URBAN SYSTEMS STUDIES

THE ACTIVE, BEAUTIFUL, CLEAN WATERS PROGRAMME: WATER AS AN ENVIRONMENTAL ASSET

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THE ACTIVE, BEAUTIFUL, CLEAN WATERS PROGRAMME: WATER AS AN ENVIRONMENTAL ASSET

CENTRE for LiveableCities SINGAPORE

First Edition, Singapore, 2017

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Set up in 2008 by the Ministry of National Development and the Ministry of the Environment and Water Resources, the Centre for Liveable Cities (CLC) has as its mission "to distil, create and share knowledge on liveable and sustainable cities". CLC's work spans four main areas—Research, Capability Development, Knowledge Platforms, and Advisory. Through these activities, CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. For more information, please visit www.clc.gov.sg.

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ISBN 978-981-11-4060-0 (print)
ISBN 978-981-11-4061-7 (e-version)

Cover photo:
Kallang River @ Bishan-Ang Mo Kio Park. Photo Courtesy of PUB, Singapore's National Water Agency.

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FOREWORD

Water has always been at the helm of our national policies even before independence. However, the discourse regarding its management and utilisation has evolved from being a resource of basic necessity to one of enhancing liveability. Being a teenager in the early 1960s when Singapore was faced with severe water scarcity, I still recall the words of our Prime Minister, Mr Lee Kuan Yew, who stated that “every other policy had to bend at the knees for water survival.” Those were the early days when Singapore grappled with fundamental issues of water insecurity ranging from inadequate supply of clean drinking water, poor sanitation to inundation from seasonal floods. It reflects the severe dependency that once faced the young nation when survival was of prime importance. Through long-term planning, sheer hard work and innovation, we have transcended into an era where the value of water in enhancing urban environments is recognised.

Today, Singapore is on its way to develop itself into a City of Gardens and Water. The Active, Beautiful, Clean Waters Programme is one initiative that has been designed with a strong focus on public engagement and bringing people closer to water. Singapore has already achieved the establishment of a robust drainage network through meticulous planning and investments in research and technology over the last 50 years. Meanwhile, people have also become more appreciative of their natural environment which is now intimately linked to their daily lives, be it a morning jog in the park or a picnic by the lake. Such a harmony of nature and community is the best way to ensure the sustainability of our city.

The Active, Beautiful, Clean Waters Programme: Water As An Environmental Asset documents Singapore's journey in transforming drainage infrastructure which used to serve the basic purpose of flood management into active, beautiful and clean recreational spaces for people of all ages to enjoy. I hope readers will find this account of Singapore's water journey captivating and informative. As the journey continues, I also hope that this book will serve to guide future generations of thought leaders and city planners in the effective management and conservation of our water resources, enabling us to prosper as a global and liveable city.

Tan Gee Paw
Former Chairman
PUB, Singapore's
National Water Agency

PREFACE

The Centre for Liveable Cities' (CLC) research in urban systems tries to unpack the systematic components that make up the city of Singapore, capturing knowledge not only within each of these systems, but also the threads that link these systems and how they make sense as a whole. The studies are scoped to venture deep into the key domain areas the CLC has identified under the Singapore Liveability Framework, attempting to answer two key questions: how Singapore has transformed itself into a highly liveable city within the last five decades, and how Singapore can build on our urban development experience to create knowledge and urban solutions for current and future challenges relevant to Singapore and other cities through applied research. *The Active, Beautiful, Clean Waters Programme: Water As An Environmental Asset* is the latest publication from the Urban Systems Studies (USS) series.

The research process involves close and rigorous engagement of the CLC with our stakeholder agencies, and oral history interviews with Singapore's urban pioneers and leaders to gain insights into development processes and distil tacit knowledge that have been gleaned from planning and implementation, as well as governance of Singapore. As a body of knowledge, the Urban System Studies, which cover aspects such as water, transport, housing, industrial infrastructure and sustainable environment, reveal not only the visible outcomes of Singapore's development, but the complex support structures of our urban achievements.

CLC would like to thank the PUB, Singapore's National Water Agency and all those who have contributed their knowledge, expertise and time to make this publication possible. I wish you an enjoyable read.

Khoo Teng Chye
Executive Director
Centre for Liveable Cities

ACKNOWLEDGEMENTS

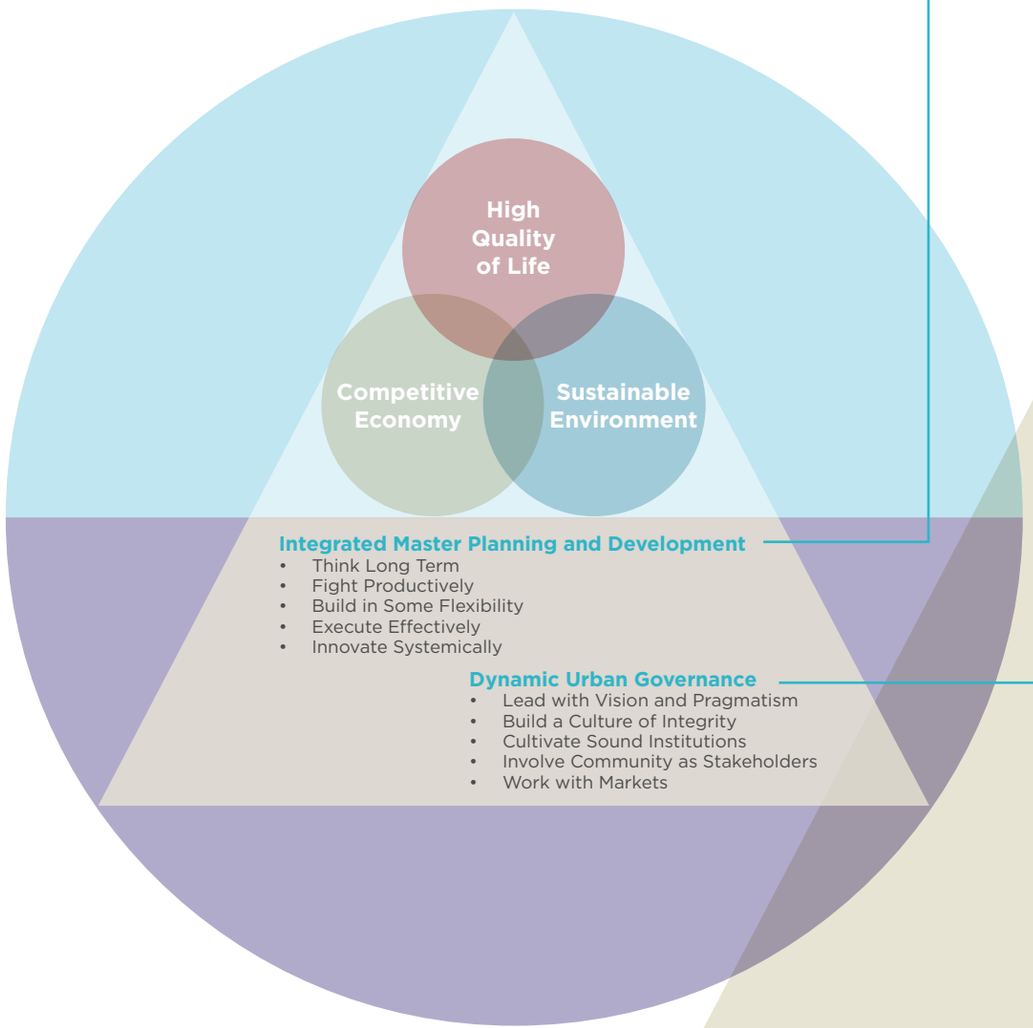
The Centre for Liveable Cities is grateful for the following urban pioneers and experts for sharing their insights through the interviews conducted as part of the research process (in alphabetical order): Damian Tang, Khoo Teng Chye, Moh Wung Hee, Tan Nguan Sen, Tan Yok Gin, Wong Kai Yeng and Yap Kheng Guan.

Thinesh Kumar s/o Paramasilvam, the writer, would like to extend special thanks to Lim Wei Da and other CLC colleagues for all the guidance and encouragement. He would also like to thank Wong Kai Yeng and Yap Kheng Guan for their invaluable advice and guidance as advisors for this publication. Finally, the writer extends his thanks to his colleagues from the Sustainability Office, PUB for their support and valuable inputs.

THE SINGAPORE LIVEABILITY FRAMEWORK

The Singapore Liveability Framework is derived from Singapore's urban development experience and is a useful guide for developing sustainable and liveable cities.

The general principles under **Integrated Master Planning and Development** and **Dynamic Urban Governance** are reflected in the themes found in *The Active, Beautiful, Clean (ABC) Waters Programme: Water As An Environmental Asset*.



Integrated Master Planning and Development

Fight Productively

The scarcity of land in Singapore necessitates the efficient planning and use of land resources. The PUB, Singapore's National Water Agency (PUB), had to work with other agencies to develop multi-use spaces where water resources are effectively weaved into existing urban infrastructure such as housing, and green spaces. The rejuvenation of Bishan-Ang Mo Kio Park as a flagship ABC Waters project would not have been possible without productive fights among agencies, including PUB, the National Parks Board (NParks) and the Housing and Development Board (HDB), which have resulted in better inter-agency coordination over time and set the precedence for future similar developments.

(see "It's Not Flooding, It's a Floodplain!": Challenges of the Bishan-Ang Mo Kio ABC Waters Project, p. 58)

Execute Effectively

The implementation of the ABC Waters Programme has been guided by an overarching master plan. Compared to the Waterbodies Design Panel (WDP) of the 1990s, the ABC Waters Programme is more ambitious in its aims and is being implemented on a larger scale. The programme is strongly backed by the various agencies and political leaders involved, who share a common understanding of the value and importance of the programme. This has provided the support and due diligence needed for the effective execution of the ABC Waters projects.

(see Floating the ABC Waters Master Plan, p. 46)

Innovate Systemically

Singapore's drainage network is a ubiquitous feature in our urban landscape. With the implementation of the ABC Waters Programme by PUB, canals have been further integrated into the urban fabric and serve multiple functions through the use of innovative engineering methods. Small-scale pilot projects and demonstration sites were developed initially to ensure that these new ideas could keep stormwater flowing efficiently, and to test the level of involvement by communities while showcasing the tremendous potential of this programme.

(see From Friendly Fights to Successful Collaborations, p. 52)

Dynamic Urban Governance

Involve Community as Stakeholders

The ABC Waters Programme has a strong people component. The strength of the programme lies in the way it involves local communities (schools, organisations and residents) in caring for our water resources. Initiatives like the ABC Waters Learning Trail and school adoption programme have encouraged the adoption of various water sites by schools. This has resulted in diverse groups coming together to keep our waterways clean, and over time, brought people closer to water.

(see Planning with People: Bringing People Closer to Water, p. 38)

Work with Markets

The ABC Waters Programme's successful implementation would not have been possible without the cooperation of the private sector. PUB worked with consultancy firms for their technical expertise in utilising bioengineering treatments for waterways. Private sector collaboration was a key factor in the effective implementation of ABC Waters design features in private developments. The ABC Waters Certification Scheme was one means to encourage the uptake of the programme by the private sector.

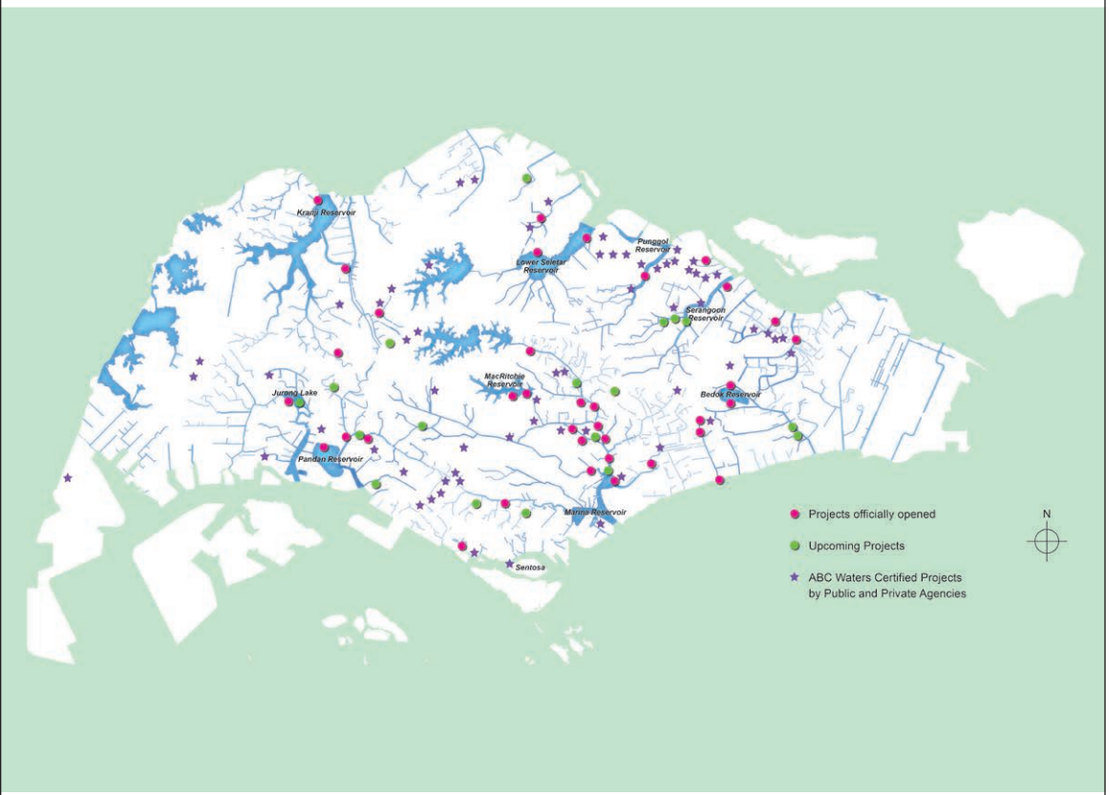
(see Building Capabilities: The ABC Waters Certification Scheme and Professional Programme, p. 63)

OVERVIEW

WATER AS A VITAL INGREDIENT FOR LIVEABLE CITIES

> *In the past, we protected our water resources by keeping people away from them; now, we will bring people closer to water so that they will enjoy and cherish it more. Many of our rivers and canals are in or close to the residential heartlands. The waterways are therefore a natural focal point for water-based activities, community events, and other recreational options. By linking up our waterbodies and waterways, we will create new community spaces that are clean, pleasant, and bustling with life and activities. We will integrate our waterbodies with our parks and green spaces and turn Singapore into a City of Gardens and Water.*
>
> Prime Minister Lee Hsien Loong[1]

Singapore has become increasingly water resilient over the years through careful policies, planning and innovations in the water sector. The journey from scarcity to sustainability has involved the integration of water policies and the holistic development of water infrastructure in tandem with urban development.[2] This Urban Systems Study documents the shifting trajectories in managing water in Singapore—from the use of utilitarian concrete drains and canals that distanced people from these blue spaces to transformed waterways and waterbodies which brought people closer to water under the ABC Waters Programme. Singapore's physical and climatic characteristics have necessitated the building of drainage infrastructures like monsoon canals, smaller tributary drains, and water storage ponds to perform key hydrological functions to alleviate flooding for most parts of her contemporary history. These crucial drainage infrastructures have since played an important role in allowing for the physical urban transformation of Singapore, from urban squalor to the global city it is today. Once the basics had been taken care of, there began a shift towards unlocking the full potential of waterbodies and waterways:



Singapore's Blue Map.
With over 8,000 km of waterways and 17 reservoirs, Singapore has much potential to integrate blue spaces with urban development.

