



**ESTONIAN UNIVERSITY OF LIFE SCIENCES**

Institute of Technology

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**Restoration of Buckingham Canal**

**Chennai as a case study**

Buckinghami kanali taastamine

Chennai linnas kui juhtumiuuring.

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<p>Käesolev uuring käsitleb Buckingham kanali praegust olukorda Chennais Indias, keskendudes eriti keskkonnahäiringutele, saasteallikatele ja kanali võimalikele taastamise meetoditele. Kanal, mis oli varem oluline transpordivahend, on linnastumise, tööstusjäätmete, ebapiisava reovee puhastamise ja tahkete jäätmete ebaõige kõrvaldamise tõttu oluliselt halvenenud. Antud tegurid on põhjustanud vee kvaliteedi olulise halvenemise ja kanali hüdroloogilise režiimi häirimise.</p> <p>Uuring rakendab põhjalikku meetodikat, alustades kanali seisundi esialgselt hindamisest, jätkates tööstusjäätmete info kogumisega ja lõpetades selle andmete uurimisega saaste peamiste allikate kindlakstegemiseks. Nendest etappidest saadud tulemused pakuvad väärtuslikke teadmisi põhjaliku saaste vähendamise kava koostamiseks, mis hõlmab reoveepuhastite kasutuselevõttu, prügi korjamise seadmete paigaldamist ja üldisele avalikkusele suunatud hariduslike algatuste levitamist. Lõputöö postuleerib pideva jälgimismehhanismi rakendamist saasteohje meetmete tõhususe hindamiseks, tagades seeläbi kanali jätkusuutliku haldamise. Uuring lõpeb kanali kõrval asuva infrastruktuuri laienemise</p>			

võimaluste uurimisega, hõlmates kahel kilomeetril jalakäijate ja jalgrattateede lõiku, laste puhkeala ja kunstile avatud näituseala.

Selle uuringu eesmärk on anda oluline panus jätkusuutliku linnavee majandamiseks, esitades tegevuskava Buckinghami kanali taaselustamiseks ja taastamiseks.

Märksõnad: Lõuna-India, Taastamine, Kliimamuutused, Sinised ja rohelised alad, Mikrokliima, Linnamikroliikumine, Keskkonnasõbralikkus, Vereostus, Veepuhastus

Estonian University of Life Sciences Kreutzwaldi 1, Tartu 51014		Abstract of Master's Thesis	
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<p>The present study investigates the existing condition of the Buckingham Canal located in Chennai, India, with a particular emphasis on the environmental hurdles, sources of pollution, and viable approaches for rejuvenation. The canal, which was previously a prominent means of transportation, has experienced a decline in its condition as a result of urbanization, discharge of industrial waste, insufficient sewage treatment, and improper disposal of solid waste. The aforementioned factors have led to significant degradation of water quality and disturbance of the canal's hydrological regime.</p> <p>The study employs a comprehensive methodology, commencing with an initial evaluation of the canal's state, proceeded by the collection of information on industrial waste, and culminating in the examination of this data to pinpoint the principal sources of pollution. The results obtained from these phases provide valuable insights for the formulation of a comprehensive pollution mitigation plan, which includes the implementation of wastewater treatment plants, the installation of litter interception devices, and the dissemination of educational initiatives targeting the general public.</p> <p>The thesis postulates the implementation of a mechanism for continuous monitoring to evaluate the efficacy of pollution control measures, thereby ensuring the sustainable management of the canal. The study concludes by examining the prospective opportunities for infrastructure expansion adjacent to the canal, encompassing the creation of a 2km segment of pedestrian and bicycle pathways, a recreational area for children, and an uncovered exhibition space for art.</p> <p>The objective of this study is to provide significant contributions to the field of sustainable urban water management by presenting a roadmap for the revitalization and rehabilitation of the Buckingham Canal.</p>			

Keywords: South India, Restoration, Climate change, Blue and green Spaces, Microclimate, Urban blue space, Eco-friendly, Water pollution, Water treatment



