposed water treatment buildings as part of the proposals, one [redacted] , just visible off the M1 and one in [redacted] in a more secluded location. Another potential action which could be considered is to create 'creeping' green walls and facades at these sites for both positive well-being and environmental impacts. This would only be on office buildings and treatment buildings, and not on any water retaining structures.

Research has shown that green walls and facades can have a positive impact on well-being and psychological status (Hartig et al, 1991). A study by Elsadek, et al., in 2019, that looked specifically at the effects of green walls on psychological well-being in comparison to normal brick or built walls also found that green facades and green walls enhanced human physiological and psychological relaxation more than brick or other built walls (Winch et al, 2020). Green facades are also found to be beneficial in helping to reduce NO_2 air pollution (Winch et al,2020), something which should be considered with the new plant by [redacted] and the M1.

However, green walls can be expensive, especially for buildings which are not located in city or town centres and thus not visible to many people. As an alternative and low-cost approach, the new water treatment buildings could be covered in creeping plant species such as ivy, virginia creepers, wisteria and creeping hydrangeas. These creeping plants would benefit the well-being of passersby and the operational workers at present. And although currently not visible to a large number of people, they could be in the future. Creating places which will be more attractive in the long term is inherently more sustainable. These creeping plants would also add to the biodiversity of the area, as part of the wider aims of a holistic Green Recovery.

Image 7: Creeping Wisteria plant on a concrete building wall.

Image 8: Creeping plants on a brick wall.

Conclusion

This research has shown the multiple ways in which Severn Trent's strategy to reduce carbon emissions, whilst also improving resilience to water shortages, can not only achieve these goals, but also have a positive impact upon well-being. This is done in two main ways:

- Through the multi-purpose use of a water storage-quarry for recreational and leisure benefits; and
- The creation of multiple reed bed water treatment centres.

These schemes will provide positive benefits to both physical and mental well-being, as well as improved health outcomes. This is due to the increased biodiversity gained by both the reedbed treatment sites and storage quarry, the blue space addition to the recreation area and the benefits of leisure activities provided on mental and physical well-being at the repurposed quarry site. There are also additional ways in which Severn Trent could consider maximising these benefits, including:

- The opening of an education centre at [redacted] on reed bed water filtration site;
- The introduction of natural swimming ponds at [redacted], to encourage visitors to the site; and
- The coverage of all new water treatment buildings in 'creeping' plants.

This research also considers how reaching out to communities in more deprived areas can maximise these benefits. The mapped-out deprivation levels in the surrounding areas to both new reed bed treatment sites shows how this is achieved, and that both sites will be within a 15 minute walking distance or an hour's public transport or cycling distance of communities in the top 10 or 20 percent most deprived areas in England. In conclusion, this research highlights that the strategies to reduce carbon emissions and improve water resilience should also have measurable positive impacts upon well-being, including for those in more deprived communities.

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Image credits

Image 1: redacted

Image 2: redacted

Image 3: Google Earth and all data providers, 2020. Brownstone Exploration and Discovery Park, Portland. Scale unknown. Google Earth [online] Available through: https://earth.google.com/web/search/Brownstone+Exploration+%26+Discovery+Park,+Brownstone+Avenue,+Portland,+CT,+USA/@41.575015,-72.645055,13.3761832a,766.51641044d,35y,0h,45t,0r/data=CroBG08BEogBCiUweDg5ZTY0YmIzNjdjYj

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Image 5: redacted

Image 6: *Redacted*

Image 7: "Wisteria" by Mike DelGaudio is licensed under CC BY-SA 2.0

Image 8: "Ivy Wall in Autumn" by garryknight is licensed under CC BY 2.0

3.0 Creating flood resilient communities

Executive summary

Create Streets have been commissioned by Severn Trent to undertake an independent analysis of their Green Recovery strategy. This was to consider how their Green Recovery proposals would positively impact well-being and to suggest how to maximise these benefits.

In addition to the direct benefits for well-being that flood-prevention interventions will have for residents in Mansfield, the proposals to use nature-based blue-green infrastructure schemes will also have positive impacts upon people's well-being in more indirect ways. The benefits for well-being that these interventions will bring include:

- *mental well-being benefits that come from greening streets with bioswales, rain gardens, permeable paving;* and
- *physical well-being and health benefits that come from greening streets.*

In addition to these well-being benefits of the proposed flooding interventions, how these changes are achieved can also be critical in improving well-being, particularly by providing communities in more deprived areas with more 'agency' over their environments (Andrés,2017). Further by providing increased local employment and with funded opportunities to improve their local area. Through a localised community engagement strategy in Mansfield, Severn Trent will maximise these benefits. This report will consider the well-being benefits of the following;

- *Targeting interventions in more deprived areas;*
- *Creating opportunities for communities to shape their local area; and*
- *Creating employment and education opportunities for local people.*

Finally, it will go on to consider other interventions that could further be used to enhance well-being in the future. These interventions consider how the creation of green walls and roofs, green corridors along roads, multifunctional spaces such as floodplain parks, and inner-city wetlands and ponds would provide further benefits for wellbeing. Finally, the report considers how these benefits will be compounded over time and with every maximisation strategy.