Diagram Courtesy of PUB, Singapore's National Water Agency.

> *[Water] is really an environmental asset. It's not just a resource, but it's an asset and if you look at the map of Singapore, we have a pervasive network of drains, canals and rivers. Each of these can be a potential asset that can be exploited to enhance the liveability of the urban environment.*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[3]

A shift in planning paradigms in the late 1980s saw authorities experimenting with the idea of integrating waterbodies with urban development—by enabling the dual use of waterways as recreational spaces as well. Initially, these efforts were largely premised on the need to improve the aesthetic appearance of the waterbodies and waterways, as seen in the work of the Waterbodies Design Panel in the early 1990s. However, more recent efforts have sought to transform the entire island into an urban water catchment, in line with broader plans to develop and manage water resources sustainably. At the core of these policies was a move to include the public in the management of these important water resources, in part to ensure the long-term sustainability of the resources.

In 2006, the Active, Beautiful, Clean (ABC) Waters Programme was launched to transform waterways and waterbodies into beautiful urban assets, integrating these drainage infrastructures with the built environment while bringing people closer to water. The strength of this programme lies in its unique approach in getting people involved to ensure the sustainability of scarce water resources. The engagement of communities was an important aspect of this programme from the start and continues today. Through the ABC Waters Programme, the potential of blue spaces in making Singapore liveable is being realised. The programme showcases the role of water in urban spaces, and demonstrates how water is a vital ingredient in the development of liveable cities.

THE ACTIVE, BEAUTIFUL, CLEAN WATERS PROGRAMME

Launched in 2006 by the PUB, Singapore's National Water Agency (PUB), the ABC Waters Programme aims to transform waterways and reservoirs in Singapore beyond their drainage and water storage functions, to create clean and beautiful rivers and lakes while allowing these spaces to be used for community bonding and recreation. By integrating the environment, waterbodies and the community, PUB hopes to realise the full potential of our waterbodies and inculcate in Singaporeans a sense of stewardship towards water. Capitalising on existing urban water infrastructure, the programme seeks to sensitise the public to the value of water by creating opportunities for people to enjoy and interact with waterbodies and waterways as part of our urban neighbourhoods and city landscape. To do so, the programme invests in the design and upgrading of waterbodies and waterways so that the space becomes an inviting environment with facilities for the community.

Apart from introducing water to the city and people, the ABC Waters Programme is holistically linked to the city's stormwater management strategy. The ABC Waters management strategy promotes the use of natural systems, the ABC Waters design features, to absorb stormwater temporarily so that peak runoff to the public network of waterways is reduced, thus lowering flood risk during heavy storms when implanted on a catchment wide level.[4] Such systems can be designed as part of landscaped spaces for people, making community spaces work twice as hard by doubling up as water infrastructure. These ideas are encapsulated in the programme's acronym, "ABC" (See Exhibit 1 for details).

Exhibit 1:

The Active, Beautiful, Clean Waters Programme[5]

ACTIVE	BEAUTIFUL	CLEAN
Creating new recreational and community spaces while bringing people closer to water.	Transforming concrete waterways into vibrant and picturesque waterscapes that are well integrated with the urban environment.	Improving water quality through holistic management of our water resources and public education by fostering better people-water relationships.

Kayaking in the Lower Seletar Reservoir.
Waterbodies were opened up for recreational activities in 2004.
Photo Courtesy of PUB, Singapore's National Water Agency.

The ABC Waters Programme is about making better use of our urban assets—space and water—to create value and support more functions. The programme provides both physical and policy space for the innovative management of waterbodies and waterways. In doing so, Singapore has achieved the arduous task of developing its urban landscape intensively while contributing to stormwater management. With the ABC Waters Programme, urban development and stormwater management have found synergy as blue spaces are integrated within the urban fabric, showcasing the potential of architecture, engineering innovations and, most importantly, urban planning in managing scarce water resources.

The following chapters will elaborate on the origins of the ABC Waters Programme, and the strategies of implementing it from the early years to more recent times. Eventually, this document will help readers navigate the evolution of Singapore's waterways over the years and chart the shifting paradigms in the utilisation of the city-state's water resources.

CHAPTER 1

A CITY OF GARDENS AND WATER: FORMATIVE YEARS

SHIFTING PARADIGMS: WATER AS AN ENVIRONMENTAL ASSET

> Today this [drainage and reservoir] system helps us to collect water, store water, and control floods. So we have taken care of the basics well. But moving forward, there is further potential—if we think creatively and work together. With some planning and enhancement, the waterbodies and waterways can be changed into vibrant areas for everyone in the community to enjoy. There can be more lifestyle activities and people will have more recreational choices. This in essence is the spirit of the ABC Waters Programme.

Dr Yaacob Ibrahim, Minister for the Environment and Water Resources[6]

Singapore has historically placed emphasis on managing its environment well, aligning this aim with national and economic development. For instance, just five years after independence, amidst housing, employment and security challenges, an Anti-Pollution Unit was set up and placed under the direct charge of the Prime Minister's Office.[7] Economic development was shaped by environmental concerns, with pollutive industries actively phased out or strategically located to minimise the pollutive impact on the general public. Similarly, greenery was used thoughtfully as an aesthetic ingredient to nourish the urban environment, with provisions made for trees to line all roads—an initiative that was overseen closely by then Prime Minister Lee Kuan Yew through the 1980s.[8] In many ways, the ABC Waters Programme follows this culture of rigorous environmental management. The techniques adopted under the programme, such as using plants and soil to treat and detain stormwater, are not unique to Singapore.[9] However, the scale in which the programme has been implemented far exceeded that of similar programmes in other countries. Within the tropics, the ABC Waters Programme is the first of its kind to be implemented successfully and remains a model of sustainable development for neighbouring nations.[10]

The ABC Waters Programme follows a slew of earlier blue-green measures to improve the aesthetical appearance of Singapore. The government had initially experimented with such projects at various scales, and with mixed levels of success. From the early 1980s, after having dealt with the major bread-and-butter issues that had plagued Singapore in the post-independence era, the government began to focus more on addressing the population's quality of life. For example, the Housing and Development Board (HDB) began improving the quality of older housing estates through the HDB upgrading programme in the 1990s, having resolved Singapore's housing crisis by the late 1970s.[11] There was a general shift in the way planning was carried out in Singapore, with an increasing focus on the qualitative aspects of living in the city. The implementation of the ABC Waters Programme is in line with this transition in planning, where water is seen as a crucial component of the urban fabric and thus, waterways and waterbodies managed as environmental assets. The planners recognised the potential of integrating blue spaces with the development of the city, by using waterways and waterbodies to create new social, cultural and economic value in urban spaces. Through the implementation of the ABC Waters Programme, the potential of waterways and waterbodies in enhancing the urban environment could be tapped fully.

Former Prime Minister Lee Kuan Yew at Holland Circus Tree-planting Day.
The ceremony also signified the beginning of an island-wide tree planting campaign, now better known as Tree Planting Day.

Photo from Ministry of Information, Communications and the Arts Collection, Courtesy of National Archives of Singapore.

In the past, the government's approach to managing water resources was to keep people away from water. However, the early 2000s saw the authorities reversing this protectionist mentality and, instead, focusing on more public education as a means to keep waterways and waterbodies clean. In 2004, reservoirs were opened for water-based recreational activities. Railings and hard barriers were replaced at some sites with natural barriers like vegetation and boulders to transform these waterways into inviting spaces, while creepers were used to soften the hard look of concrete canals. These measures sought to bring people closer to water while educating the public on the need to keep waterways and waterbodies clean and fostering a sense of water consciousness.[12] This was a new approach to managing water resources for the PUB—one that maintained the basic hydrological and drainage functions of waterways but with an increased emphasis on engaging key stakeholders like the public.

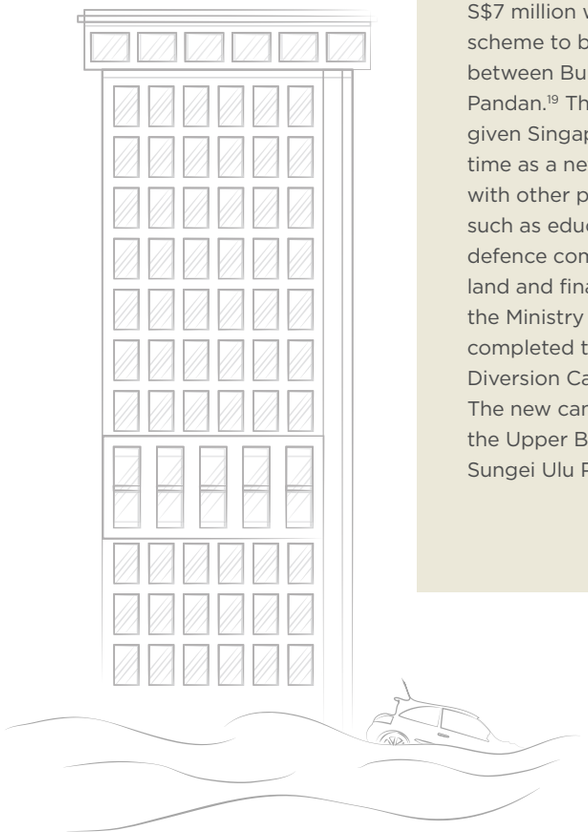
MANAGING FLOODS AMIDST RAPID URBAN DEVELOPMENT IN THE EARLY DAYS (1970s–1980s)

Singapore's drainage developments in the earlier years were mainly a response to the nation's flood risk and its associated sanitation risk. The earliest drainage network in Singapore was a long-term, public health measure to combat the deathly spread of malaria in 1914 by preventing the breeding of mosquito larvae.[13,14]

Over time, these early drainage networks doubled up as flood-alleviating infrastructures. However, by the 1950s, rapid development and urbanisation had increased flood risks on the low-lying island, putting these drainage networks under severe pressure. The turn of the decade saw the formation of a joint committee under the Public Works Department (PWD) in 1951 to improve Singapore's drainage system.[15] This marked the first coordinated effort to combat flooding under a single department, ensuring a more focused and effective approach to reducing Singapore's flood risk. During the earlier days, the newly commissioned unit worked on flood alleviation projects in several residential areas like Queenstown, Geylang, Bedok, Potong Pasir, Whampoa, Jurong, Tampines and Seletar.[16]

As Singapore faced the need to urbanise as part of its national development, authorities were hard-pressed with the dual challenge of mitigating existing flood risk while preventing floods associated with the urbanisation of new areas in Singapore.[17] For instance, a massive New Town development programme was initiated in the 1970s by HDB to address the severe housing shortage. Drainage engineers were thus tasked with the challenge of ensuring that these new developments would not exacerbate flood risks. To do so, drainage issues had to be addressed before the start of any development. Despite their utilitarian appearance, these drainage infrastructures played a crucial role in allowing for the urban development of Singapore. Moreover, these would lay the foundations for the implementation of the ABC Waters Programme in the later years.

BALANCING COMPETING NEEDS: THE BUKIT TIMAH FLOOD ALLEVIATION SCHEME



One key project implemented was the Bukit Timah Flood Alleviation Scheme (BTFAS) in 1966. In the early days, justifying such projects was difficult and obtaining the necessary funding was often a tedious process. Then Minister for Finance, Dr Goh Keng Swee could not justify the millions required for BTFAS, especially as the floods were not hazardous albeit being frequent. He felt that "there was no justification spending millions of dollars just to enable folks to go home on time for dinner!"[18] Eventually, approximately S$7 million was set aside under the scheme to build a diversion canal between Bukit Timah and Sungei Ulu Pandan.[19] This was a major decision, given Singapore's situation at the time as a newly independent nation with other pressing national issues such as education, housing and defence competing for its limited land and financial resources. In 1972, the Ministry of Environment (ENV) completed the Bukit Timah 1st Diversion Canal under the BTFAS.[20] The new canal diverted water from the Upper Bukit Timah Catchment to Sungei Ulu Pandan.

The Bukit Timah Flood Alleviation Scheme.
Large diversion canals were constructed to divert water away from the Upper Bukit Timah Catchment.

THE FIRST WAVE OF REORGANISATION: THE DRAINAGE MASTER PLAN

The early 1970s saw a reshuffling of functions to ensure a more coordinated approach to managing drainage – partly in response to the intensification of flooding incidents. The Drainage Department was set up formally under the ENV in 1972, having been transferred out of the PWD.[21] This move ensured more synergy in managing water resources, as drainage along with sewerage and public health were all transferred to ENV. Rapid development of new housing and industrial estates had resulted in increased stormwater flows that required an extensive and expanded drainage system. Land-use changes have an impact on rainfall collection and the rate of runoff. In Singapore, the increased urbanisation and development of new towns in previously rural areas meant that natural surfaces were being concretised, thus increasing surface flows to drainage waterways.

Acknowledging the need to overcome these issues, ENV developed a drainage master plan in consultation with the Urban Redevelopment Authority (URA), Jurong Town Corporation (JTC), HDB and other development agencies in the mid-1970.[22] Aimed at reducing the number of flood-prone areas in Singapore, the master plan guided the Drainage Department in planning and implementing drainage networks across the island. Tan Nguan Sen, then a drainage engineer, recalls the dilemma faced with urbanisation needs and flood prevention:

> *"[T]he URA manages all land use. When HDB wants to build a new housing town, like Hougang New Town, URA will consult all the agencies. The Drainage Department and Sewerage were then consulted. We would impose our requirements on them and URA will then set aside the land for it. There's this trade off; should we give more land for the housing or more land for the drains, or more land for the roads? It is always this balance that URA has to manage between roads, drainage and buildings."* [23]

The move to place the Drainage Department under ENV was a strategic move, as the government recognised the relationship between drainage systems and public health.[24] Nevertheless, the Drainage Department continued to work well with other agencies to overcome flooding issues and this was in part due to the presence of a good governance structure that allowed for the cooperation of the various agencies to overcome Singapore's developmental problems.