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## **LIST OF ABBRIVATION**

NWP - National Water Policy

B CANAL - Buckingham Canal

STP - Sewage Treatment Plants

BGI – Blue Green Infrastructure

IIHS - Indian Institute for Human Settlements

MRTS - Mass Rapid Transport System

INTACH - Indian National Trust for Art and Cultural

IIT - Indian Institute of Technology

NIOT - National Institute of Ocean Technology





# CHAPTER ONE: INTRODUCTION

## 1.1 Buckingham canal

The 796-kilometer-long Buckingham Canal, which has a history dating back 200 years and connects the cities of Kakinada in Andhra Pradesh and Chennai in Tamil Nadu, runs along India's east coast. The canal was first constructed in the early 19th century during the British colonial period and was largely utilised for shipping goods and people along the coast. (Jeyanth K, 2008). Due to the growing vulnerability and sensitivity of cities and human settlements to its impacts, climate change has become a crucial worldwide problem that has an influence on urban and regional development. (Martos et al., 2016). Natural solutions are becoming a vital part of urban climate change adaptation all around the world. (Frantzeskaki et al., 2019) Urban regions are now more conscious of the risks posed by the climate, which has increased public support for natural solutions. (Badura et al., 2021).

The Buckingham Canal's rehabilitation is anticipated to have a variety of positive effects, including better irrigation water supply, transportation for people and products, increased tourism, and biodiversity protection. The project serves as an example for future canal restoration initiatives in India by showing how a run-down waterway may be revived and given new vitality. (Jeyanth K, 2008). In order to increase the flow of water, the restoration work included dredging and desilting the canal, repairing and rebuilding embankments and walls, removing encroachments, and constructing new inlets. Additionally, sewage and industrial effluent are being treated before being discharged into the canal in an attempt to enhance the water quality. (K. Venkateshwarlu, 2017)

An attempt has been made in recent years to bring the Buckingham Canal back to its former splendor. The Tamil Nadu and Andhra Pradesh state governments are supporting the repair project being carried out by the National Waterway 4 Development Corporation of the Indian government. The canal was used less and less as time went on, and parts of it were either filled up or encroached upon. As a result, the surrounding regions saw more floods during monsoon seasons, a reduction in water quality, and a loss of aquatic species. (K. Venkateshwarlu, 2017)

With a focus on the difficulties, solutions, and results of this project, I will investigate the continuing restoration efforts of the Buckingham Canal in my master's thesis. My main goals are as follows:

examining the Buckingham Canal's historical, ecological, and social significance while highlighting the necessity of its restoration in terms of urban and regional development. examining the causes of the canal's deterioration, such as urbanization, industrialization, and neglect, to better comprehend the challenges associated with its rehabilitation.

analyzing the techniques and tactics used in the restoration process, including as dredging and desilting, mending and removing encroachments, enhancing water quality, and constructing new inlets for improved water flow. Examining changes in water quality, biodiversity, and the health of the ecosystem as a whole, as well as socioeconomic advantages like greater tourism, can help determine how successful the restoration efforts were.

Finding the best practices and lessons learned that may be used for future projects of restoring urban waterways, as well as considering the potential that the restoration of the Buckingham Canal may serve as a model for other initiatives of a similar sort in India and around the globe. providing recommendations for further measures and legislation to ensure the long-term sustainability and effectiveness of the Buckingham Canal restoration project and associated future activities, as well as providing design proposals along the canal.

The design proposal is based on the findings of the site survey carried out in the region between Kasturibai Nagar MRTS and Thiruvanmiyur MRTS along the Buckingham Canal. It aims to address the issues found during the assessment and take advantage of the opportunities provided by the site's distinctive features.

## **1.2 Aim:**

This research aims to identify and assess the issues with polluted urban blue spaces caused by the industrial revolution and what steps may be taken to restore the infrastructure of polluted urban blue-green spaces using some design methodologies for the Buckingham Canal in Chennai, India.