Introduction

The planet is becoming an increasingly urbanized place. By 2050, it is predicted that 68 percent of the world's population will live in cities (UN Habitat, 2018). Society is also facing an unprecedented and human-induced global climate and ecological crisis, with consequently and increasingly extreme weather conditions. Solutions to reduce the impacts of these more extreme weather conditions for cities must be holistic, founded in systems thinking, for people and the planet. This nature-based approach to urban design is often called 'biomorphic urbanism' (Kindel, 2019). When cities are formed and designed around life, they are 'bio-centric', they create shared natural assets for all forms of life that enhance the human experience of cities, providing a multitude of well-being benefits. In the words of Peter Kindel, architect,

urbanist and Director of Urban Design and Planning at SOM: 'Biomorphic urbanism proposes ways to reconsider quality of life. As we reconnect people with the places they inhabit, we might rediscover a basic but often overlooked fact: that ecological health and human well-being are not mutually exclusive, but instead fundamentally connected'. So how does greenery improve well-being? This section of the report will now go on to consider how the range of biomorphic (nature-based) flood-prevention and mitigation schemes, proposed by Severn Trent, could have positive impacts on both the mental and physical well-being and health of people in Mansfield. These nature-based solutions include swales, raingardens, street trees/planters, permeable paving and inner-city ponds and wetlands.

Positive mental well-being benefits of nature-based flood mitigation strategies

Research has demonstrated that urban green spaces, such as those that many nature-based SuDs and street trees offer, have a positive impact on mental well-being (Iovene et al, 2019). Perhaps, due to something which biologist E.O. Wilson called 'biophilia' (Wilson, 1984). Biophilia is usually understood to mean humans' innate and genetic affinity with natural environments. The concept has been used to understand why humans feel the 'urge to affiliate with other forms of life' since we are evolutionarily 'hard-wired to find particular scenes of nature calming and restorative'. (Wilson, 1984). This may explain why human happiness has been linked with natural environments (Iovene et al, 2019). Therefore, introducing swales, rain gardens and street trees to streets should improve the well-being of residents (Winch et al, 2020).

A study by Troy et al in Baltimore (2012) actually found a 1.2 percent decrease in crime levels for every 1 percent increase in tree canopy (Winch et al, 2020)

In 1988, a study (specifically looking at the connections between street trees and well-being) also concluded that people prefer streets with trees on them (Smardon). This is a rational preference since street trees make for safer, healthier, and happier streets. One study found that the presence of trees on an otherwise similar stretch of urban street reduced speeds by 7 to 8 miles per hour. A study of five arterial roadways found that mid–block car crashes declined by 5 and 20 percent in areas where there were features such as trees along the road. Several other American studies corroborate this (Dumbaugh, 2006).

One specific research project focused on 33 London boroughs, undertaken from 2009 until 2010, examined the connections between street tree numbers and the number of people on prescriptions for antidepressants - an indicator of poor mental health (Taylor et al, 2015). It found that there was a decrease of 1.18 prescriptions per 1000 people with every extra street tree per kilometre of street (Taylor et al, 2015). In other words, in one kilometre of street, one extra street tree was associated with a 1.18 percent decrease in the number of people prescribed antidepressants. Findings of another survey in London (this time in Greenwich) by Guite et al in 2006, similarly found that street trees were a major factor reported to contribute to positive mental health and well-being for people living in the area. Research has also shown that green spaces and greenery on streets encourages people to slow down, linger and interact with each other (UKGBC, 2020). On residential streets this could enable stronger communities to form with an increase in social interactions for well-being.

At least eight studies have also shown that greenery near buildings can be associated with lower levels of expected crime, fear of crime or with lower levels of residents' violence (Iovene et al, 2019). A study by Kuo and Sullivan in 2001 found a 56 percent reduction in violent crime associated with increased greenery. Similarly, a specific study looking at street trees also linked reduced crime rates and increased feelings of safety with the presences of street trees. A study by Troy et al in Baltimore (2012) actually found a 1.2 percent decrease in crime levels for every 1 percent increase in tree canopy (Winch et al, 2020). Academics believe that this is due both to the calming effect of greenery and to its association with greater outdoor use of spaces (Kuo and Sullivan, 2001).

However, greenery can be significantly different in their design and levels of 'green-ness'. See images below for a comparison in quality of rain gardens, with comparatively only incremental cost increases.

Image 1: Swales Image

2: Rain gardens in Hammersmith and Fulham

A great example of where the benefits of greenery in rain gardens and swales have been maximised is on Alma Road in the borough of Enfield in London. This was a residential road in a deprived area, previously with no greenery and issues of surface water flooding (Susdrain, 2020). Five sections of pavement have been replaced with rain gardens, one of which also replaced speed cushions and acted as a traffic calming measure at the junction between Alma Road and Scotland Green Road (Susdrain, 2020). The purpose of the project was both to reduce the surface water flood risk, 'normalise' SuDS, improve the public realm in the area and to improve road safety (Susdrain, 2020).

Greenery on streets encourages people to slow down, linger and interact with each other (UKGBC, 2020).

Image 3: Aerial view of *Alma Road Rain Gardens, Enfield, London.*

Image 4: Rain Gardens Alma Road, Enfield, London.