> *[W]e have a very good system of government, where all the agencies work together. And then in a way... we [have] managed to settle a lot of these issues.*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[25]

A key aspect of the drainage master plan was the demarcation of drainage reserves, which are reserved land alongside new waterways to allow for possible future expansion whilst ensuring accessibility for the maintenance of these waterways.[26] Having learnt from the rapid development of Bukit Timah—here developments were built too close to the edge of the waterways, thus limiting any expansion of the drains—the Drainage Department saw the need to set aside land should there be a need to expand the drainage network.[27] It was important to safeguard these strips of land to ensure the success of the drainage schemes years later.[28] However, multiple uses would be allowed where feasible. For example, the implementation of drainage reserve guidelines along with the strengthening of river banks at the Singapore River enabled the development of recreation facilities right up to the water's edge, thereby creating a convivial waterfront area in the later years.[29]

The Drainage Department was hard-pressed to solve Singapore's flooding problems during the early crucial stage of the nation's development. Drainage engineers had to implement infrastructural solutions that could work efficiently to alleviate flooding woes. Often, these involved the construction of concrete canals, which were effective in channelling water away quickly during a rainfall event. The recurring flooding put further pressure on the Drainage Department to work towards alleviating floods in Singapore:

> *"Those were the days. Flood problems [were] very bad, but getting worse and worse by the months and the years. Partly because, Singapore was urbanising, we were just out of independence and there was that strong push to provide for public housing, industrialisation, all the modern infrastructure. And every one of these had a potential of [causing] more flood problems. Or worse still, in some places that's not [been] experiencing any flood, the potential of new flood problems being created."*
>
> Yap Kheng Guan, former Director of 3P Network, PUB[30]

INTEGRATING WATER WITH URBAN SPACE

Singapore's drainage was planned and developed to deal with flooding pragmatically till the late 1980s. At the turn of the decade, amidst economic growth and improving social conditions, there was a shift in the government's approach in managing waterbodies and waterways:

> *"Waterbodies are a ubiquitous feature of the Singapore landscape. Whether canals, drains, reservoirs or stormwater collection ponds, their development has allowed us to overcome the physical impediments of high rainfall and low topography to develop a modern and prosperous city-state. Historically, waterbodies have been developed as a practical necessity. But, with increasing financial well-being and awareness of our environment, the emphasis is shifting towards making them aesthetically pleasing as well. Developing attractive waterbodies is an especially important part of creating Singapore as a tropical city of excellence."*
>
> Dr Richard Hu, former Minister for National Development[31]

Singapore has often intervened early to implement policies that improve the country's urban façade. Likewise, the value of keeping waterways clean was recognised from the early days, with the successful implementation of clean-up projects for the Singapore and Kallang Rivers. It was during the early 1990s that planners saw the value of waterbodies beyond their functional uses—as environmental assets for "everyone to enjoy"—eventually leading to a paradigm shift where the government began actively planning for the softer aspects of Singapore's urban landscape.[32] This included planning for greenery and incorporating waterbodies into the built environment.[33] In part, the successful conversion of drainage reserve spaces into park connectors inspired engineers and planners to think of more innovative ways of using these drainage spaces.[34]

Former drainage engineer, Moh Wung Hee, recalls the way the Drainage Department cleverly used the drainage reserves as jogging paths in the early days while ensuring that the waterways remained accessible for maintenance.[35] These jogging paths would later form the foundation of Singapore's extensive network of park connectors. The changing use of waterways and waterfront spaces arose from the need to better utilise drainage reserves in Singapore and over time, these spaces were creatively appropriated into the urban fabric of the city.

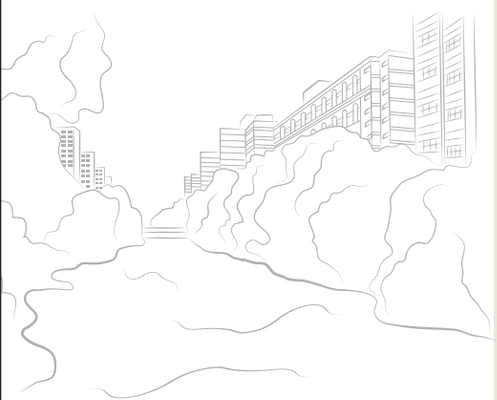
WATERBODIES DESIGN PANEL (1989–2000)

In 1989, URA developed a vision to re-naturalise Singapore's waterways as a means to incorporate more greenery into the city. The idea was developed by Lim Hng Kiang, then Deputy Secretary at the Ministry of National Development (MND). The Waterbodies Design Panel (WDP) was thus set up as an advisory body within the government to evaluate and advise on the design and aesthetics of major waterways. This was the first coordinated, inter-agency effort by the government to beautify waterways and incorporate them into Singapore's urban landscape.[36] The panel, through URA, worked closely with the Drainage Department and other agencies to transform identified canals into aesthetic walkways and recreational spaces. The early efforts to beautify waterways were propelled by urban planners with the help of drainage engineers, with the aim of transforming such projects for enhancing the urban landscape.[37] WDP would set the precedence for integrating waterways with Singapore's urban fabric through the successful development of pilot projects.

WDP was chaired by Liu Thai Ker[38] and consisted of representatives from both public agencies and the private sector including members from HDB, the Parks and Recreation Department, the Port of Singapore Authority, PWD, ENV and the Drainage Department. Wong Kai Yeng, a former director from URA, recalled the political support behind the formation of WDP and the involvement of the private companies. Henry Steed, then a director in BCP Far East Ltd, was in WDP during the early stages to lend his technical expertise to beautify waterbodies.[39] Two private landscape companies were also involved in the early demonstration period of beautifying waterbodies. WDP was one of the first efforts to incorporate waterbodies in urban design in Singapore. It sought to raise awareness for its work through some carefully chosen demonstration sites made possible through an integrated, inter-agency effort that broke away from the norms of silo planning.

The WDP created some outstanding projects. Amidst the high-rise public housing of Pasir Ris Town, Sungei Api Api became a scenic river lined with lush mangroves, instead of a typical monsoon canal. In another town, Bukit Panjang, what might have been a bare stormwater pond became an attractive wooded lake. WDP worked very strategically in getting involved in these projects, by working with other agencies to identify possible developments and dovetailing their operations with potential upgrading work.[40] A lot of coordination among different stakeholders was necessary for the successful completion of the demonstration projects. Early intervention was another important factor in ensuring the success of these projects. WDP's efforts were enabled by a shift within the government towards formulating creative solutions to overcome our water and land scarcity issues.

"A PRETTY SMART LOOK FOR CANALS AND DRAINS"[41]: BEAUTIFYING SUNGEI API API



Sungei Api Api was "saved" by WDP in the early 1990s. The rest of the river had already been concretised; and with the development of new housing precincts, there was an increasing need to further upgrade the river to cater to drainage needs. WDP intervened in a timely manner to ensure that these drainage requirements were met while enabling the mangroves—a unique feature of Sungei Api Api—to continue thriving. Drainage engineers and HDB architects racked their brains alongside landscapers from the Parks and Recreation Department (later known as NParks). It was then decided that one way to ensure that the river could cater for the drainage needs of the area was to stabilise and expand the banks of the river, while replanting the mangroves to soften the banks and lend a naturalised look to the upgraded river.[42] Due to the low tidal conditions of the river, engineers had to create a permanent body of water to improve the aesthetics. In the end, the Drainage Department had to resort to driving piles into the sides of the canals to prevent soil on the banks from collapsing. Thereafter, mangroves were replanted alongside hardy plants to soften the banks, thus retaining the natural heritage of the river.[43,44]

> *"The Sungei Api Api meanders and flows through a mangrove swamp. [If] development takes place, the storm flow will increase and the river [will have] to be made bigger. Of course, one way to overcome this was to build a conventional canal. But we had these mangroves over there and it made a lot of sense to conserve the mangroves."*
>
> Moh Wung Hee, former Director of Best Sourcing & Deep Tunnel Sewerage System, PUB[45]

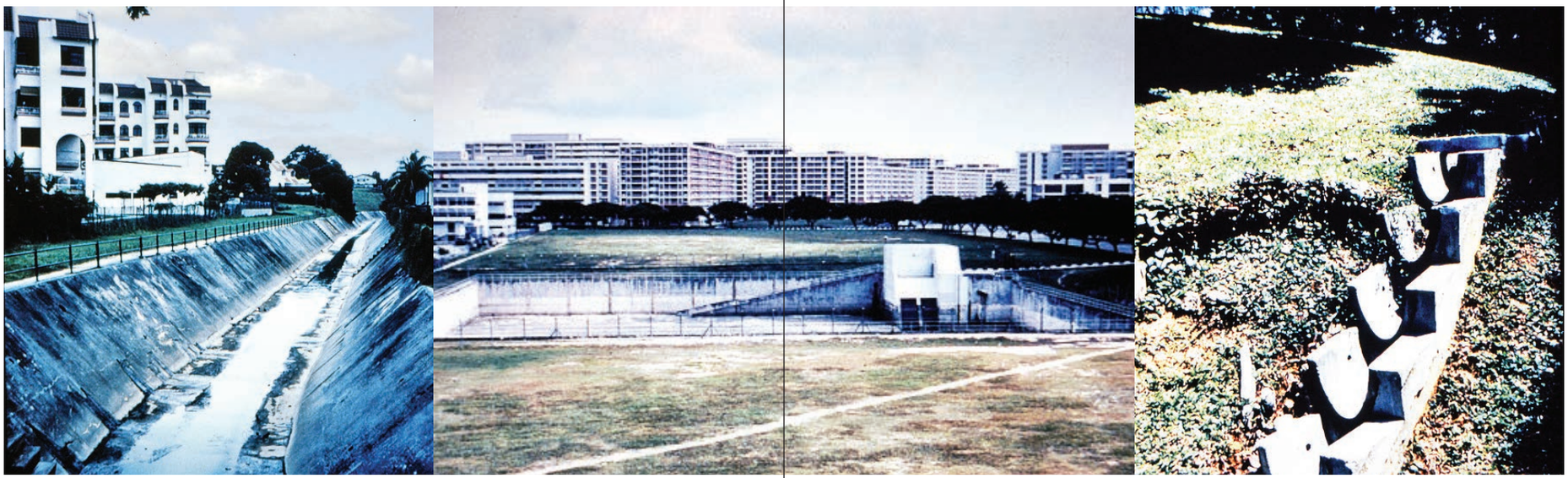
The successful redevelopment of Sungei Api Api was a stellar example of different agencies working together to overcome bureaucratic barriers in development. This cooperative mindset also helped to resolve the question of everyday maintenance, with HDB eventually getting involved since the new development exceeded the boundaries of the drainage reserve.[46] Moreover, the development of Sungei Api Api demonstrated the need for flexibility in policies governing land use. With the right foresight and sufficient policy space, drainage reserves can become more than reserved land and, instead, be remade into usable recreational space. Through WDP, drainage reserves were rezoned as control zones in the Sungei Api Api site, which enabled the construction of landscape facilities and park furniture.[47]

These early projects were important in showcasing the potential of harnessing waterbodies to beautify Singapore's urban landscapes. The resulting policy changes and flexibility in implementation demonstrated the feasibility of such projects—albeit requiring a lot of creative thinking and coordination between agencies!

THE 1991 CONCEPT PLAN

The 1991 Concept Plan further enshrined WDP's aim of incorporating waterbodies in urban planning. The Concept Plan emphasised the tropical island identity of Singapore and promoted the enjoyment of nature through the implementation of a "Green and Blue Plan."[48] The "Green and Blue Plan" showed the potential of park connectors in forming a framework for leisure, with an increased emphasis on recreational opportunities relating to the sea, quarries, and nature parks. This shift in planning paradigms meant moving beyond providing for bare necessities to looking at improving the quality of living—"to create a city within an island which balances work and play, culture and commerce: a city of beauty, character and grace, with nature, waterbodies and urban development weaved together."[49]

The 1991 Concept Plan acknowledged the shortage of land in Singapore as inhibiting developmental goals, and proposed the creative use of existing land resources to allow for better quality of life. This essentially involved the better use of waterfront areas, as well as park and greenway connectors, with the Singapore River and Marina Bay identified as key zones for these plans. For example, the 1990s saw the implementation of a Singapore River Development Guide Plan (DGP) to guide land use and urban landscaping efforts in the area.[50] These plans and efforts signalled the shifting trajectory of managing water in Singapore, with authorities recognising the potential benefits of incorporating blue spaces into the urban environment.



Utilitarian concrete drains and stormwater collection ponds.
Some examples of utilitarian drainage and stormwater infrastructure in post-independence Singapore.

BURYING OUR PROBLEMS: THE UNDERGROUND STORMWATER POND IN OPERA ESTATE

In Opera Estate, an underground pond was constructed in 1996 to collect stormwater before it was pumped into the main canal.[51] Constructed under the football field of Opera Estate Primary School, the pond was a means to encourage dual usage of land and to serve as a way to overcome land-related issues encountered in expanding the existing drainage network. The old outlet drain at this location was eventually replaced and covered to enable recreational activities such as jogging and cycling. This successful construction was an early example of drainage being dealt with in ways other than building concrete canals. More importantly, it illustrated the potential of drainage infrastructure to provide more than one service through innovative and strategic planning.

Flooding at Opera Estate.
Flooding episodes occurred regularly in this low-lying estate.

THE DEMISE OF THE WATERBODIES DESIGN PANEL

Then Chief Executive Officer (CEO) and Chief Planner of URA, Mr Khoo Teng Chye recalls the involvement of URA in drawing up DGPs through the 1990s which resulted in insufficient attention in following up on the initial demonstration projects by WDP.[52] Between 1992 and 1993, URA released a set of Development Control Submission Guidelines for developments adjacent to waterbodies, aligning its work closer to that of WDP. These guidelines included the use of Temporary Occupation Licences to promote the development of compatible waterside activities on drainage reserves on an annual basis while delegating the maintenance of these spaces to the license holder.[53] Besides regulating the usage of waterfront spaces, these guidelines ensured that the drainage capacity of waterways would not compromised, a reminder of the importance of water conveyance and retention for Singapore's urban catchments.

The lack of an institutional framework to concretise the WDP as a long-term project eventually contributed to its demise.[54] In May 2000, the panel was dissolved to allow for more innovative ideas from the private sector. However, due to the economic downturn in the late 1990s and early 2000s, the anticipated innovations did not materialise.[55] Efforts to beautify Singapore's waterways languished and lay dormant for several years thereafter.[56] Unlike the Park Connector project where NParks took charge, the mantle of WDP was not actively taken up by the Drainage Department:

> *"In a sense, the panel was seen as an ad-hoc thing started by URA and the ownership of it was not really taken up by the drainage folks. This was quite different from the park connector project where NParks took ownership—they were very enthusiastic and came out with a master plan and so on."*
>
> Khoo Teng Chye, former CEO, PUB[57]

Although largely supportive of these beautification projects, the Drainage Department was focused on its main mission to alleviate and prevent flooding in Singapore. The institutional set-up of the department further limited the reach of WDP. For example, the Drainage Department had to put up a five-year programme for building drainage systems and have it approved by ENV and then the Ministry of Finance (MOF) before funding could be obtained.[58]

Despite the institutional demise of WDP, these early efforts would set the premise for the implementation of the ABC Waters Programme later. Through the implementation of successful pilot programmes, WDP showcased the potential of water as an asset within urban space and demonstrated a new paradigm for the planning and development of blue spaces in Singapore. However, Singapore's experience with the panel also proved the importance of having a strong institutional framework to ensure the longevity of programmes.

Sungei Api Api and the Pang Sua stormwater pond are some of the legacies of WDP from the early 1990s. The work of WDP was important not only because it ensured that functional waterbodies became beautiful, recreational spaces but also because it set the precedence for the ABC Waters Programme later. WDP's efforts to beautify waterbodies were the first attempts to do so outside of the city centre. Previous initiatives, like the Singapore River clean-up, focused solely on cleaning up and beautifying waterfront areas and were largely limited to the city centre. With the WDP projects, more people could enjoy beautified waterbodies, especially since these were located in residential towns.

According to Khoo Teng Chye, the early 1990s was a period when older HDB estates were due for upgrading. In a bid to improve the quality of these residential areas, there was talk of the potential of beautified waterbodies in enhancing living quality in these areas.[59] With these considerations in mind, the beautification efforts for waterbodies occurred in a timely fashion to ensure that they could be carried out concurrently with upgrading or development works. At the same time, efforts were taken to ensure that beautified waterbodies were part of upcoming new housing towns, as was done in Bukit Panjang.