## **1.3 Thesis objectives**

### **1.3.1 The study's primary goal**

- To evaluate the current condition of Buckingham Canal and to pinpoint the biggest obstacles to its rehabilitation.
- To assess the success of the present restoration initiatives and offer suggestions for improvement.
- To create a restoration plan that is resilient and sustainable, and that takes into consideration future consequences from climate change as well as the ecological, social, and economic demands of the canal and its surroundings

## **1.4 Research questions**

1. Is the restoration of urban canals contributing similarly to achieving social sustainability in urban spaces?
2. Can a design proposal contribute to achieving social sustainability by restoring the polluted canals?

### **SUB QUES**

3. What is the role of Canals in urban settings?
4. How do the stakeholders affect the restoration of canals? map
5. What are the current usage and problems of this canal

## 1.5 Thesis Structure

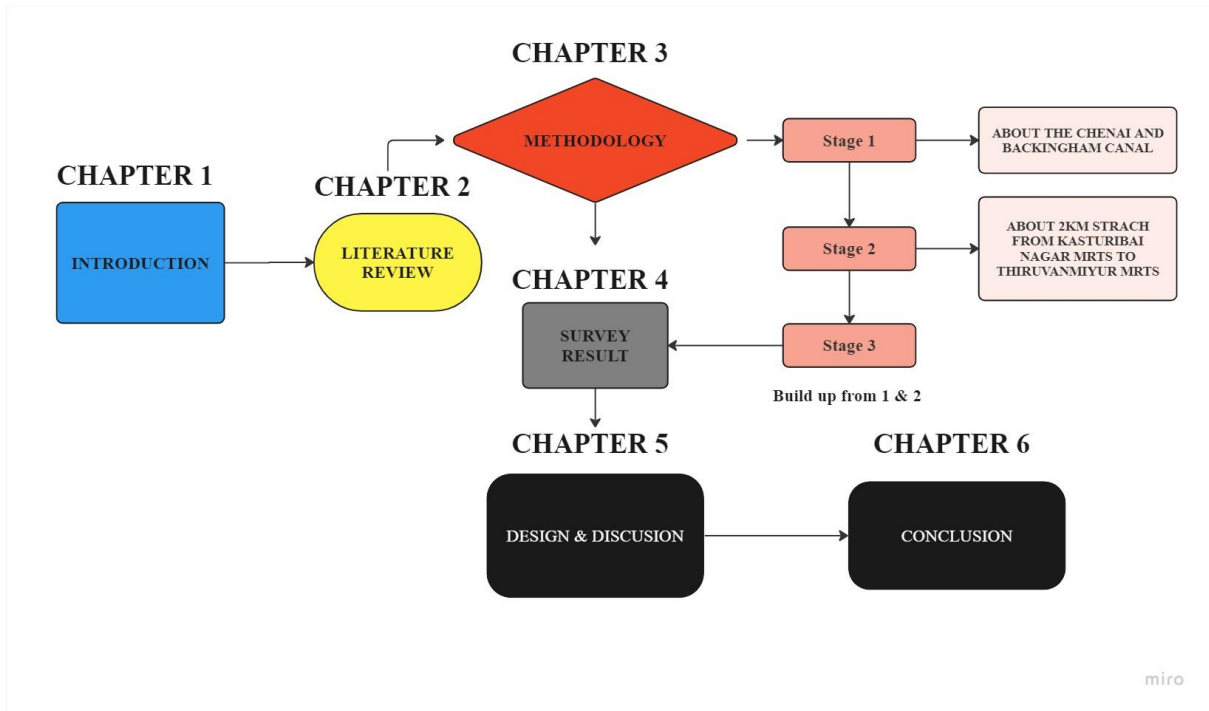
The first chapter of the thesis, **Chapter 2**, is a literature study that examines the problems and concerns that are now present, the history and significance of the Buckingham Canal, and case studies of successful canal restoration efforts. The research methodology, including data collecting techniques, site analysis, and the choice of study locations along the Buckingham Canal, is covered in detail in

In **Chapter 3**, the focus is on collecting relevant data for the research area, which is the Buckingham Canal. This chapter will involve gathering information about the canal's characteristics, historical background, and the surrounding environment.