Positive physical well-being benefits of nature-based flood mitigation strategies

In addition to the positive benefits that greener streets bring for mental well-being, greenery and street trees also seem to be associated with a higher state of physical well-being. Multiple studies have found this (Sarajevs, 2011). In two studies, one by Atif et al in 2002 and one by Lee and Moudon in 2008, both looking at the relationship between urban design, greenspace, and physical activity, it was noted that the presence of street trees was an important factor for creating a space for physical exercise (Sarajevs, 2011). More specifically, multiple studies have found a significantly positive relationship between walking and cycling levels in areas with street trees (Forsyth et al, 2008; Larsen et al, 2009; Lee, 2007; Heath et al, 2006). In one of these studies by Heath et al in 2006 it was found that the numbers of people cycling increased by 20 percent in areas with street trees. In addition to creating spaces where individuals are more likely to take up physical exercise, it has also been found that street trees help to increase the air quality of streets (Nowak, 2006).

Image 5: Humphrey Road, Greenhill, Sheffield, without Street Trees.

Image 6: Humphrey Road, Greenhill, Sheffield, with street trees.

In a study by Heath et al in 2006, numbers of people cycling in areas with street trees increased by 20 percent compared to areas without.

The image below shows what kind of interventions could be made and how they might look. The before and after images allow for comparison between what a current road (Nottingham Road) in Mansfield looks like and what it could potentially look like after Severn Trent's suggested interventions.

Image 7: Nottingham Road in Mansfield.

Image 8: Nottingham Road in Mansfield, showing how proposed raingardens, a more pedestrian friendly road, and street trees could look.

Maximising the well-being impacts of flood resilience interventions in cities

This section will go on to consider how the benefits of currently proposed interventions can be further maximised through their method of implementation. To do this, this section of the review will mainly focus on one case study in Hammersmith and Fulham by 'Groundwork', where flood resilience schemes were targeted in more deprived areas, implemented with a community-led approach and also produced local education and employment opportunities.

Deprived communities, often with less green space, have higher stress levels (Roe et al, 2013) and increased incidence of obesity (Lachowycz and Jones, 2011).

Targeting more deprived areas. 85 percent of people consider that the quality of public space and the built environment has a direct impact on their lives and on the way they feel (CABE, 2002). Research has also found that deprived communities, often with less green space, have higher stress levels (Roe et al, 2013) and increased incidence of obesity (Lachowycz and Jones, 2011). Research has also confirmed that people in more deprived or 'left behind' communities feel that they have less agency and control over decisions about their local area (Andrés, 2017). By taking a community-led approach to these interventions, this would give people back this agency and control over their local area, as part of the broader levelling up agenda to decrease inequalities in the UK and to maximise their benefits. Similar to the project on Alma road in Enfield, all of the SuDs interventions which we suggest can be targeted in more deprived areas where improvements in the public realm are also needed (Susdrain, 2020).

One project in Hammersmith and Fulham in London aimed to decrease flooding risks for those living in three social housing estates. (Groundwork, 2020). The landscape was transformed to provide green spaces with enhanced biodiversity, purpose and productivity, with; 24 sqm of food growing beds installed; 565 trees, shrubs & hedges planted; 432 sqm of green roofs installed enough to cover a basketball court; and 4,537 sqm (half a football pitch) of land improved.

This project was part of the EUR Climate-Proofing Social Housing Landscapes project. It was co-funded by the EU LIFE+ Programme and delivered by environmental regeneration charity Groundwork London in partnership with Hammersmith and Fulham Council (Groundwork, 2020).These interventions not only provided access to increased quality green spaces for well-being, they also provide green walls and facades, shown to have a positive impact on well-being and psychological status, especially in towns and cities (Hartig et al, 1991; Elsadek et al, 2019) and associated with lower crime rates (Iovene et al, 2019). The provision of allotments as part of this space is also important for boosting well-being and connecting the community members with others (Bramley, 2020). A study by Guitart et al in 2012 has concluded that it was the actual experience of gardening and physically engaging with the soil that brought the most benefits of all.

Image 9: Hammersmith and Fulham social housing, green roofs, allotment planters and rain gardens. Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London.

Creating opportunities for the community to shape their neighbourhood for the good. The journey matters as well as the destination. It is not only about how the flood interventions themselves improve the well-being of the people around them. The way in which interventions are designed and implemented can also have a positive (or negative) impact on resident well-being. A report from the London Assembly, looking at the lessons learned from five SuDs retrofit projects across London, said that:

'one of the strongest themes running through the five retrofit projects has been the importance of engaging local people from concept and design to installation and maintenance. This is not an 'optional extra' but a crucial part of any successful SuDS project. If done well, it can;

- *result in better-designed and multi-functional SuDS measures;*
- *raise awareness of climate change, potentially leading to behaviour change;*
- *encourage community ownership and maintenance of SuDS measures; and*
- *encourage additional SuDS measures to be installed in the neighbourhood.'*

On Alma road in Enfield, the SuDs were implemented with the community. Throughout the process local residents were kept informed by regular leaflets, posters, and ward forums (Susdrain, 2020). A mural was also commissioned by Thames 21 and completed by local residents, students from Alma Primary School and Oasis Academy (Susdrain, 2020). This was designed by a local artist, Jo Peel, and students from the local school. It focused on how the rain gardens work (Susdrain, 2020). In follow up, Thames 21 held sessions educating pupils on the water cycle, river pollution and SuDS (Susdrain, 2020).