THE SECOND WAVE OF REORGANISATION: PUB, SINGAPORE'S NATIONAL WATER AGENCY

> *"PUB was in the post-NEWater phase so the idea was that a lot of Singapore would become water catchments. We needed to engage the people so that they would know about the water catchments and would help keep them clean—the idea of stakeholder engagement. We thought the ABC Waters Programme would be the right programme to get people all fired up to be ... close[r] to water. If this programme had been a nice thing for URA but of little value to PUB, it would not have taken off."*
>
> Khoo Teng Chye, former CEO, PUB[60]

The early 2000s saw a range of institutional and policy changes that paved the way for the implementation of the ABC Waters Programme in 2006. At the core of these changes was the reorganisation of PUB in 2001. PUB was transferred out of the Ministry of Trade and Industry (MTI), where it had overseen water supply needs alongside energy and gas utilities, and merged with the Sewerage and Drainage Departments under ENV to form a consolidated PUB under the environment ministry. Under the Public Utility Act (2001), PUB became the sole agency in charge of all the operational nodes of the entire water loop—water catchment, drainage and sewerage, water treatment and distribution, and eventually, NEWater and desalinated water.[61] This realisation of the need to manage the entire water loop was important in setting the context for many of PUB's policies in the subsequent years, but more importantly, it helped to streamline operational and institutional processes for managing the country's water resources. The integration of all water-related functions under PUB would eventually allow for the implementation of the 3P (People, Public, Private) network schemes in the later years.[62]

The merger of the Water Department (then under MTI) and the Drainage Department (then under ENV) proved challenging initially as these two departments had contradictory functions. With the merger in 2001, the Water and Drainage Departments had to forgo old mentalities and instead, worked holistically to ensure the sustainability of Singapore's water resources. This included ironing out conflicting agendas, which was seen in the management of water levels in reservoirs. The Drainage Department wanted to keep water levels low to prevent flooding whilst the Water Department had wanted water levels to be at maximum capacity for water use.[63] With Kranji Reservoir, Yap Kheng Guan describes the productive fights between the different departments over water levels and the risk of flooding:

> *"The water people would want to make it as high as possible, but that has upstream consequences. The low-lying grounds upstream—like the Neo Tiew farms, Lim Chu Kang and so on—will flood. For example, the Neo Tiew farm floods every now and then because the water reservoir level is too high."*[64]

Apart from water levels, the maintenance of waterbodies was a recurring issue within the different departments. Hence, the merger in 2001 not only helped to streamline the operations of the various departments but also, in the process, ensured the cleanliness of these waterbodies.[65]

Previously, reservoirs were polluted with rubbish from upstream canals, posing a challenge for the Water Department to tackle. With the merger, a catchment approach was undertaken to manage Singapore's water catchments—meaning waterways were kept clean to ensure that the end point reservoirs, would be kept clean too.[66] The reorganisation of PUB would facilitate the implementation of the ABC Waters Programme in the later years as the Drainage and Water Departments came under the purview of one organisation; this was a vastly different state of affairs compared to the situation in the early 1990s, which saw the efforts of WDP petering out as different departments had various agendas. Under the helm of one organisation that oversaw Singapore water policies holistically, efforts to beautify and transform waterways and waterbodies were strategically placed not only in managing water resources but also, to engage the public.

GETTING PEOPLE INVOLVED: A PUBLIC-CENTRIC APPROACH TO MANAGING WATER RESOURCES

Beyond the reorganisation of PUB, the early 2000s also saw the emergence of a people-centric approach towards the development of waterways in Singapore. The Parks and Waterbodies Plan unveiled in July 2002 aimed to enhance the living environment while retaining Singapore's identity and built heritage. Spearheaded by URA, the plan was given a three-month consultation period to gather the views of the public on the proposals pertaining to blue and green spaces in Singapore.[67] The public consultation was broken into three subject groups, with one group solely dedicated to gathering feedback on the planning and development of waterbodies. A report (Subject Group Report on Parks & Waterbodies Plan and the Rustic Coast) was published at the end of this process, identifying various key ideas such as the softening of waterbodies with greenery and the preservation of natural waterways, with early plans outlining possible waterfront developments at Punggol Point and Coney Island. For the first time, nature reserves were reflected in Singapore's statutory land-use plan (master plan 2003) and areas with high biodiversity outside of nature reserves were accorded some form of status in the land-use planning process, with 18 areas designated as "nature areas" in the Parks and Waterbodies Plan.

This period also saw the successful launch of the NEWater programme. NEWater was officially launched at the National Day Parade on 9 August 2002, where then Prime Minister Goh Chok Tong led 60,000 people in a toast with NEWater.[68] With increasing priority given to achieving water sustainability, PUB's focus shifted, with an increasing focus on get the community. A public-centric approach was adopted to get people more involved in matters relating to water and, eventually, to have the public play their part in keeping waterways clean. This was followed by the opening up of waterbodies for recreational activities in 2004.

Launch of NEWater.
Former Prime Minister Goh Chok Tong was one of the political leaders who endorsed the NEWater during its launch in 2002.

Photo from Ministry of Information, Communications and the Arts Collection, Courtesy of National Archives of Singapore.

The Ministry of the Environment and Water Resources (MEWR), renamed from ENV in 2004, has since allowed greater public access at MacRitchie, Bedok, and Lower Seletar Reservoirs and Jurong Lake for community and sporting activities.[69] Opening up these waterbodies was not a simple task; PUB had to strategically account for the differing interests of various stakeholders while maintaining the core function of reservoirs as a source of water supply. Hence, a process evolved to work with these stakeholders—which included nature groups and other interest groups—alongside consultations with the public and the kickstarting of a 3P network (read more in Chapter 3) within PUB.[70] For example, there were concerns over the pollutive impact of recreational water sports on Bedok Reservoir, thus careful research was undertaken to find ways to minimise pollution, such as through the use of electric boats.[71] The opening up of waterbodies was done in a manner that accounted for the varied characteristics of different reservoirs. MacRitchie Reservoir was identified as a more pristine water catchment where water sports activities would be limited. On the other hand, Bedok Reservoir was developed as a water sports hub, considering its more urban characteristic as it is located in a residential area.[72]

> *"[W]e were also concerned about the interest groups, like Nature Society and so on. Reservoirs are so fondly loved by them, and for a good reason, and we had to assure them that, "Look, we were not about to turn MacRitchie into an East Coast Park or Disneyland," and all that, it's not going to be like that. The tranquility of the place, the kind of things that you love about the place will still be preserved."*
>
> Yap Kheng Guan, former Director of 3P Network, PUB[73]

Yap Kheng Guan recalled the importance of working with other stakeholders, especially non-government organisations and the public, to effectively roll out a policy:

> *"[S]ometimes, you see some of these interest groups as though they are enemies and a resistance group to whatever projects you want to do. But if you can understand them well, understand where they are coming from, there's really no need for us to see them as adversaries. In fact... the moment you can understand each other, you can actually improve on the quality of the project by getting them on board."*[74]

Opening of the MacRitchie Reservoir demonstration site.
Deputy Prime Minister, Teo Chee Hean at the official opening of the site.
Photo Courtesy of PUB, Singapore's National Water Agency.

Starting with the reorganisation of PUB, various policies thereafter were built up towards the implementation of the ABC Waters Programme in 2006. A natural policy trajectory was established unintentionally as PUB began to embrace sustainability in its everyday operations and, more significantly, to include the public in making Singapore's water resources more resilient. Furthermore, the evolution of waterways in Singapore from being functional, concrete canals to reduce flood risks in urban built-up areas, to becoming a part of the nation's water catchment system had showcased the importance of innovating systematically whenever the technology became available. In the early days, the high risk of floods and developmental issues spurred the government to concentrate efforts on building functional drains then. However, as the country progressed and bread-and-butter issues became less pressing in the 2000s, the time became ripe to delve into new policies that complemented the older infrastructure. The Drainage Department and later PUB were not afraid to innovate where necessary and took on bold and challenging projects to push the boundaries. Khoo Teng Chye was then CEO of PUB, and his previous experience in planning and urban development would eventually lead him to push for the ABC Waters Programme to revive the agenda of the earlier Waterbodies Design Panel.

CHAPTER 2

THE ABCS OF WATERBODIES: FORMULATING THE ABC WATERS PROGRAMME

> The fundamental hasn't changed. Canals and drains make sure Singapore doesn't flood. That will still remain the primary function of the watercourses, and that's where it added the challenge to the engineers and the designers; you need to prevent flooding and yet at the same time, make it look beautiful. It's much easier to build a concrete drain and water goes out, but it's not nice. We had to add all the flowers and all the grass, and still make sure it doesn't flood.

Wong Kai Yeng, former Director of Planning & Policy, PUB[75]

THE UNTAPPED POTENTIAL OF WATER

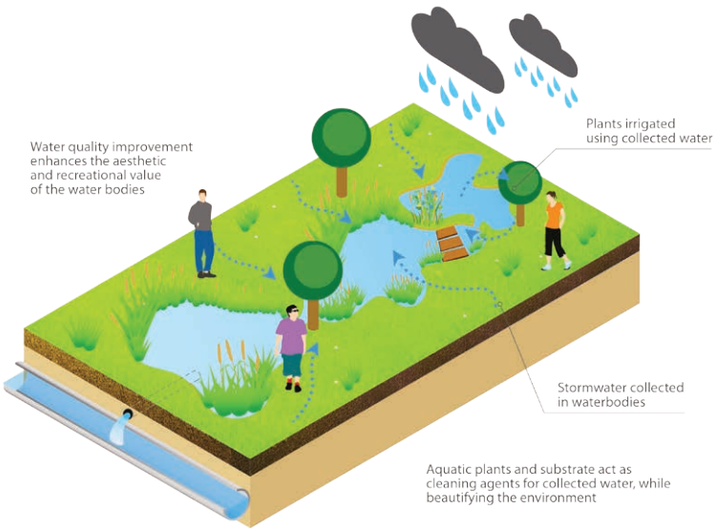
Concrete waterways are necessary features in Singapore's highly developed urban landscape, as they perform the crucial function of transporting storm discharge in limited urban space. Due to the nature of Singapore's climate, these monsoon canals tend to be empty and thus very unattractive during dry seasons. Over time, planners saw the role of waterways and waterbodies expand beyond their drainage function and have formulated plans accordingly to tap the potential of these waterways to enhance the urban environment.

For example, the Singapore River was cleaned through a 10-year master plan initiated in 1977 by then Prime Minister Lee Kuan Yew. Beyond the technical aspects of the clean-up, there was a strategic effort to tackle pollution at its source. This saw the removal of slums and squatters, and the resettlement of pollutive industries, which essentially led to the entire catchment being cleaned up.[76] As a result, a bustling waterfront district within the city centre emerged, with the development of pubs, restaurants and shops along the river banks.[77] This example showcases one way to tap the potential of waterways in enhancing the urban landscape, as opposed to earlier developments, which tended to avoid the waterfront areas:

> *"If you look at the old developments along Singapore River, especially in the days when nobody really wants to have anything to do with the river, other than if you have business to do down there, the warehouses, the bumboats and so on. But if they were building a shopping centre like Liang Court, the last thing you want is to have your front facing the river, because it's... not nice to look at, and [it's] smelly, and it's filthy. Their frontage, the best part of the building, actually faced River Valley Road, and the part that is facing the Singapore River is... a car park or something like that."*
>
> Yap Kheng Guan, former Director of 3P Network, PUB[78]

Partly fuelled by the 1991 Concept Plan, which sought to bring out Singapore's characteristic as an island, plans were developed in the 1990s to interweave waterbodies with the urban landscape.[79] This era saw a shift towards the more qualitative aspects of beautifying Singapore. Specifically, planners from the Urban Redevelopment Authority (URA) understood the role of water in this pursuit. The Waterbodies Design Panel (WDP) completed a few demonstration projects during this period, most notably in residential areas, where it showed the potential of beautified waterways and waterbodies in rejuvenating entire residential areas.

As demonstrated, Singapore was no stranger to embracing waterbodies and waterways, and integrating these drainage features into the urban fabric. The Active, Beautiful, Clean (ABC) Waters Programme is part of a long term master plan to tap the potential of multi-functional waterways—with the design features being planned at a catchment level and implemented. Prior to the ABC Waters Programme, efforts to integrate water with the urban sphere tended to be overtly on a micro-scale, with initiatives being concentrated at one location, or a few select locations island-wide. The vision of the 1991 Concept Plan was never properly attained due to the lack of institutional frameworks. Herein lay the difference with the ABC Waters Programme; the ABC Waters Programme was an island-wide initiative from the start with PUB, Singapore's National Water Agency (PUB), leading efforts to implement the programme.



The ABC Water Design Features.
Implementing the ABC Waters design features within developments would improve the quality of stormwater surface runoff while beautifying urban environments.

Diagram Courtesy of PUB, Singapore's National Water Agency.

The Kallang River @ Bishan-Ang Mo Kio Park.
The ABC Waters flagship project at Kallang River @ Bishan-Ang Mo Kio Park showcases the potential of water as an environmental asset.

Photo Courtesy of PUB, Singapore's National Water Agency.

The creation of recreation spaces unmarked by boundaries was one clear potential of this programme. The ABC Waters Programme was conceived with the idea of overcoming physical boundaries involved with planning to integrate landscapes seamlessly with water, to create beautiful waterfront spaces for public recreational use. Previously unused spaces on the drainage reserves could be transformed into attractive promenade areas with park furniture, encouraging recreational and community usage. Where possible, bureaucratic boundaries were blurred as various agencies came together to merge land previously zoned for green spaces or residential use with blue spaces. The ABC Waters Programme had the potential to unlock the full value of concrete waterways, which tended to remain as bare waterways devoid of any form of life. The programme offered the opportunity to beautify the urban landscape in many parts of Singapore. This, of course, meant that residents could enjoy beautiful waterfront views at their doorstep. The programme also offered the potential to turn waterways into an educational tool—as "outdoor classrooms" to educate the public on the merit of water consciousness and, more importantly, the need to keep waterways clean.

Beyond its potential to transform living environments with beautiful waterways, the ABC Waters Programme offered homeowners the prospect of increasing property values and this helped PUB gain more public support.[80]

The merits of the ABC Waters Programme would later be expanded to include benefits that were accrued to the public and private sectors. In 2010, PUB launched the ABC Waters Certification Scheme to recognise the work by public agencies and private developers who had embraced ABC Waters design features in their developments. The inclusion of ABC Waters design features in the Building and Construction Authority (BCA) Green Mark scheme would further incentivise the private sector in later years.[81] Such schemes have increased the adoption of ABC Waters design features within new developments, contributing to PUB's success in encouraging the uptake of the ABC Waters concept.

The ABC Waters Programme showcases the shifting paradigms within PUB, from a focus on utilitarian measures to one that appreciates the social, and often intangible value of blue spaces in Singapore. Land scarcity in Singapore drives constant innovation to ensure the efficient use of land. In this spirit, the ABC Waters Programme blurs the lines in typical land-use planning and, instead, encourages the integration of various land infrastructure with existing green and blue spaces. Above all, the implementation of the ABC Waters Programme gives concrete canals a new lease on life—a function beyond conveying stormwater.

BUILDING POLITICAL SUPPORT

The idea to revive efforts to beautify waterways received ample political support from the onset. Two of the political leaders in favour of the ABC Waters Programme were Dr Yaacob Ibrahim, then overseeing Ministry of the Environment and Water Resources (MEWR), and the late Lee Kuan Yew, who was then Minister Mentor.[82] The support of key political leaders was important in ensuring that the programme was approved in Cabinet and subsequently funded by the Ministry of Finance (MOF).