In **Chapter 4**, a survey is carried out to find out how people feel about the canal's present condition, its effects on the neighborhood, and prospective restoration plans. This chapter will employ graphs, pie charts, and pictures to show how the survey respondents responded.

In **Chapter 5**, design alternatives are suggested together with a thorough analysis of their viability, advantages, and possible drawbacks. Experts in the subject will be contacted in the latter stages, and their remarks and recommendations will be recorded in this chapter.

The study's findings and suggestions are covered in **Chapter 6**, Conclusion which also provides insight into how the Buckingham Canal restoration project could go in the future. The thesis's sources are included in the bibliography, while the appendices provide additional information including maps, charts, and pictures as shown in (Figure 1).



**Figure 1.** Layout of the thesis

## 1.6 Scope and Limitations

### 1.6.1 Scope:

Examining the physical, biological, and cultural factors along the way, the research will cover the whole path of the Buckingham Canal starting in Chennai, Tamil Nadu.

The research will use interdisciplinary methodologies from the fields of social sciences, environmental engineering, urban planning, and landscape design to provide a comprehensive evaluation of the restoration options. The present research aims to investigate the historical backdrop of the Buckingham Canal, its significance to the local communities, and the factors contributing to its deterioration, with the ultimate objective of providing valuable insights for the restoration efforts. The study will examine current restoration initiatives, their achievements, and obstacles, in addition to the optimal methodologies derived from analogous endeavors across the globe.

The research will involve discussions with stakeholders, including government agencies, non-governmental organizations, and local communities, to ensure that the recommended

restoration strategy aligns with their objectives and interests. From Kasthubai Nagar to Indira Nagar, a 2 km length of the canal would be the center of the design proposal, which will include comprehensive design interventions and solutions for this particular segment.

#### 1.6.2 Limitations:

The study will only make use of information and data that is currently in the public domain, including news articles, scholarly research, and official documents. There may be inaccuracies or gaps in the information that is currently accessible, which might affect the study's results on the canal in Chennai. Every part of the canal restoration procedure in Chennai, including the precise technical design, building methods, and costs, would not be able to be covered by the research. The major focus will be on the restoration project's general framework and guiding ideas.

The study will rely on existing climate change models and projections, which may alter over time. As a result, the anticipated repair schedule for the canal in Chennai would need to be changed if new information becomes available.

It's conceivable that the research won't be able to address every issue particular to the Chennai segment, including site-specific limitations and barriers, given the vastness and variety of the Buckingham Canal. The recommended restoration plan should be viewed as a starting point for future growth and development.

The implementation of the restoration plan will depend on a variety of factors, such as political will, funding, and community support, all of which fall outside the scope of this study. The success of the canal project in Chennai will be determined by these factors.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Industrial revolution

Industrial revolutions are times of rapid change, achieved through innovation. The First Industrial Revolution began in the mid-1700s, with the arrival of steam engines and their radical influence on manufacturing, by enabling machine production and factories (Schulze et al., 2019). The existence of dispersed contaminated sites is a significant attribute of urban areas with industrial activities, especially in the past industrial hubs where the disposal of industrial effluents was inadequately monitored (BenDor et al., 2011; Njue et al., 2012; Martuzzi et al., 2014). Since environmental footprints are frequently located in close proximity to residential zones, their potential effects on the urban ecosystem and human well-being are noteworthy. Comprehending the environmental hazard that these polluted terrains present to the inhabitants residing in the adjacent vicinities is imperative in formulating effective management approaches to mitigate the unfavourable ecological ramifications. A contaminated site located in Greater Manchester (UK), which played a significant role in the first Industrial Revolution, has been subject to our investigation. The results of the investigation indicate that the soils in the studied regions exhibit elevated concentrations of arsenic and heavy metals. These contaminants have the potential to be disseminated to the surrounding atmospheric and aquatic environments through mechanisms such as dust formation and flooding, as reported in previous studies (Mukwaturi and Lin, 2015; Qin et al., 2016; Nworie et al., 2019).