People in more deprived or 'left behind' communities feel that they have less agency and control over decisions about their local area (Andrés, 2017)

In Hammersmith and Fulham, 'Groundwork' also worked with the residents throughout the project (Groundwork, 2020). They were able to inform the designs based on how they used the existing spaces, problems they experienced, and improvements that they wished to see. In total 427 residents were involved (Groundwork, 2020). After the project was finished, engagement continued through; food growing and gardening clubs; training for locals on sustainability; 55 community events; and photography competitions. This is important both for the upkeep of the intervention in the long-term and to help embed behaviour changes for long term well-being.

Image 10: Green roofs, Queen Caroline estate, Hammersmith and Fulham. Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London.

Image 11: Rain Gardens, Queen Caroline estate, Hammersmith and Fulham. Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London.

Creating opportunities for new local jobs. Green interventions can also be used to generate new employment opportunities. The Hammersmith and Fulham example, cited above, created both new jobs and apprenticeship programs for young local people (Groundwork, 2020). There were eight training workshops held for the local council, maintenance team and for the local young and unemployed (Groundwork, 2020). In a report, the following benefits for local employment were reported;

- 11 new jobs were created by the project;
- 8 people were trained as sustainability champions;
- 46 council contractors and managers were trained; and
- 22 young people were employed as 'green team trainees' and received a Level 1 horticulture qualification from City and Guilds (the leading skills development organisation in the UK) and were supported to find employment on completion of the programme.

Maximising well-being impacts of flood interventions - looking to the future

In addition to the already planned interventions by Severn Trent, this section goes on to consider further flood mitigation interventions which could be made, looking to the future.

Creating multifunctional recreational spaces for flooding. Research has found that green spaces such as parks have a positive impact on well-being, since they provide an attractive place to rest and exercise. They can also foster a sense of local distinctiveness, 'ownership' and 'civic pride' associated with positive

well-being. (Everard et al, 2012). One study found that those living within a mile of a green space were 38 percent more likely to engage in physical exercise than those living further away (Cohen et al, 2007), positively contributing to well-being.

Parks can also be built to act as floodplains, not just increasing neighbourhood well-being but also mitigating flooding impacts. The Ignite project, by Winch et al (2020) reported that 84 percent of rainwater runoff was retained by parks and open green spaces. In Copenhagen, this strategy has been widely adopted. Their masterplan has included 'parks and playgrounds that can be flooded during heavy rainfall but in dry weather serve as recreational spaces for the citizens' (Ramboll, 2002). This is part of their more holistic strategy that means flood mitigation and prevention interventions will also 'support the overall goal of increasing the liveability of the city of Copenhagen' (Ramboll, 2020).

Image 12: Multipurpose park. Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London.

However, scale and location really matter. Greenery that is too infrequent or too far from where people live may not be used very often (Boys Smith, 2016). An indicative survey of people living in New York found this. No respondents reported that they had been to Central Park in the previous week (Montgomery, 2013). Greenery that is close to home is normally better used and has a more measurably positive impact on well-being as it can be used and appreciated far more frequently (Jackson, 2003).

One example of a small-scale multi-purpose park which could easily be retrofitted into an existing city or public space is Clandeboye Primary School in Bangor. Completed in 2017 the 'rainwater garden', has several ponds and provides a biodiverse greenspace and a children's play space, proving positive impacts for their social, mental and physical well-being (Susdrain, 2018). Interventions that increase biodiversity, such as this, could also improve children's health. Research has shown that spending time in places with

increased biodiversity decreases chances of developing inflammatory-based illnesses such as asthma, cardiovascular disease (CVD), some cancers, potentially some neurodegenerative diseases, type 2 diabetes, inflammatory-associated depression, and some presentations of obesity (Haahtela et al., 2013). This scheme has also successfully reduced the risk of flooding (Susdrain, 2018).

Creating wetlands and ponds in cities. The introduction of green and blue spaces, such as those wetlands and ponds provide, into towns and cities, has been linked with positive well-being impacts for those who spend time near them (Iovene et al, 2019). A report by White (2020) summarised multiple studies, by MacKerronand and Mourato in 2013, White et al in 2013, Korpela et al in 2010 and Vaeztavakoli et al in 2018, which all concluded that positive emotional states are particularly enhanced in blue spaces, compared to purely green ones. As early as 1981 the effects of blue spaces on stress-reduction were demonstrated by Professor Roger Ulrich. By measuring neural oscillations whilst exposing subjects to both blue and green spaces, Professor Ulrich investigated how subjection to different environments affected stress. He demonstrated the positive effects of blue spaces on neural oscillations, concluding that subjects were less stressed when subject to blue spaces - even more so than when subjected to green spaces. A more recent study in 2020 by Vert et al demonstrated the effects of walking amongst blue spaces on office workers during their lunchtime. This study also showed an increase in subjective well-being and feelings of vitality by those exposed to blue spaces during their walk (White et al, 2020). This was compared to those who went on a purely urban walk or no walk at all (White et al, 2020). Other studies by Natural England, one in 2012 and one in 2013, also demonstrate the restorative effects of blue spaces on well-being, with between 30 and 40 percent of those who used blue spaces experiencing some sort of restorative effects (Environment Agency, 2020).