Timing was an important factor in obtaining this support for the ABC Waters Programme.The successful opening up of the waterbodies in 2004 for recreational activities propelled the move towards a large-scale master plan to harness the potential of waterways. The ABC Waters Programme was pursued along with other important goals such as enlarging the water catchment to boost water supply, while adding a human dimension to managing our water resources. In anticipation of not being able to keep people out of the water in future reservoirs like the Marina Reservoir, which would be located next to the city centre, the ABC Waters Programme was seen as a preemptive move. From a policy perspective, this was an attractive window of opportunity which was rightfully and strategically tapped by PUB to ensure the implementation of the programme.

At the forefront of this policy was Khoo Teng Chye, who was then Chief Executive Officer (CEO) of PUB. With his previous experience as CEO and Chief Planner in URA, and later with WDP, he ensured that the engineers in his organisation understood the full benefits of merging water with land use—by illustrating the potential of the ABC Waters Programme in helping PUB manage water resources more efficiently, rather than simply being an urban beautification project.

INITIAL RESERVATIONS

Despite support from these leaders, there was a lot of scepticism about the ABC Waters Programme. There was a need to convince the Members of Parliament (MPs) of the potential and feasibility of the programme. These MPs would play crucial roles in getting grassroots leaders involved in adopting completed ABC Waters sites, such as by encouraging the community to enjoy the ABC Waters sites and related facilities in a responsible manner. To ensure the implementation of the ABC Waters Programme, PUB set up an inter-agency working committee and held monthly meetings with various stakeholders to resolve issues.[83] Tan Nguan Sen, then Director of the Catchment and Waterways Department in PUB, recalled speaking to MPs over lunch during parliamentary sessions to explain the ABC Waters Programme to them.[84] This continuous engagement with stakeholders would prove to be an important step in ensuring the success of the ABC Waters Programme in the later years.

The support of key political leaders and the vision of a driven CEO were vital factors in securing the approval of this programme at Cabinet level. At its inception, the ABC Waters Programme was envisioned to add another dimension to Singapore's move towards water sustainability, by capitalising on the potential of water to enhance various aspects of life.[85] Strong political support was also needed to ensure that the programme would be implemented smoothly over time.

PLANNING WITH PEOPLE: BRINGING PEOPLE CLOSER TO WATER

To a large extent, this project justified itself by its ability to enhance living environments through the beautification of concrete waterways throughout the island. The ABC Waters Programme had the potential to activate waterbodies and waterways as key recreational spaces and, in the process, bring people closer to water. The public was brought closer to water to involve them in efforts to keep waterways clean.This became of strategic importance over time as the drainage network doubled up as water catchment.

> *"Today, PUB collects and removes about 15 tonnes of litter daily from float booms that are installed at various river mouths. Litter from as far as Ang Mo Kio can end up in the Marina Bay. If one area becomes polluted with rubbish and waste, it can easily contaminate the water in other parts of the island. Be it in the city where we are converting the Marina Bay into a freshwater lake, or in the residential heartlands where we are bringing waterfront living to HDB neighbourhoods, we must make an extra effort to keep our waters clean. Then we can all enjoy beautiful waterfront settings in the city and in our homes."*
>
> Prime Minister Lee Hsien Loong[86]

Beyond getting the buy-in from key political appointment holders, PUB recognised the need for the public to be involved early in the formation of the ABC Waters Programme. PUB's previous public campaigns had had mixed success, and PUB knew that a bolder approach was needed to ensure the success of the programme.[87] Hence, PUB embarked on demonstration projects at various locations to prove the feasibility of the ABC Waters Programme.[88] These projects were important for gaining the initial buy-in from various political leaders and convincing the public of the potential of the programme in the early days—by showcasing the possibility of converting concrete canals into beautiful, recreational spaces while catering for drainage needs.

DEMONSTRATION SITES

Officially opened in 2008, the demonstration phase of the ABC Waters Programme started in Kolam Ayer, followed by projects in Bedok Reservoir and MacRitchie Reservoir. The demonstration projects were highly successful in gathering initial support for the programme. However, getting people involved in the management of water resources was no easy feat and was beset with challenges from the start. For example, PUB engineers were concerned that the cleanliness of water would be affected if waterbodies were opened for recreational use and exposed to bodily contact. Initially, a wading area was considered in the plans to rejuvenate Bedok Reservoir, but this was not implemented in the end due to concerns about hygiene stemming from primary contact activities.[89] Engineers persevered and innovated where possible, and a wading area was eventually built in the MacRitchie Reservoir site. This highlighted PUB's commitment to bring people closer to water with the ABC Waters Programme, as well as the organisation's flexibility in innovating and adapting plans according to site conditions.

Kolam Ayer demonstration site.
The Kolam Ayer demonstration site was officially opened in 2008.

Photo Courtesy of PUB, Singapore's National Water Agency.

According to Yap Kheng Guan, the Kolam Ayer ABC Waters demonstration project was important as it determined the success of the entire programme, and would later provide many lessons for the development of other waterways. This was partly due to the various characteristics present at the site that necessitated working with multiple agencies like Housing Development Board (HDB) and URA, and more importantly, was a key pilot effort by PUB to engage with the communities in adjacent residences:

> *"Kolam Ayer is going to be the test bed for many of the rivers and canals. You have the Sungei Kallang passing through it, HDB blocks, the Kolam Ayer HDB estates and all that. Most of the people you talked to before hardly even looked at the river, hardly walked along the river even though we have clean water already. But it is not one of the things that they would want to do naturally. It was quite a waste since it's actually a really nice waterfront. So we said, okay, let's give it a try and we came up with our plans."*[90]

BUILDING RAPPORT WITH THE PUBLIC

In 2006, then Permanent Secretary of MEWR, Tan Yong Soon, suggested the need to create more publicity for the upcoming projects through public exhibitions, which would serve to educate the public on the ABC Waters Programme.[91] This saw the implementation of a larger public relations (PR) campaign to promote the ABC Waters Programme and the creation of a slew of communication strategies to reach out to the masses. In 2007, the ABC Waters Exhibition was launched to invite the public to learn more about the programme; and the ABC Waters Master Plan was unveiled concurrently. The six-day exhibition was a success as residents were generally excited about the projects coming up near their estates.[92] This leveraged a range of unique communication strategies that had been developed earlier to raise awareness of PUB's programmes. Even before the launch of the ABC Waters Programme, PUB's mascot, Water Wally, was developed in 2005. A lifestyle magazine, "PURE", was published

The ABC Waters Exhibition.
Prime Minister Lee Hsien Loong launched the ABC Waters Exhibition on 6 February 2007 at the Asian Civilisations Museum as a means to invite the public to learn more about the programme.

Photo Courtesy of PUB, Singapore's National Water Agency.

alongside the production of a game show aptly titled the "ABCs of Water", which was aired on primetime television as a means to gain more public traction to the ABC Waters Programme.[93] An easy-to-remember name was formulated by then CEO of PUB, Khoo Teng Chye, who coined the terms "Active", "Beautiful" and "Clean."[94] The "ABC" acronym was catchy and, with the right PR campaigns, helped to extend the reach of the programme to the masses.

PUB's mascot, Water Wally.
Launch of PUB's mascot, Water Wally, in 2005 to engage and educate the public on water consciousness and sustainability.

Photo Courtesy of PUB, Singapore's National Water Agency.

Television show, "ABCs of Water".
A game show titled "ABCs of Water" was launched in 2006 to extend the reach of the ABC Waters Programme to the masses.

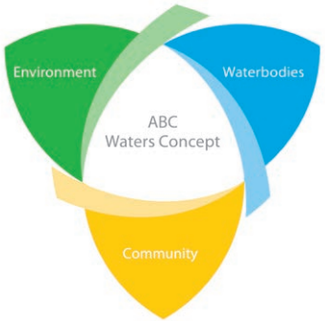
Photo Courtesy of PUB, Singapore's National Water Agency.

It was necessary to engage the community so that these projects did not end up becoming white elephants after redevelopment in the absence of the crucial buy-in from the masses. To ensure the success of the ABC Waters Programme, PUB knew that it had to tailor its PR campaigns according to different site characteristics and, more importantly, showcase the possibility of integrating these waterways and waterbodies into people's everyday life, where they become usable social and recreational spaces:

> *"Just like as Kolam Ayer [has] shown that if we had not engaged the community, the people who were living near the estates and who are going to be beneficiar[ies] of this project, then it may turn out to be another white elephant. But the fact that we did, got them very excited... before the project, during the project and after the project, they continued to really see this as part of themselves. In other places where there are no nearby neighbourhood[s], it could be just like Bishan Park, where it is more like the public kind of project that is where you need that larger audience... the buy-in from the larger audience.... In some sense, you have to be very localised, but many of the projects are actually very general. And a public exhibition was necessary for that reason, and for the reason that we also wanted people to understand that if we get this thing right, water is going to be a feature of Singapore's life."*
>
> Yap Kheng Guan, former Director of 3P Network, PUB[95]

Understanding the importance of public communications in propelling the success of PUB's policies that were increasingly public facing, the communications team was formally set up with new communications experts and was headed then by Yap Kheng Guan, who would later oversee the organisation's 3P network.[96] There was a general paradigm shift in the way PUB communicated with the masses in regard to water policies. The ABC Waters Programme was one such initiative with a heavy emphasis on public outreach. Communication strategies that were set up before the ABC Waters Programme was implemented in 2006 provided the necessary foundation for the successful implementation of the programme later on. Overall, there was a belief that engaging people and making them stewards of Singapore's waterways was an effective way to ensure long-term sustainability in managing Singapore's water resources.

"LET'S GET IN FORMATION!": SETTING UP THE 3P NETWORK



The ABC Waters Concept.
The ABC Waters Programme aims to integrate the Environment, Waterbodies and the Community seamlessly to create new community spaces around existing waterbodies.

Diagram Courtesy of PUB, Singapore's National Water Agency.

Even before the launch of the ABC Waters Programme in 2006, a dedicated team was set up within PUB in 2005 to oversee an integrated approach in dealing with various stakeholders. The 3P (People, Private, Public) Network was created to engage people and the private and public sectors holistically to give life to PUB's water management projects. The 3P Network would later form the backbone of the ABC Waters Programme, which took a tri-sector approach to bring together and work with multiple stakeholders.

Yap Kheng Guan, who was appointed as Director of the 3P Network in 2005, recalled the general shift in PUB's approach in managing water resources in the mid-2000s:

> *"[T]he thinking was mooted that we should push for a much more aggressive programme to engage the public. If you like, to almost make water a national consciousness, to have people having a relationship with water. That's how 3P was formed."*[97]

Although Mr Yap lacked experience in PR communications, the employment of a dedicated communications team helped PUB with the implementation of a more rigorous public engagement programme. Mr Yap's previous role as a senior engineer helped align the communications messages within PUB's operational and institutional context.[98]

Beyond the involvement of people, as previously discussed, the 3P Network was a broader approach that also included the public and private sectors in the management of water resources. For instance, the Inter-Agency Working Committee (IAWC) was set up to coordinate the planning of projects amongst various agencies such as PUB, HDB and National Parks Board (NParks). This ensured that the agencies supported the ABC Waters Programme by incorporating ABC Waters design features into upcoming developments:

> *"[I]t's very important that we actually work together with other agencies and also try to catch them when they are doing the development next to the river because then... it's more cost effective, you actually spend less and you get greater results."*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[99]

At the institutional level, the support of other agencies was crucial for the success of the ABC Waters Programme. The programme sought to integrate various landscapes seamlessly and this required not only effective coordination with other agencies, but also their expertise. As the project would inevitably extend beyond the boundaries of PUB's drainage reserves, there was a need for other agencies to work with PUB to formulate the initial plans. Tan Nguan Sen recalled chairing monthly meetings with representatives from the agencies that would oversee the ABC Waters master plan, and deliberating with them on the possibility of these developments.[100]

The 3P Network actively encouraged the involvement of the private sector. To tap the expertise of the private sector for the development of ABC Waters projects, PUB set up the ABC Waters Review Panel, which consists of top architects, engineers and developers.[101]

Ultimately, the 3P Network has played a crucial role in bringing together various stakeholders for the development of ABC Waters sites. The ABC Waters Programme was initiated with the 3P Network as an underlying strategy. This approach would evolve, but remains a linchpin of the programme. As Tan Yok Gin, then PUB's Director of Policy, puts it, "The whole ABC Waters Programme in itself is a 3P initiative; it's a 3P activity."[102]

FLOATING THE ABC WATERS MASTER PLAN

The nature of the ABC Waters Programme—one that was highly collaborative at a national scale—meant that there was a need to formulate a master plan to coordinate efforts and ensure the overall success of the programme. PUB dipped its toes into the ABC Waters Programme carefully, considering the potential cost of the programme and, more importantly, the feasibility of the projects. There was a need to work with consultants, many of whom had had experience with the implementation of ABC Water design features that are crucial for the continued success of the programme. Khoo Teng Chye highlighted the importance of institutionalising the ABC Waters Programme through the formulation of a master plan—much like the Park Connector master plan of NParks:

> *"The park connector is a very simple idea. NParks started to do it in the late [19]80s, at the same time that Waterbodies Design Panel started – and that is the value of institutionalising this – because NParks took it and took ownership. NParks drew up a master plan of how we are going to develop all the [300 kilometres of] park connector systems in Singapore."*

An ABC Waters master plan was drawn up, identifying more than 100 potential projects that could be implemented in phases by 2030.[103] This was done before approval was obtained from the government, as it was a means to showcase the potential of the waterways and waterbodies and thus justify the cost of the programme.[104] The master plan divided Singapore into three distinct catchments: the Western, Central, and Eastern catchments. These catchments were identified based on a number of criteria. Firstly, each catchment presented unique physical characteristics. For instance, the Western catchment had a predominantly industrial land use, while the Central and Eastern catchments were more commercial and residential, respectively.[105] Hence, PUB decided to engage three consultants, one for each catchment area, to plan for ABC Waters sites in line with each catchment's land-use characteristic and topography.

Secondly, it was decided internally that three consultants would be the optimal number to work with, to ensure the success of the programme while working within an institutional framework.[106] For PUB, the engagement of consultants at such a scale was unprecedented and there was a need to manage them systematically. The consultants brought with them a multitude of experience and, more interestingly, approached the development from a more inter-disciplinary perspective—this ensured that the ABC Waters Progamme would be more than just an engineering project.

Black & Veatch, CH2M Hill and CPG Consultants were appointed as consultants for the Western, Central and Eastern catchments, respectively.[107] The consultants would devise concepts for the various catchments, which PUB would then develop further with the help of other agencies—mainly to dovetail proposed projects with upcoming and existing developments by other agencies.[108] The ABC Waters master plan would later form the basis for PUB to seek government support and, eventually, funds from MOF. Almost 100 sites were identified in the initial master plan, with development spanning 20 to 30 years—this would form the institutional basis for the success of the programme in the later years.