**Figure 2** Image showing how the industrial revolution affect the environment (Source: Yogendra Singh)

Following the onset of the industrial revolution, there has been a significant proliferation of industries, leading to the introduction of numerous anthropogenic compounds into the environment. Residues of persistent organic pollutants have been detected in geographically isolated regions across the globe. Pollution can be characterized as the existence of natural or anthropogenic substances in our surroundings that are deemed undesirable, or a chemical that surpasses the typical background level and has the capacity to cause harm. The term "harm" encompasses the negative biochemical or physiological alterations that impede an individual or organism's capacity to thrive, reproduce, or develop. Water is a crucial renewable natural resource that is indispensable for the survival of all life-sustaining systems on the planet. The predominant type of water present on the planet Earth is saline in composition. Freshwater is a scarce resource, with only a limited amount available. The overexploitation and pollution of water have resulted in the scarcity of freshwater resources. The escalation of pollution has resulted in the depletion of both surface and subsurface water resources. Industries, agriculture, and domestic activities are identified as the primary causative factors for water pollution. Moreover, the expansion of industrial activities and the resulting discharge of pollutants into freshwater bodies pose a significant threat to this delicate ecosystem, as illustrated in (Figure 2).

The self-purification capacity of aquatic systems has been impacted by the substantial volume of waste produced by a continuously expanding populace. The availability of usable water is reduced as a result of both excessive utilization and contamination. The prudent and judicious utilization of the planet's resources, particularly water, is of paramount importance. In order to assess the impact of contamination on aquatic habitats, it is necessary to conduct an analysis of the composition of aquatic constituents, as well as evaluate physicochemical and biological parameters. (Arivoli et al., 2018).



### **2.1.1 Chennai's industrial revolution**

Chennai is a city located on the eastern coast of India. The populace of the metropolitan agglomeration experienced a growth from 2.64 million in 1971 to 4.68 million in 2011. According to the 2011 Census. As per the Census of India, the current population estimate has exceeded 9.0 million and is projected to escalate to 14.0 million by 2030. Chennai has undergone a transformation from a commercial and manufacturing centre to a burgeoning hub for information technology development. (Krishnamurthy and Desouza, 2015).

The economic growth of Chennai has contributed to urban agglomeration spreading through the bordering municipalities, and growing from an earlier 176 sq. km. to 426 sq. km. in 2011 (IIHS, 2018). The built-up area increased by 20 % between 1997 and 2017, to reach 88 % of the entire surface area (IIHS, 2018). Several urban sectors were developed in the city's flood-prone areas leading to substantial declines in vegetation surfaces, open spaces, and water bodies. Despite the progress made in recent years, Chennai lagged in urban infrastructure development and resilience planning. Its sewerage system and stormwater drainage capacity were much below the recommended norms set by the Ministry of Urban Affairs, Government of India (Gupta a.k Nair, 2011; Govindarajulu, 2020).

The insufficiency and limited availability of reasonably priced housing resulted in the establishment of impoverished urban communities in flood-prone regions such as canals and river banks within the city (Joerin et al., 2012, 2014) According to the 2011 census, Chennai exhibited suboptimal performance in the provision of civic amenities at the household level, specifically in the areas of potable water distribution and access to sewerage connections. Moreover, the per capita allocation of urban green spaces, which was less than 1 sq. m., fell significantly below the recommended standards of 10-12 sq. m. as advised by the Government of India (Govindarajulu, 2014).

### **2.1.2 The Buckingham Canal context.**

This study examines the impact of the Industrial Revolution on the development of transport infrastructure in southern India. The Industrial Revolution led to the construction of various transport systems, including canals and railways, such as the prominent Buckingham Canal, within the region. The canal played a pivotal role in fostering the economic development of the region by facilitating the transportation of goods and people across the area (K.