An example of where wetlands have been used has been in Cheltenham. In 2015, Cheltenham Borough Council, with the support of the Environment Agency, redesigned an open space within a 1960's housing development within the town centre. The area, which was traditionally prone to flooding, was reimagined through the creation of several shallow detention basins or ponds within the existing areas of open space (Susdrain, 2019).

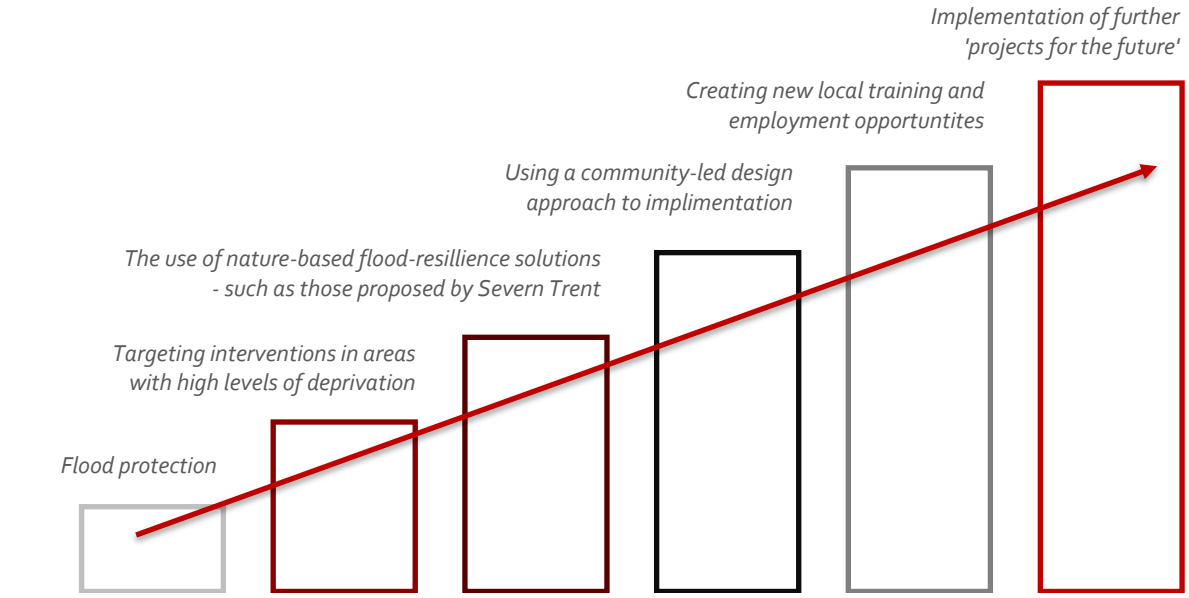
Greening walls and roofs. Green walls and roofs have multiple positive impacts for well-being. Not only preventing flooding, research has shown that they also provide a positive impact on well-being and psychological status, especially in towns and cities (Hartig et al, 1991; Elsadek et al, 2019) and are associated with lower crime rates (Iovene et al, 2019).

Creating green SuDs corridors as part of a pedestrianisation scheme. In Sheffield, 1.6km of road space was transformed into a green route for pedestrians, cyclists and public transport (Green Cities, 2019). This is an example of where the benefits of flood resilience measures have been maximised, since they have combined the traditional benefits associated with rain gardens, swales, street trees and greenery (discussed earlier) with the additional benefits of active travel, provided by the pedestrian spaces for walking, overall improvement in public realm, public transport routes and cycle ways (Green Cities, 2019).

Active travel has many benefits, both for mental and physical well-being. Research by Living Streets (2011) found that those who walk regularly, for long or short periods, are significantly more likely to feel that they have better mental health than those who walk less. Active travel has also been found to have many well-being impacts for physical health. A 2011 research report from the Department of Health found evidence that those who are active every day reduce their risk of type 2 diabetes, coronary heart disease, Alzheimer's disease, hip fracture, breast cancer, and colon cancer.

The compounding benefits of the Severn Trent flood resilience strategy

The graph below illustrates how the benefits would compound over time, through the use of nature-based solutions such as those being proposed by Severn Trent. The benefits would be achieved by targeting interventions in areas with high levels of deprivation using a community-led implementation approach, creating new local employment opportunities with scope to implement additional projects in the future. The accrued benefits are in no particular order and are not representative of quantitative improvements, only to show illustratively, how over time and with every aspect of this strategy the benefits will be compounded.



A graph to show how the well-being benefits of Severn Trent's nature-based flood mitigation strategies would accrue over time and further with strategies to maximise benefits.

How can these well-being benefits be quantified?

How can Severn Trent quantify these benefits in future?