LEARNING FROM OTHER CITIES

Beyond the private sector, PUB also looked externally for research partnerships and towards cities that had implemented similar programmes successfully. A learning exchange was conducted with Melbourne Water[109] to look into their case studies of successfully executed Water Sensitive Urban Design.[110] The exchange with Melbourne Water was highly useful for drawing up technical plans for the ABC Waters Programme. In particular, their experience with Water Sensitive Urban Design was important in determining ideas that could work and be implemented in Singapore. This convinced PUB's engineers of the potential of these techniques, even though many of them had been skeptical of the use of bioengineering treatments for waterways:

> *"[T]hey have this programme called the Water Sensitive Urban Design and the CEO introduced me to this person named Tony Wong. I got Tony Wong in... because he is an engineer [and] you need this type of people who can bridge. He was able to almost write a code of practice of how you do ABC Waters, so that our engineers can be satisfied. The engineers need to be satisfied [about the technical viability before you can get them] to do all these funny things, like turning a concrete canal [in]to a meandering river through a park, and to calculate whether the meandering river is doing the job of making sure [that] there is no flooding"*
>
> Khoo Teng Chye, former CEO, PUB[111]

THE SUSTAINABILITY OFFICE AND THE ABC WATERS PROGRAMME

Learning from the failure of WDP in the 1990s, then CEO of PUB, Khoo Teng Chye, stressed the importance of institutionalising the ABC Waters Programme. There was a need for PUB to take charge of the programme and implement it systematically through an overarching master plan that allocated a master planner to be in charge of each catchment.[112] This would ensure the success of the programme in the later years, unlike the WDP projects that petered out due to the lack of an institutional framework.

The ABC Waters Programme was initially placed under the Catchment and Waterways Department within PUB, headed by Tan Nguan Sen. At the onset, this made sense as the programme involved working in close collaboration with the drainage and reservoir divisions to plan for the early projects. In 2014, Mr Tan would lead a new department called the Sustainability Office that would oversee the ABC Waters Programme as part of PUB's environmental sustainability efforts. This was done to establish a more directed approach to ensure the longevity of the ABC Waters Programme, away from the more operational work that the drainage and reservoir divisions dealt with.[113]

EVOLUTION OF THE ABC WATERS PROGRAMME

The presence of a master plan and a dedicated team of consultants helped to drive the development of the ABC Waters Programme. PUB was also strategic in the way it implemented the programme, especially in the sequence of its projects, to ensure that they were able to garner both public and political support.

The completed ABC Waters sites started with signature projects to garner buy-in from the public. Projects integrated with drainage improvement works were also added to the list of completed projects, and the latest focus was projects within the heartlands.[114] Chief Sustainability Officer, Tan Nguan Sen, stressed the importance of piloting with the signature projects in the early days. These were essentially big, flagship projects that got the buy-in from the masses and showed the political leaders that the ABC Waters Programme was a feasible development project.[115]

> *"[I]t's important in the first phase that you get the buy in. You must do these projects and then of course, make sure it's successful. Once people see that it works, you know, and once you finish, you can see the place become an attractive place for people to come, then people will like it. That was the initial phase, the phase one projects."*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[116]

The successful implementation of these early signature projects led to the development of ABC Waters sites that were done in tandem with drainage improvement works. More recent ABC Waters projects have focused on enhancing liveability in residential areas. As of June 2017, 36 projects have been completed. All projects were conceived taking into account various factors from a multi-disciplinary perspective, such as land-use plans, demographics, hydrology, as well as historical and cultural considerations. Careful, measured steps ensured the successful formulation and implementation of the ABC Waters Programme. PUB also had the foresight to learn from past lessons and worked to ensure that the programme was overseen by a dedicated team over time.

Yishun Pond near Khoo Teck Puat Hospital.
The Yishun Pond has been transformed into a multi-generational, health-promoting park especially for patients at the nearby Khoo Teck Puat Hospital.

Photo Courtesy of Centre for Liveable Cities.

CHAPTER 3

FLOATING THE IDEA: IMPLEMENTATION AND CHALLENGES

> PUB can't go alone; we can't go alone... It was a challenge working with other agencies, because different agencies [have] different objectives. But then, we are glad that we are able to come together and deliver a lot of these projects.

Tan Yok Gin, Deputy Chief Executive (Operations), PUB[117]

FROM FRIENDLY FIGHTS TO SUCCESSFUL COLLABORATIONS

"I think we did come up with a lot of things ourselves, because many countries were not solving their flood problem, and we did not say, 'Well, others' [problems] were not solved, so we are one of them.' But on the contrary, we were very determined and we were very confident that we will solve our flood problem... We kept our heads down and [tried to] get the facts right about the catchment, also kept ourselves linked into the whole ecology of the planning systems, worked very closely with HDB, URA, JTC, the Planning Department, other agencies and even utility agencies. We worked very, very closely with them, it's like anything that we do, we will consult them. Anything that they do, they will consult us."

Moh Wung Hee, former Director of Best Sourcing & Deep Tunnel Sewerage System, PUB[118]

Productive collaborations played a key role in ensuring the successful implementation of the Active, Beautiful, Clean (ABC) Waters Programme. The effective partnership of the PUB, Singapore's National Water Agency (PUB) with other agencies, the private sector and the public (see "Let's Get in Formation!": Setting Up the 3P Network in Chapter 2) allowed the smooth implementation of projects under the ABC Waters Programme. The nature of the programme necessitated the blurring of administrative and planning boundaries, and cooperation between agencies was of utmost importance in bringing life to the ABC Waters master plan. Beyond the ABC Waters Programme, this successful collaboration between the different agencies and stakeholders illustrates the potential benefits of rethinking the way Singapore's urban fabric is planned.

The Urban Redevelopment Authority (URA) master plan zones land use in Singapore and allocates land to various agencies for development. Agencies would inevitably try to defend whatever land space allocated for their own development purposes. For example, Moh Wung Hee recalls the importance of reserve land to the Drainage Department in the early days:

> *"We planned our drainage reserves and these were literally etched into what we call the land block sheets, we called them the litho sheets. The land block sheets show where are the land boundar[ies]... where are the plot boundar[ies] and we mark in them. Literally, in those days, it's all paper. And then we safeguarded all this land, reserves for all land developments."*[119]

The ABC Waters Programme provided an opportunity to break out of this silo thinking and develop a truly integrated landscape. One means to encourage and facilitate this integration was to ensure that there was an avenue to exchange knowledge between agencies. For instance, the Chief Executive Officer (CEO) of National Parks Board (NPark) then, Ng Lang, was highly supportive of the ABC Waters Programme. Strategically, this was important for the success of the programme, since there was ample potential for PUB and NParks to collaborate and learn while making the ABC Waters plans a reality. Moreover, enlightened leaders set the vision for such projects, and were instrumental in driving them. Nevertheless, there was a lack of technical experts who could implement these grand plans, especially within PUB.

INTER-AGENCY EXCHANGE

Through the strong links between both agencies' CEOs, PUB could leverage NPark's landscape planning expertise to ensure the realisation of its plans. Specifically, Khoo Teng Chye recognised the importance of working with landscape architects from NParks to ensure the success of the ABC Waters Programme. Damian Tang, then a landscape architect at NParks, was sent to PUB in 2008 to assist with the initial drafting of ABC Waters plans during a six-month secondment. He brought highly-valued expertise that PUB required since the organisation was mostly made up of engineers.

PUB capitalised on this secondment as a means to ensure that plans under the ABC Waters Programme would be realised. This stint was also useful for Damian Tang, who through his time in PUB understood the work of engineers, especially in planning drainage systems in Singapore, having worked on conceiving a master plan for developing the Kallang River earlier.[120,121] This exchange of knowledge bore fruit in the years that followed, with the successful redevelopment of Bishan-Ang Mo Kio Park as one of the flagship projects under the ABC Waters Programme. This culture of working closely with other agencies and stakeholders, particularly in areas that PUB had no expertise in, would set the precedence for a committed working environment within PUB, ensuring the long-term success of the ABC Waters Programme.

Bird's eye view of the rejuvenated Bishan-Ang Mo Kio Park.

Completed in 2011, the rejuvenated Bishan-Ang Mo Kio Park features a meandering waterway flanked by park land that serves as a floodplain during wet weather and as a recreational space during dry weather.

Photo Courtesy of PUB, Singapore's National Water Agency.

"[The] early years was all about PUB doing things. And with the ABC Waters Programme, we have to kind of make sure that people understand, it is a very inclusive programme. It's not just PUB working on it, and even if PUB [is] working on it, it is not working alone, because it cuts across a lot of agencies.... Even the projects like Kolam Ayer, Bedok, MacRitchie, we need NParks, we need URA, we need HDB, we need People's Association. And that is again... one of the first few times where government agencies had to think very carefully about working together with other agencies. It becomes... very multi-dimensional... it's no longer [a] straightforward drainage project."

Yap Kheng Guan, former Director of 3P Network, PUB[122]

REJUVENATING BISHAN-ANG MO KIO PARK (2009)

"[In] Bishan-Ang Mo Kio Park.... When it rains, there is no flood, but when it doesn't rain, everybody appreciates the greenery and the park. We bring visitors just to take a look at it and they love the integration... That's quite satisfying. There is no compromise in meeting technical requirements, and we don't need to do it at the expense of the environment."

Wong Kai Yeng, former Director of Planning & Policy, PUB[123]

Prior to the launch of the ABC Waters Programme at Bishan-Ang Mo Kio Park in 2009, the park was a typical green space that was constructed to act as a buffer between the residential estates of Ang Mo Kio New Town and Bishan New Town. It was bounded on one side by a 2.7 km-long concrete canal that served the purpose of efficient drainage and flood control during heavy downpours. Built in 1988, the park was due for major refurbishment and the canal for upgrading in the early 2000s. A decision was eventually made to carry out the redevelopment works to naturalise the linear canal into a meandering river, and in doing so, create a seamless blue-green network with new community spaces. Moreover, then CEO of NParks, Ng Lang suggested combining the resources and budgets of both agencies for the rejuvenation of both the park and canal concurrently. The idea to create an integrated landscape arose from the broader Kallang River master plan, where certain nodes were identified for potential rejuvenation.

"It is not just about beautifying the canal. It is about looking at the canal and the park together; what opportunities [can be] created by running the canal through the park?"

Khoo Teng Chye, former CEO, PUB[125]

Hailed as the flagship project of the ABC Waters Programme, the transformation of Kallang River at Bishan-Ang Mo Kio Park has produced meaningful and valuable outcomes. Today, the park is teeming with life. Besides additional spaces for *tai chi* and improved lawns for picnics and sports, the ABC Waters project has created new lifestyle activities. Whereas residents were previously separated from the park by a utilitarian concrete canal, they are now able to go down to the river to play with the water and fish for guppies during dry weather. A community-initiated butterfly habitat has also been created, where the planting of butterfly-attracting plants has attracted butterflies of many different species. Furthermore, the park's biodiversity has increased with regular sightings of dragonflies, water hens, egrets, purple herons, and smooth-coated otters. The bioengineered river has also increased water conveyance capacity.

The revamped park opened in March 2012, and was awarded the Landscape of the Year Award at the World Architectural Festival Awards, the Environmental Award at the Waterfront Center Awards, and the President's Design Award in Singapore. The rejuvenation of Bishan-Ang Mo Kio Park showcases the success that dedication of the right people can bring, as they turn a bold vision into reality. More importantly, it demonstrates that bringing together various agencies and the private and public sectors in an inclusive manner can create truly integrated, spectacular landscapes.

"IT'S NOT FLOODING, IT'S A FLOODPLAIN!": CHALLENGES OF THE BISHAN-ANG MO KIO ABC WATERS PROJECT

A massive and progressive project under the ABC Waters Programme, implementing the plan to rejuvenate the Bishan-Ang Mo Kio Park was not without difficulties. Both PUB and NParks faced three main challenges. Firstly, there was a need to break down barriers. Prior to the redevelopment, there were very distinct boundary lines that demarcated the areas each agency was responsible for. This was typical of various planned spaces in Singapore. Integrating Kallang River with the adjacent park and residential estates blurred these lines, and required PUB and NParks to work together to proactively understand each other's roles and responsibilities. The outcome of this collaboration was a beautiful waterway meandering through a green space. This integration allowed for the more efficient use of urban space that would otherwise have been locked away in the empty canal space during dry weather.

Faced with the blurring of boundary lines, PUB and NParks held discussions to establish common grounds and worked towards consensual goals that reflected the agenda of each agency—an example would be the naturalisation of the canal itself. While PUB's vision is to ensure an efficient, adequate and sustainable supply of water for all, NParks aims to create a quality living environment through excellent greenery and recreation. Both of these objectives were incorporated into the transformation of Kallang River, with extensive greenery planted along and within the river while the rejuvenated canal continues to function as a stormwater conveyance channel.

Meandering waterway in the Bishan-Ang Mo Kio Park.
Today, the park and the meandering waterway have been transformed into a vibrant recreational space.

Photo Courtesy of PUB, Singapore's National Water Agency.

Damian Tang, one of the lead landscape architects for the Bishan-Ang Mo Kio Park project, also recalls how the original plans for the rejuvenation had much more meandering of the waterway. While this plan would have created a more spectacular landscape, it would have resulted in many of the old and established trees being cut down and an increase in the cost of the project. Such trade-offs, although difficult, are often necessary in ensuring that developments can achieve the maximum potential for use.[126]

> *"When the Bishan-Ang Mo Kio Park project was planned, and the concept plan revealed the number of trees to be removed, it came as a shock. However, with [the] width of this canal, initially being just... about 15 metres I think, now took up more than 50 metres with a floodplain. I must admit NParks initially jumped at the potential loss of these trees. But we also understood the opportunity cost and weighed the desired outcomes of this project. So we have to ask ourselves, 'How can we minimise the loss of trees and at the same time plant more trees and better species to create greater values to this park?' There were some tough decisions at that time when we knew we wanted a great product but could not bear with the upfront loss. With some painstaking efforts to remodel the meanders to the best we can, we also managed to transplant some of the trees. But definitely some were lost. It was fortunate that all the decision-makers then, saw the big picture and saw how an initial compromise could actually give back more to the public at the end of its completion."*
>
> Damian Tang, Senior Director, NParks[127]

"IT'S NOT FLOODING, IT'S A FLOODPLAIN!": CHALLENGES OF THE BISHAN-ANG MO KIO ABC WATERS PROJECT

Secondly, early into the rejuvenation of Bishan-Ang Mo Kio Park, the need to reconnect people with nature was recognised. To create a place that the community could appreciate and call their own, there had to be platforms where people could develop a relationship with water and understand the importance of conserving water and keeping waterbodies clean. Prior to the launch of the ABC Waters Programme, PUB's outreach programmes have not engaged the public to this extent before. As illustrated in Chapter 2, the setting up of a dedicated team was one means by which PUB would ensure coordinated moves to include people in these plans.

PUB knew that the vision of sustainable water management would not be possible without the support of the community. This was particularly important for the project at Bishan-Ang Mo Kio Park, as the park was surrounded by dense housing estates. PUB therefore engaged the residents in the area from as early as the design phase, to help them understand the value of water and how to care for the park. This also ensured that residents were educated on using the naturalised canal in a responsible and safe manner, considering there would be no railing to segregate the canal and the park. Additionally, PUB encouraged schools to develop educational learning trails and provide experiential education so that students could learn how to appreciate water and keep the river clean. Students would gain insights into the unique bioengineering techniques put in place at the park, alongside broader lessons about water sustainability and the Four National Taps.[128]

Finally, ensuring that these rejuvenated canals worked during a storm event was of utmost importance to PUB. In redesigning the park, PUB and NParks engaged landscape architects from Ramboll Studio Dreiseitl, who were at the forefront of urban hydrology and stormwater management techniques, to work with engineers from CH2M Hill to realise the rejuvenation plans. A series of workshops, on-site tours, and discussions were organised, and ideas on ways to integrate the park, river, and surrounding residential estates were exchanged. One of the outcomes of this engagement was the successful adoption of bioengineering techniques. This approach of combining traditional engineering with natural systems is exemplified by the bioengineered river edges that use a variety of plants and bedding materials to stabilise the river banks and prevent exposed materials from being eroded. In addition, a cleansing biotope consisting of wetland plants was introduced to provide natural cleansing systems. Other park features include green roofs and vegetated swales, which slow down water conveyance and facilitate the removal of coarse pollutants. These systems are part of the ABC Waters design features, which utilise natural systems to detain and treat rainwater on-site before it flows into our waterbodies.

Concrete canal at the Bishan-Ang Mo Kio Park.
Before the implementation of the ABC Waters Programme, part of the Kallang River ran through this concrete canal, located where the floodplains are today.

Photo Courtesy of PUB, Singapore's National Water Agency.

MAINTAINING THE ABC WATERS PROJECTS

Historically, boundaries have played an important role in the management of built infrastructure in Singapore, ensuring that built infrastructure would not fall into disrepair, being under the control of their respective agencies. The introduction of the ABC Waters Programme challenged this mode of operation since the integrated blue-green landscape required new models of maintenance. By pushing and blurring existing boundaries, the ABC Waters Programme made it necessary for agencies to work together to devise new means to maintain waterways and the adjacent areas.

To ensure a seamless integration of design with the surrounding landscape, the geographical boundary of ABC Waters projects along waterways sometimes go beyond the drainage reserve. There was a need to win the local leaders over so that local town councils took over the maintenance of the facilities, amenities and any ABC Waters design features implemented outside the drainage reserve.[129]

> *"[At] that time, the project hasn't started and there were no completed projects for [Town Councils] for reference. In a way, there wasn't much resistance... That's why when we started building them, we had to actually get them on board to do the maintenance. Because if not, after you finish and you suddenly hand it over to them, and then, you can see all the pushback."*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[130]

The inclusion of greenery and landscaping meant that the cost of constructing waterways would increase, especially at initial construction stages. However, beyond the initial capital cost of construction, many of these ABC Waters design features actually require minimal maintenance since they function as natural systems. For example, bio-retention swales need to be checked to ensure that litter or sediment does not clog up the filtration medium and to ensure that the shape of the bioswale is maintained to allow for optimal function. This requires only routine inspection and maintenance of the porosity of the filter media when needed, on top of a landscaper to maintain healthy vegetation growth.[131] Routine cleaning is also recommended especially after a storm event, to clear any blockage from inlets, outlets and overflow points.[132] Designed as natural, green infrastructure that mimic natural processes and systems, ABC Waters design features should technically become cost-effective and self-sustaining in the long run.[133] Regardless of cost, there is an understanding that by creating new value for previously under-used waterways and waterbodies, the ABC Waters Programme has immense potential to improve the environment.[134]

Apart from cost concerns, the inclusion of ABC Waters design features in an integrated green and blue landscape also shifted or blurred existing boundaries within which the various authorities traditionally worked, which complicated the allocation of maintenance duties. Former drainage engineer Yap Kheng Guan recalls the issues faced with maintaining waterbodies and the adjacent areas, since various contractors were employed by different authorities to provide maintenance services in specific areas. Contractors would pick up rubbish from certain sections of the waterways and ignore other parts that were not within their area of responsibility.[135] Unsynchronised grass-cutting also resulted in the reserve areas looking unsightly, since town councils, NParks and PUB managed different parts of the reserve land.

The completion of more ABC Waters sites would only further complicate the maintenance regime. One way to work around this issue is to decide early on who the maintenance of the sites would fall under. With more sites being developed, PUB has learnt to communicate with its stakeholders better to ensure that waterways continue to be maintained in an efficient manner.

BUILDING CAPABILITIES: THE ABC WATERS CERTIFICATION SCHEME AND PROFESSIONAL PROGRAMME

> *"You have to develop the whole ecosystem in order for it to be sustainable. Besides PUB implementing projects, we get other agencies and private developers on board, but the important thing is that you must have the expertise, which means that you have to train up our local engineers and architects to be able to design such features."*
>
> Tan Nguan Sen, Chief Sustainability Officer, PUB[136]

ABC Waters Certification Programme.
The latest batch of awardees from the ABC Waters Certification Programme.
Photo Courtesy of PUB, Singapore's National Water Agency.

In line with the goal of ensuring the longevity of the programme, PUB recognised that there was a need to build capabilities through certification and professional programmes. In 2010, the ABC Waters Certification Scheme was launched to recognise public agencies and private developers that adopt ABC Waters design features in their developments. Projects are evaluated based on four design criteria, assessing their active, beautiful, clean and innovative elements. Beyond giving recognition, the certification scheme aims to encourage the uptake of ABC Waters design features in private and public-sector developments—extending the reach of the ABC Waters Programme beyond waterbodies and waterways for the first time.[137] As of April 2017, 62 projects have been accredited and this number is set to increase as more developers understand and appreciate the benefits of incorporating ABC Waters design features into their developments.[138]

To further encourage the incorporation of ABC Waters design features into built infrastructure, PUB teamed up with the Building and Construction Author (BCA) to dovetail the latter's Green Mark Scheme.[139] Developers can now obtain points for implementing ABC Waters design features under BCA's Green Mark Scheme, where buildings are awarded Green Mark ratings according to the total number of points accumulated. To entrench these planning principles and build up industry expertise in ABC Waters design, PUB rolled out the ABC Waters Professional Programme in 2011. This aims to ensure that there are suitably qualified individuals to undertake the design of these unique water features. PUB collaborated with the Institution of Engineers Singapore (IES) to launch the programme, with additional support from the Singapore Institute of Landscape Architects (SILA), Singapore Institute of Architects (SIA), Housing Development Board (HDB), Land Transport Authority (LTA) and NParks.[140] These are just some of PUB's initiatives aimed at increasing the uptake of the ABC Waters Programme and more importantly, building professional capabilities to ensure the longevity of the ABC Waters Programme beyond 2030.

GETTING INTO THE CLEAN BUSINESS: PILOTING JTC'S JURONG ECO-GARDEN

As Singapore's first eco business park, Jurong Town Corporation's (JTC) Jurong Eco-Garden[141] is a laboratory for the test-bedding and demonstration of clean technology solutions amongst many other research and development activities.[142] In line with the vision of the development, the Jurong Eco-Garden was developed within the business park, with ABC Waters design features like cleansing biotopes and bio-retention swales. Jason Foo, Deputy Director of JTC's CleanTech Department, recalls some of the conscious decisions made by JTC to preserve the natural elements of the site:

> *"While we have [had] some success in developing [Jurong Eco-Garden] as an ecosystem for clean technology, one of the key challenges while we were developing this new estate was to rethink how JTC typically master plans and develops our products. For a start, this is a picture of the original site condition. [Jurong Eco-Garden] is actually... secondary rainforest, so it's a greenfield development. One of the key challenges when we were assessing the site was that the site was not uniform, in the sense that it has undulating terrain, with high areas with a height difference of almost 20 metres. So if you look at the type of space that we have, areas in the high ground are very densely populated with vegetation. Areas in lower ground or low-lying areas are very sparse with natural water ponding.*
>
> *In a typical approach, what JTC would have done—it would have been much simpler if we had just done what we had previously—just to level off all the trees, dictate a platform level and start building infrastructure from scratch. But we adopted a different approach for [Jurong Eco-Garden]. I think that gives us an opportunity to see how we can balance economic consideration[s] when we are developing such [an] estate, with ecological consideration[s]."*
>
> Jason Foo, Deputy Director (CleanTech), JTC[143]

The adoption of ABC Waters design features was crucial in achieving the vision of developing Jurong Eco-Garden as a sustainable estate. Because these ideas were included upstream, early on in the planning process, Jurong Eco-Garden was successfully developed with the right balance between ecological considerations and economic needs, and it remains as the first-ever attempt at integrating a stormwater management system within a JTC estate.[144]

JTC's Jurong Eco-Garden.
Singapore's first eco business park is a test-bedding site for many clean technologies including ABC Waters design features.

CHAPTER 4

NAVIGATING THE FUTURE BEYOND 2030: MAINSTREAMING THE ABC WATERS PROGRAMME

> [W]hy does PUB want to get involved in [the ABC Waters Programme]? Actually, it's about social engineering. We know that the day will come when the larger part of Singapore will be a water catchment. You can't go around enforcing against water pollution. You can't be everywhere all the time, [and thus] public education is extremely important.

Tan Gee Paw, former Chairman, PUB[145]

In the span of a decade, the Active, Beautiful, Clean (ABC) Waters Programme has helped transform the urban landscape of Singapore by beautifying waterways and waterbodies, and making them accessible for all to enjoy. With the strong leadership of passionate leaders and the institutionalisation of the programme under PUB, Singapore's National Water Agency (PUB), the ABC Waters Programme continues to succeed in remaking utilitarian waterways into aesthetically pleasing environmental assets.

In the early days after independence, concrete drains and canals were developed as a necessity to solve the nation's dire flooding issues as quickly as possible and later, to support rapid urban development, with waterbodies serving as key catchment areas. Since then, the use of waterways and waterbodies has evolved through the ABC Waters Programme which is activating under-used blue spaces and integrating them into the environment as social and recreational spaces:

> *"It started off very functional. It was a life-and-death kind of issue, because in the 1970s, if you don't catch up with all this, Singapore will not be what it is today. It will cripple a lot of things if flooding still continues to be a big problem. Fortunately, we took the right steps and worked hard and then we have what it is and that allowed us to go... further with clean water [and] ABC Waters Programme, adding on [as a] feature of Singaporean life."*
>
> Yap Kheng Guan, former Director of 3P Network, PUB[146]

These blue spaces continue to serve the critical function of drainage, but now also double up as environmental assets that enhance residential areas and complement green spaces while serving as educational tools to increase awareness of water-related issues to the public while bringing them closer to water. The programme has been successful at encouraging communities to take ownership of Singapore's waterways and waterbodies with 321 active partners adopting ABC Waters sites, as of March 2017. In short, this programme showcases just how water is a vital ingredient for the development of liveable cities.

In charting the journey of the ABC Waters Programme and the evolutionary trajectory of Singapore's waterways, we have learnt many crucial lessons. Dynamic urban governance is one key lesson from the ABC Waters Programme—the PUB understood the importance of working with other agencies and involved them accordingly to create visionary integrated landscapes. PUB was not afraid to work with markets when necessary to ensure that plans were executed efficiently. Furthermore, the successful implementation of the programme showcases the importance of reaching out to public stakeholders. By encouraging members of the public to be stewards of water, PUB has managed to design a sustainable method to ensure that waterways and waterbodies remain clean. Despite having to realign mindsets and work processes, PUB has managed to find ways to work with the public and involve them in the management of Singapore's scarce water resources.

Moving on, what is next for the ABC Waters Programme? In comparison to the 50 years spent on greening Singapore, it has been a mere 10 years since the launch of the ABC Waters Programme and Singapore is still far from fully unlocking the potential of water as an environmental asset. Herein lies a wealth of opportunities to upscale, further entrench and institutionalise the programme by adopting planning norms. When ABC Waters design features are no longer seen as add-ons but as part of planning norms in the upstream policy process, Singapore's planners will be better equipped to seamlessly integrate blue and green components into their water plans. PUB already has established design guidelines that help to frame technical guidelines. This, coupled with the ABC Waters Certification Scheme, will help to incentivise the private sector to build ABC Waters design features into their developments. This will also encourage other public agencies to incorporate such water features into their projects.

With these objectives in mind, a forum was organised by the Centre for Liveable Cities in 2015 to discuss strategies for mainstreaming the ABC Waters Programme. This forum brought together various government agencies and the private sector. By the end of that inaugural forum, an inter-agency taskforce chaired by the Urban Redevelopment Authority (URA) and PUB was set up to spearhead efforts to mainstream the ABC Waters Programme. The successful design and development of the man-made Punggol Waterways in Singapore's first eco-town by Housing Development Board (HDB) demonstrates what can be achieved through mainstreaming the ABC Waters Programme, where ABC Water design features are designed upfront in the planning process. With careful planning, a clear vision and inter-agency coordination, Singapore can truly become a City of Gardens and Water.

EVOLUTION OF SINGAPORE'S WATERWAYS AND WATERBODIES

1960

1966
- **Bukit Timah Flood Alleviation Scheme implemented**. Large drains and canals were constructed to flush out flood waters from Bukit Timah to the sea. This would later reduce flood risk in this area.

1969
- **Floods of 1969**. One of the worst flood events in Singapore; floodwaters wreaked havoc across the island, and five lives were lost. About 3,000 people were made homeless during the two and half days of incessant rain.

1970

1972
- **Drainage Master Plan implemented**. To mitigate against increased flooding risks that might occur with the development of new towns by the Housing and Development Board and industrial development programmes by the Jurong Town Corporation, there was a need for a designated drainage planning and control strategy. In close collaboration with other development agencies, a drainage master plan was drawn up to guide the provision of drainage systems, and to set aside drainage reserves for future requirements.

1980

1989
- **Waterbodies Design Panel set up**. Chaired by the Urban Redevelopment Authority, the panel assisted in evaluating waterbodies linked to developments and assessing the aesthetic treatment of these developments along major waterbodies. Projects included collaborations with the Ministry of the Environment's Drainage Department to transform Sungei Api Api and Sungei Kallang.

1990

1991
- **Concept Plan.** The 1991 Concept Plan emphasised the tropical island identity of Singapore and promoted the enjoyment of nature through the implementation of a Green and Blue Plan.

2000

- **Waterbodies Design Panel dissolved.**

2001

- **Reorganisation of the Public Utilities Board (PUB).** PUB was transferred out of the Ministry of Trade and Industry, where it oversaw water supply needs alongside energy and gas utilities, and merged with the Sewerage and Drainage Departments under the Ministry of the Environment. Under the Public Utility Act (2001), the newly formed PUB became the sole agency in charge of all the operational nodes of the entire water loop—water catchment, drainage and sewerage, water treatment and distribution and eventually, NEWater and desalinated water.

2002

- **NEWater successfully launched.**

2003

- **Parks and Waterbodies Plan.** Introduced under the 2003 master plan, provisions were made for an islandwide network of green spaces and improved access to waterways and waterbodies for recreation.

2004

- **Reservoirs and waterbodies opened up for recreational activities.** The Ministry of the Environment and Water Resources increased access to waterbodies for community use activities.

2000s

2005

- **PUB's tagline changed to "Water for all: Conserve, Value, Enjoy".**

2005

- **Formation of PUB's 3P Network.** The 3P (People, Private and Public) Network was set up to engage the community, the private and public sectors to give life to PUB's water management projects.

2006

- **Cabinet approval was given for the Active, Beautiful, Clean (ABC) Waters Programme.**

2006

- **ABC Waters Programme launched by PUB.** The programme aimed to realise the full potential of water infrastructure that had been built over the years, to improve the quality of water and people's lives. This involved the integration of drains, canals, reservoirs with the surrounding environment to create beautiful and clean streams, rivers and lakes in community spaces for all.

2007

- **ABC Waters Public Exhibition was launched in February.** The exhibition was held over six days to invite the public to learn about the programme and plans for more than 20 ABC Waters projects were unveiled. Exhibits were brought on a three-month island-wide roadshow.