1. *Customer research*. Severn Trent has 4.3 million customer connections and serves almost 8 million people. Encouraging customers to feedback following interventions within close proximity of their properties, will provide targeted and rich quantified data.
2. *Local resident surveys before and after in areas affected by interventions.* This can be via traditional methods (such as surveys through the letter box) or via a more digital approach. There are a number of online digital mapping platforms that now allow local residents to engage about their area more meaningfully and effectively than ever before (challenges of inclusivity remain for both approaches).
3. *Social Return On Investment (SROI).* This form of evaluation enables organisations to account for a much broader concept of value than is traditionally accounted for in other evaluation tools. One London study demonstrated that climate change adaptations could be measured beyond

alleviating flooding. It also quantified how the residents' pride, their sense of belonging and social ties improved as a result of the measures. Using the SROI approach the study found that every £1 invested in the programme generated £4.39 of benefits (Groundwork b, 2020)

4. *Use of the Benefit Estimation (B£ST) tool.* This approach can assess and monetise the financial, social and environmental benefits of blue-green infrastructure interventions. In 2019, Guildford Borough Council used this tool to value a proposed Sustainable Alternative Natural Greenspace to support a new housing development. Along with the benefits of improved air and water quality, the tool was able to value how proposals might improve the physical and psychological health of local residents through more attractive areas and a better quality local environment. (Susdrain, 2020)

Conclusion

There are many ways that the nature-based flood resilience schemes being proposed by Severn Trent can have a positive effect on people's well-being in addition to the direct prevention of floods themselves. How Severn Trent's flood resilience schemes can enhance well-being can be seen in the positive impacts from greening streets for both mental, social, and physical well-being. This research also considers not just what well-being benefits the proposed schemes provide, but also how the ways that the schemes are implemented can maximise these well-being benefits.

These have been outlined using the case study in Hammersmith and Fulham where; interventions were targeted in more deprived areas; a community-led approach was taken; and the implementation has also created local employment and education opportunities. In addition, and depending on funding partnerships, even more holistic flood resilience schemes *might* in future provide additional benefits via; pedestrianisation schemes, such as that in Sheffield; the use of green roofs and walls; the creation of multipurpose parks; and the creation of ponds and inner-city wetlands. Overall, Severn Trent's flood resilience schemes will not only enhance well-being directly by reducing their risk of flooding, but they can also enhance well-being indirectly and more subtly.

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Image 7: Google Maps street view and all data providers, 2019. Nottingham Road, Mansfield.

Image 8: Google Maps street view and all data providers, 2019. Nottingham Road, Mansfield. Edited by Create Streets using photoshop.

Image 9: *Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London*

Image 10: *Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London*

Image 11: Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London

Image 12: Photos courtesy of Groundwork London's Climate Proofing Social Housing Landscape Project, funded by EU LIFE+ programme, London Borough of Hammersmith and Fulham and the Mayor of London

4.0 Taking care of supply pipes

Executive summary

Create Streets have been commissioned by Severn Trent to undertake an independent analysis of their Green Recovery strategy. This was to consider how their Green Recovery proposals would positively impact well-being and to suggest how to maximise these benefits.

Replacing lead pipes, including those under private property, can lead to positive benefits for human well-being. It can have positive impacts, by;

1. *reducing the financial burden of replacing lead pipes for more deprived communities, so as to support better health and well-being for all, not just those who can afford it;*
2. *greening front gardens and streets for those affected by disruptions*; and
3. *creating opportunities for communities to shape their neighbourhoods for the good through a community-led design approach.*

Introduction

Lead in water, caused by water running through historic lead pipes, is associated with a range of health risks, especially for children. These risks include; increased blood pressure; memory loss; fatigue; joint pain; abdominal pain and an enhanced miscarriage risk. Therefore, they need to be replaced. However, despite the undoubted positive health impacts from upgrading pipes, the actual *process* of replacing lead pipes is often a negative experience for customers. It can cause disruption on private driveways on public roads and in public spaces (Hackett, 2019).

However, Severn Trent intend to change this tradeoff between long term gain versus short term problems by ensuring that the replacement of lead pipes has an overall and measurable positive impact upon well-being. This will be by; taking responsibility for the replacement of pipes under private properties; focusing action in more deprived areas in Coventry and Worcester; and, critically, using the unavoidable disruption as an opportunity for making clear and positive long-term improvements to front gardens and streets. This will also be undertaken through a community-led design approach, giving local people the agency to positively shape their own local neighbourhood. This section will examine how the various interventions that Severn Trent are proposing will provide positive impacts for residents' well-being.

Reducing the financial burden of replacing lead pipes for more deprived communities

The average cost to a Severn Trent customer to replace a lead pipe under their private property is estimated to be between £1000 and £1,500. This is a significant amount of money - particularly when you consider that the median UK income in the second lowest decile is £11,300 (for an individual) and £26,800 (for a family of two adults and two children) (HM Treasury, 2014).

People in this category, the lowest 20 percent of income households, are already two to three times more likely to develop mental health issues than those who are not (Marmot et al, 2010). This is particularly true for the young. Research focused on the linkages between the mental health of young people, aged between 10 and 15 years old, and socio-economic status found that those with a 'low socio-economic status' had 2.5 times higher prevalence rates of anxiety or a depressed mood than their peers (Centre for Social Justice, 2011). Another study looking more specifically at debt levels in England found that 50 percent of people with any debt at all, have some sort of mental health disorder (Jenkins et al, 2009). This is compared with 14 percent of people who do not have any debt (Jenkins et al, 2009).