2008
- **Opening of inaugural ABC Waters project at Kolam Ayer.**

2009
- **ABC Waters Design Guidelines launched.** This was a call for partnerships to encourage the private and public sectors to incorporate the ABC Waters concept into their design.

2010
- **ABC Waters Certification Scheme launched by PUB.** This served to provide recognition to public agencies and private developers to embrace the ABC Waters concept and incorporate ABC Waters design features into their developments with minimum design standards.

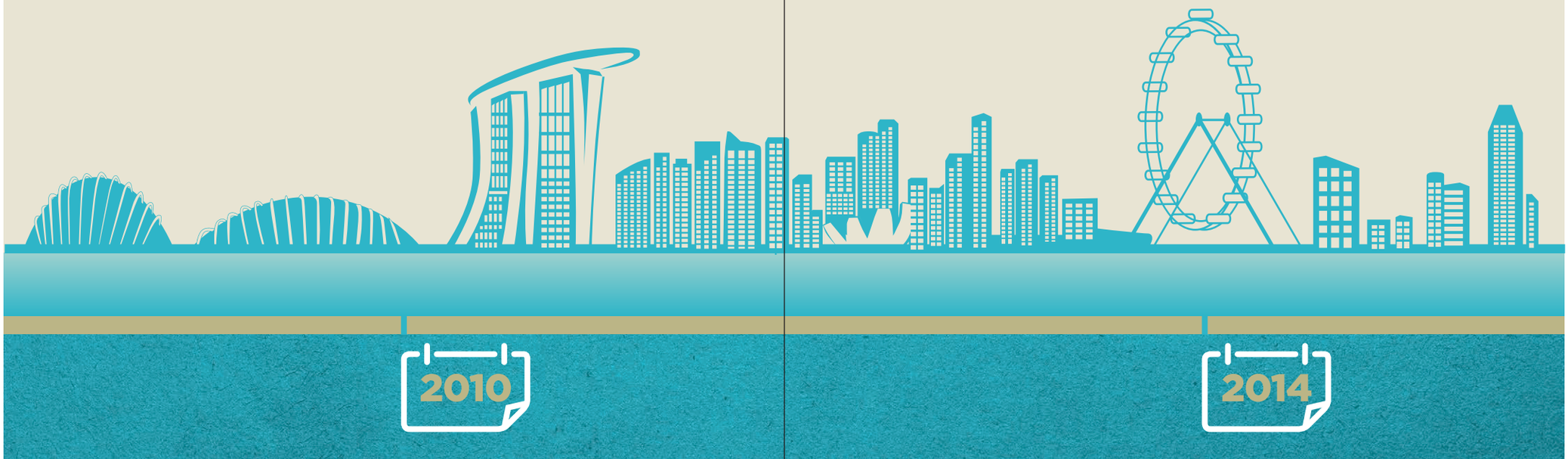
2011
- **Completion of Bishan-Ang Mo Kio Park flagship project.** This joint project by PUB and the National Parks Board saw the transformation of concrete canals into a meandering waterway through the adjacent park. This remains one of the most ambitious projects completed under the ABC Waters Programme.

2011
- **ABC Waters Professional Programme rolled out by PUB and Institution of Engineers Singapore (IES).** This programme was also supported by Singapore Institute of Architects, Singapore Institute of Landscape Architects, National Parks Board, Housing and Development Board, and Land Transport Authority.

2011
- **Second edition of the ABC Waters Design Guidelines launched.**

2013
- **Official launch of ABC Waters Professional Registry.** Experts in this registry are qualified and trained to provide professional advice to developers on the design, implementation and maintenance of ABC Waters design features.

2014
- **Third edition of the ABC Waters Design Guidelines launched.**



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[109] Melbourne Water is a government owned statutory authority that controls much of the water systems in Melbourne, Victoria. Services provided include the management of water supply catchments, the treatment and supply of drinking and recycled water, and the management of waterways and major drainage.
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[114] Refer to Appendix B for a list of some of the completed sites under the ABC Waters programme.
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[127] Ibid.

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[130] Ibid.

[131] PUB, Singapore's National Water Agency. (2014). *ABC Waters Design Guidelines*. (3rd ed.) Retrieved from https://www.pub.gov.sg/abcwaters/Documents/ABC_DG_2014.pdf

[132] Ibid.

[133] Yap, Kheng Guan. (2016, November 22). *Interview with Centre for Liveable Cities* (unpublished transcript). Accession number CLC/027/2016/005. Centre for Liveable Cities, Ministry of National Development.

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APPENDIX A

Governance Tools for the Management of Singapore's Waterways and Waterbodies

(I) Legal Instruments

Tool	Description
Water Pollution Control and Drainage Act	Passed in 1975, it consolidated the 1970 Local Government (Disposal of Trade Effluents) Regulations and the 1971 Environment Public Health (Prohibition of Discharge of Trade Effluent). The Water Pollution Control and Drainage Act was consolidated together with the Clean Air Act and the Drainage Act under the new Environment Pollution Bill in 1999. Part V of the Bill deals with water pollution control.
Public Utilities Act 2001	The Public Utilities Act 2001 repeals and re-enacts the then existing Public Utilities Act in order to integrate the Sewage and Drainage Department of the Ministry of Environment (ENV) as part of the Public Utilities Board (PUB), restructure the Board as the Water Authority and divest its role as the regulator of electricity and piped gas industries.
Sewerage and Drainage Act and the Sewerage and Drainage (Trade Effluent) Regulations	Formerly part of the Water Pollution Control and Drainage Act, the Act and Regulations govern the provision, operation and maintenance of Singapore's sewerage system, including the treatment and discharge of industrial wastewater into public sewers. The Act and Regulations are administered by PUB.
Code of Practice on Surface Water Drainage	Issued under the Sewerage and Drainage Act, the Code of Practice on Surface Water Drainage specifies the minimum engineering requirements for surface water drainage for new developments.

(II) Executive Policies

Tool	Description
Bukit Timah Flood Alleviation Scheme	The Bukit Timah Flood Alleviation Scheme was introduced to alleviate flooding in the Bukit Timah Catchment. The scheme was carried out in two phases–Phase 1 tackled the immediate flood problems in the Upper Bukit Timah Catchment; and Phase 2 looked to solve the flood problems in the Bukit Timah Valley.
Drainage Master Plan	Then Ministry of Environment (ENV) developed a Drainage Master Plan in consultation with the Urban Redevelopment Authority (URA), Jurong Town Corporation (JTC), Housing and Development Board (HDB) and other development agencies in the mid-1970s. Aimed at reducing the number of areas prone to flooding in Singapore, the master plan guided the Drainage Department in planning and implementing drainage networks across the island.
Waterbodies Design Panel	Chaired by URA, the Waterbodies Design Panel was set up in 1989. The panel assisted in evaluating waterbodies linked to developments and assessing the aesthetic treatment of these developments along major waterbodies. Projects included collaborations with ENV Drainage Department to transform Sungei Api Api and Sungei Kallang.
Parks and Waterbodies Plan	Introduced under the 2003 master plan, provisions were made for an island-wide network of green spaces and improved access to waterways and waterbodies for recreation.
Active, Beautiful, Clean (ABC) Waters Programme	The ABC Waters Programme aims to create beautiful and clean streams, rivers and lakes with community spaces for all to enjoy.

(III) Institutions

Tool	Description
PUB, Singapore's National Water Agency	Statutory board responsible for Singapore's water management system.
Ministry of the Environment and Water Resources (MEWR)	Parent body of the PUB.
Ministry of Environment (ENV)	Predecessor of MEWR, which was originally formed to tackle issues such as pollution control, sewerage, drainage and environmental health. It housed the Sewerage and Drainage departments before the PUB merger in 2001.
Ministry of Trade and Industry (MTI)	MTI oversees issues pertaining to economic growth and job creation. Before PUB's merger in 2001, PUB was parked within MTI overseeing water supply needs alongside gas and energy utilities.
Public Works Department (PWD)	Formed under the colonial government, PWD developed and managed public works in Singapore such as schools, road and airports. It also set and administered building and housing control, and parking policies. The Drainage Department was initially parked under the PWD before it was formally set up under ENV.

APPENDIX B

A Select List of Completed Active, Beautiful, Clean Waters Sites in Singapore.
(More information can be found on https://www.pub.gov.sg/abcwaters)

Year		Completed Site
2008	Demonstration Pilot Project	Kolam Ayer ABC Waterfront
2008		Bedok Reservoir
2009		MacRitchie Reservoir
2008		Kranji Reservoir
2010		Lower Seletar Reservoir (Family Bay)
2010		Lower Seletar Reservoir (Rower's Bay)
2010		Sungei Whampoa (St George's Lane)
2010		Jurong Lake
2010		Pandan Reservoir
2010		Pang Sua Canal
2010		Sungei Kallang (RiverVista)
2010		Alexandra Canal
2011		Sengkang Floating Wetland
2011		Lorong Halus Wetland
2011		Yishun Pond
2012		Kallang River (Bishan-Ang Mo Kio Park)
2013		Sungei Ulu Pandan
2013		Sungei Pandan
2014		Geylang River
2015		Sungei Tampines
2015		Sungei Api Api
2015		Rochor Canal
2015		Kallang River (Potong Pasir)
2015		Siglap Canal (near Telok Kurau Primary School and Kembangan Community Club)
2016		Bukit Batok Canal
2017		Pang Sua Pond
2017		Kallang River (Bishan – Braddell)
2017		Kallang River (Upper Boon Keng – Sims Avenue)
2017		Siglap Canal (ECP to the sea)
2017		Sungei Whampoa (Kim Keat Road – Central Expressway)

APPENDIX C

Active, Beautiful, Clean (ABC) Waters Design Features

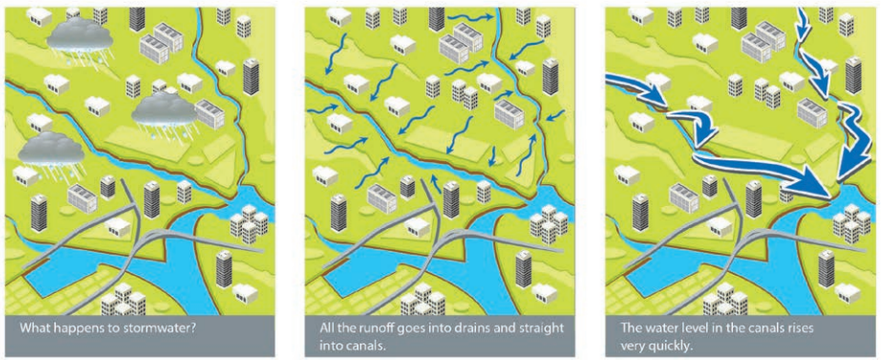
Urban environments tend to produce increased surface runoffs due to the pervasiveness of impervious surfaces like footpaths, parking lots and roofs. As a densely build-up city-state in the tropics, Singapore's waterways have been built to cope with increased runoffs during periods of intense rainfalls.

ABC Waters design features detain stormwater runoff and treat it to improve water quality closer to source before discharging it to the downstream waterways. Moreover, coupled with other stormwater detention systems (i.e. tanks, surface ponds, etc.), ABC Waters design features also help to lower peak flows generated by intense storms, potentially reducing the risk of floods.

Before a large scale implementation, ABC Waters design features were piloted in selected areas in Singapore to test their ability to improve water quality. Between 2008 and 2010, three pilots conducted were the Balam Estate Rain Garden, the bio-retention swale at Sengkang West Way and the Grove Drive Wetland. Integration with the urban landscape is important for ABC Waters design features. For example, at Balam Estate Rain Garden, the opportunity to implement the rain gardens arose when Land Transport Authority (LTA) was working to reinstate the landscape after building the Kallang-Paya Lebar Expressway (KPE) which affected the Park Connector at Balam Estate along Pelton Canal. With the support of Housing Development Board (HDB), National Parks Board (NParks) and LTA, the Balam Estate Rain Garden was built to integrate with the Park Connector and the existing drain that connected to the Pelton Canal. Piloting the ABC Waters design features was important in demonstrating the feasibility of these green features, which have proven to be successful overseas, under local conditions.

With two-thirds of Singapore functioning as water catchment areas, it is important to manage the quality of water flowing into our reservoirs. When implemented catchment-wide, ABC Water design features can help to improve the water quality through natural treatment processes that remove sediments and nutrients from urban surface runoff before it is channelled into our waterways and eventually our reservoirs.

Hydrological functions under the traditional stormwater management and the ABC Waters Management Strategy:

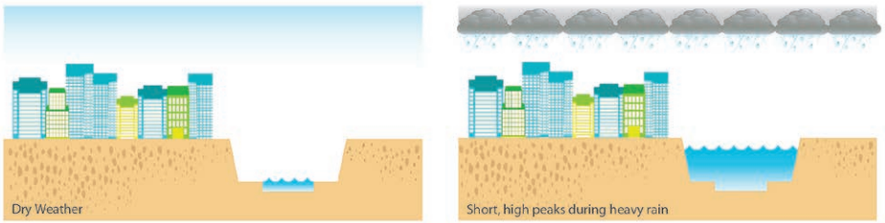


Traditional Stormwater Management

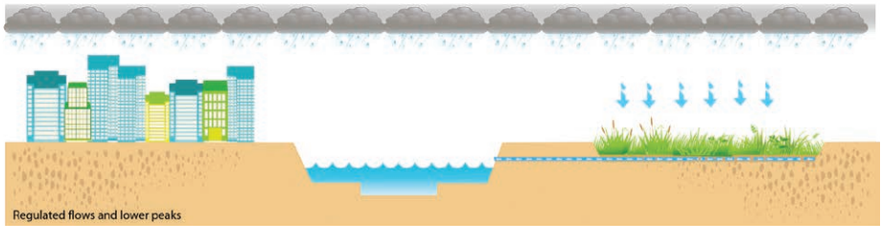
ABC Waters Management Strategy

Diagram Courtesy of PUB, Singapore's National Water Agency.

Differences in canal water levels under the traditional stormwater management and the ABC Waters Management Strategy:



Water levels in the canals under the traditional stormwater management.



Water levels in the canals if the ABC Waters Management Strategy is applied catchment-wide.

Diagram Courtesy of PUB, Singapore's National Water Agency.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THE ACTIVE, BEAUTIFUL, CLEAN WATERS PROGRAMME: WATER AS AN ENVIRONMENTAL ASSET

"In the past, we protected our water resources by keeping people away from them; now, we will bring people closer to water so that they will enjoy and cherish it more.... We will integrate our waterbodies with our parks and green spaces and turn Singapore into a City of Gardens and Water."

Prime Minister Lee Hsien Loong
at the Active, Beautiful, Clean Waters Exhibition (2007)

Concrete drains and canals were once seen only as essential infrastructure that served the critical functions of stormwater management, allowing for the rapid urban development of Singapore in the early days. This changed in 2006 with the launch of the Active, Beautiful, Clean Waters Programme, which transformed waterways and waterbodies into beautiful recreational spaces to be enjoyed by people—marking a shift in the government's approach towards the management of vital water resources.

Drawing upon archival research and interviews with urban pioneers, *The Active, Beautiful, Clean Waters Programme: Water As An Environmental Asset* documents the development of the Active, Beautiful, Clean Waters Programme and illustrates the potential of Singapore's blue spaces as environmental assets to enhance the liveability of urban environments.

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