50 percent of people with any debt at all, have some sort of mental health disorder (Jenkins et al, 2009).

Clearly it cannot and should not be expected that less prosperous customers should be updating their own lead pipes. Therefore, by offering to remove this financial burden from individuals, and instead, sharing the cost between all Severn Trent customers over an extended period of time, Severn Trent will help to negate any further financial pressures and negative mental health outcomes on the lowest income households. This is the right thing to do; both by helping to meet Severn Trent's ambitions to improve customer well-being; but also by chiming with the Government's 'levelling up' agenda, to reduce inequality.

Greening streets with biodiverse front gardens, swales, street trees, rain gardens

Research has shown that people living in urban areas have an increased risk of poor mental health (Dye, 1998; Peen et al, 2010). Thus, with an increased number of people living in urban areas more now than ever before we must ensure that these urban areas are designed to prevent negative well-being impacts. So how can this be done?

Creating permeable driveways or biodiverse gardens. One way to do this is through improvements to people's personal driveways and front gardens where they would already face disruptions from lead pipe replacement works. This could be done through offering to improve people's gardens with biodiverse greenery. This would increase the overall greenery and biodiversity of streets for well-being (whilst also helping to reduce the risks of flooding). Research has shown that both biodiversity and green spaces enhance well-being (Sandifera et al, 2015). This is for both mental and physical well-being. Lower levels of anxiety, stress and depression have been associated with more biodiverse spaces (Winch et al, 2020). Research has also shown that a decrease in biodiversity causes a loss of microbiota, found on skin which protects against inflammatory-based illnesses such as asthma, cardiovascular disease (CVD), some cancers, potentially some neurodegenerative diseases, type 2 diabetes, inflammatory-associated depression, and some presentations of obesity (Haahtela et al, 2013). By offering to put in permeable driveways or biodiverse front gardens for customers with small front gardens it would help to improve the overall 'green-ness' of the local street and therefore, resident's overall well-being (whilst also helping to reduce flood risk for the future).

Planting Street Trees. A 1988 study concluded that people prefer streets with trees on them (Smardon). This is a rational preference. Street trees make for safer streets, healthier and happier streets. For example, the rational response to obstacles on urban streets such as trees is to drive more slowly. This is precisely what people do. One study found that the presence of trees on an otherwise similar stretch of urban street reduced speeds by 7 to 8 miles per hour. This in turn makes streets safer. A study of five arterial roadways found that mid–block car crashes declined by 5 and 20 percent in areas where there were features such as trees along the road. Several other American studies corroborate this (Dumbaugh, 2006). But the benign impact of street trees on public well-being appears to be much more profound than this. Urban trees improve air quality. (Nowak, 2006) And they moderate heating and cooling energy use. (Akbari et al, 2002).

Per one kilometre of street, one extra street tree was associated with a 1.18 percent decrease in the number of people prescribed antidepressants (Taylor et al, 2015)

Trees also seem to be associated with higher mental and physical well-being. One specific research project focused on 33 London boroughs, from 2009 until 2010. It examined the connections between street tree numbers and the number of people on prescriptions for antidepressants, an indicator of poor mental health (Taylor et al, 2015). It found that there was a decrease of 1.18 prescriptions per 1000 people with every extra street tree per kilometre of street (Taylor et al, 2015). In other words, in one kilometre of street, one extra street tree was associated with a 1.18 percent decrease in the number of people prescribed antidepressants.

In two studies, one by Atif et al in 2002 and one by Lee and Moudon in 2008, both looking at the relationship between urban design, greenspace and physical activity, it was noted that the presence of street trees was an important factor for creating a space for physical exercise (Sarajevs, 2011). More specifically, multiple studies have found a significantly positive relationship between walking and cycling levels in areas with street trees (Forsyth et al, 2008; Larsen et al, 2009; Lee, 2007; Heath et al, 2006). In addition to creating spaces where individuals are more likely to take up physical exercise, it has also been found that street trees help to increase the air quality of streets (Nowak, 2006).

The images below show how a terraced street in Coventry could look with similar interventions, using a combination of raingardens and street trees. Here you can compare the before and after images to see how it could look and feel.

Image 1: A terraced street in Coventry.

Image 2: A terraced street in Coventry, showing how proposed raingardens and street trees might look.

Creating opportunities for communities to shape their neighbourhoods for the good with a community-led design approach

The journey matters as well as the destination. The way in which interventions are designed and implemented can also have a positive (or negative) impact on resident well-being. Approaches which empower communities, particularly those with less experience of 'agency', in more deprived areas, can be very beneficial. Research has confirmed that people in more deprived or 'left behind' communities feel that they have less agency and less control over decisions about their local area (Andrés, 2017). They are often right. They also believe that their relative decline has been ignored by the political process (Local trust, 2019). Giving agency and control over their local area back to people can reverse this. Opportunities for residents to redesign their front gardens, streets, and community spaces, present the opportunity to re-empower them, as part of the broader levelling up agenda to decrease inequalities in the UK. This section examines how these interventions might be delivered via a community-led design approach.

Research has confirmed that people in more deprived or 'left behind' communities feel that they have less agency and less control over decisions about their local area (Andrés, 2017).

Communities have long provided feedback on developments or improvements in their area through traditional consultation workshops often held during weekday evenings. This is not without merit. However, participation rates can be very low. Time and transport pressures prevent many from attending these physical events. We are fortunate that a range of new digital tools and platforms have come to market in recent years. These can help achieve wider and deeper community engagement both cost efficiently and effectively. These have been spurred not just by advances in technology, but also the growing acceptance of 'online' as a primary means to communicate. Clearly, the 2020 pandemic has dramatically accelerated these trends.

By way of illustration, Create Streets have loaded one of these platforms ('Create Communities') with Severn Trent projects to show how this might be done. Of course, other platforms are available which may be more appropriate further down the process. 'Create Communities' is an online interactive map. It enables users quickly and simply to make comments about a specific point within a predefined area (see examples below). Primarily used by local authorities, developers and urban designers to provide feedback on physical changes in neighbourhoods, this platform could also be used to allow the community to ask for certain improvements in their streets linked to the replacement of lead water pipes. For example, planting of street trees where the road has been dug up, installing rain gardens, or in the case of front gardens, repaving with permeable surfaces that would improve drainage. There is an opportunity to roll out multiple projects cost-efficiently to engage the community in suggesting street and front garden improvements.

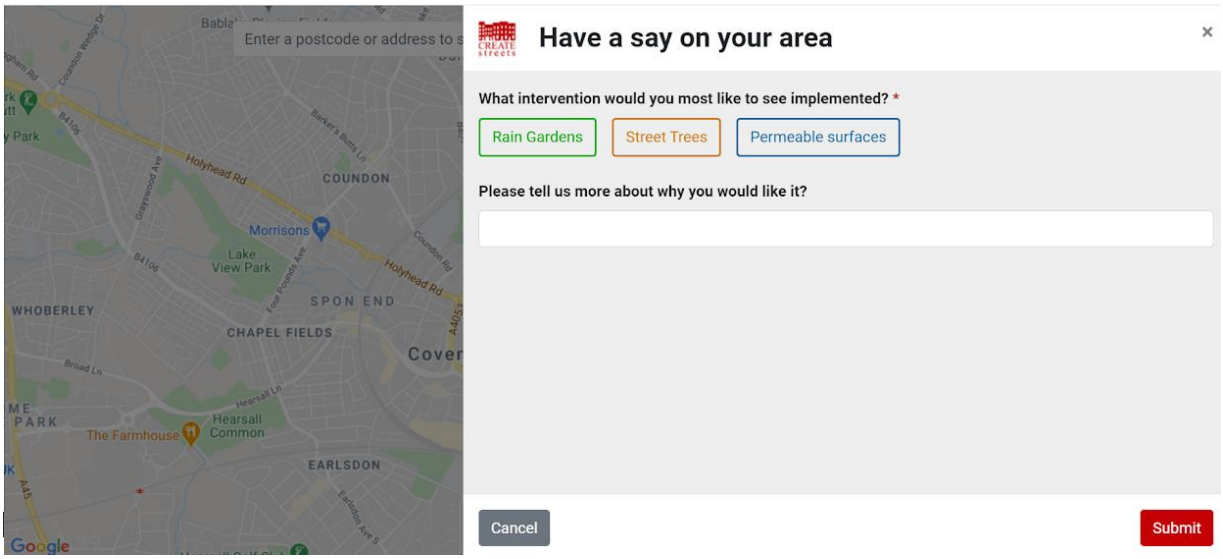

Image 3: The Create Communities platform with an example 'street intervention' project.

Through the use of community engagement methods, it should be possible to provide people affected by the disruption of pipe replacement with choice over how to shape and improve their street. Community engagement has been shown to be 'effective in improving healthy behaviours, health consequences, participant self-efficacy and perceived social support for disadvantaged groups' (O'Mara-Eves et al, 2013). There is an opportunity for Severn Trent to trial this strategy to see how to improve streets following intrusive street works. The ideal outcome would be an increased sense of agency from the community, and resultingly popular and sustainable street interventions which could improve the well-being of residents. If successful, it could then be easily and cost efficiently scaled.

Conclusion

Reducing and eventually removing lead in water, caused by water running through historic lead pipes has an obvious health benefit for the customers of Severn Trent. But there are wider potential benefits for health and well-being as well. It is important to look further than the pipes themselves and consider how the disruption caused by their removal could provide the opportunity to implement more holistic solutions that improve well-being. The interventions that will have positive impacts include; planting street trees, creating rain gardens and swales to provide greenery on the street and improve biodiversity and improving customers' front gardens (many of these may also help reduce the risk of flooding). This strategy will also help to deliver the 'levelling-up' agenda by taking responsibility for the replacement of pipes under private properties and focusing on delivering improvements in more deprived areas. Critically, by delivering these interventions through a community-led design approach and giving local people the 'agency' to shape and invest positively in their own local neighbourhood, the well-being benefits of these interventions will be maximised.

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Images Credits

Image 1: Google Maps street view and all data providers, 2019. Canterbury Street, Coventry.

Image 2: Google Maps street view and all data providers, 2019. Canterbury Street, Coventry. Edited by Create Streets using photoshop.

Image 3: The Create Communities platform with an example 'street intervention' project