Venkateshwarlu, 2017) The transformation of the BGI in Chennai commenced in 1876 with the construction of the Buckingham Canal, which was subsequently developed into a prominent waterway. The canal was initially designed to function as a means of waterborne transportation, linking the inland lakes and rivers of Chennai and its surrounding areas.

Additionally, it played a crucial role in serving as a vital stormwater drainage system for the city. (Gupta a.k Nair, 2011; Ramachandran et al., 2019). the canal ceased to serve its purpose as a waterway for transportation circa 1954. Consequently, significant portions of the canal network became inoperable due to diminished drainage capacity. The city has faced additional challenges due to the swift urbanisation that has occurred over the past twenty years. This has resulted in significant wetland loss and alterations to the city's drainage systems, including those that flow into Buckingham Canal (Srinivasan et al., 2013).

Blue-green infrastructure (BGI) refers to a system of interlinked landscape features that encompass both naturally occurring and human-made elements. These elements include water bodies such as rivers, streams, and lakes, as well as green spaces such as parks and marshes (Ghofrani et al., 2017). BGI performs a variety of tasks including flood control, wildlife habitat, water storage for irrigation and industrial usage, recreation space, and other crucial nature-based solutions for climate adaption in urban areas (Ghofrani et al., 2017; Govindarajulu, 2014).

undertakes a diverse range of functions such as flood management, provision of habitats for wildlife, storage of water for industrial and irrigation purposes, creation of recreational areas, and other essential nature-oriented measures for climate adaptation in urban regions.

Academics have conducted recent studies on the impact of the Industrial Revolution on the Buckingham Canal. Although the canal played a significant role in fostering the expansion of

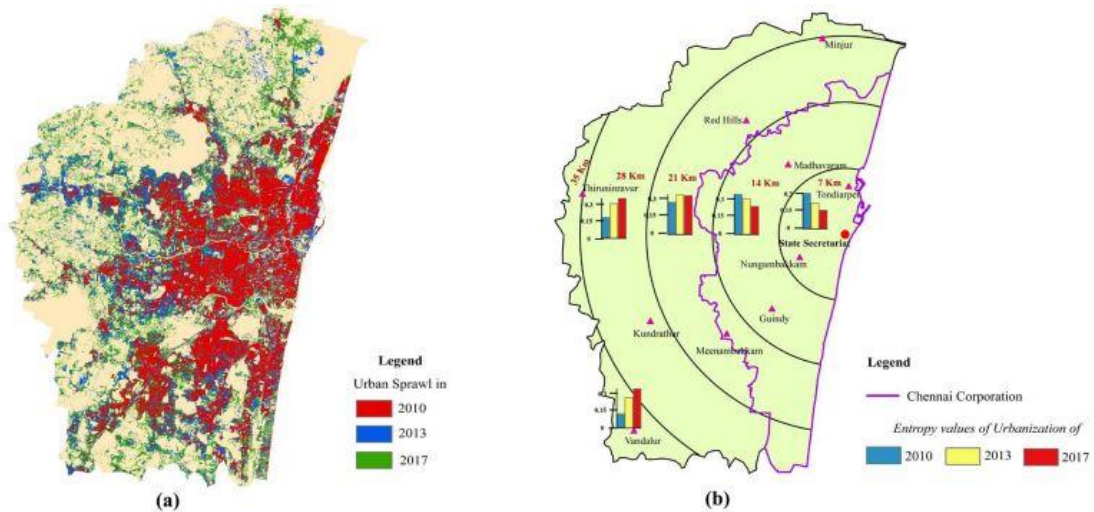
the local agricultural sector, it also had adverse effects on the environment, including pollution and siltation. (K. Venkateshwarlu, 2017)

To summaries, the Buckingham Canal has played a significant role in promoting the economic development of southern India, with notable impacts on both commercial activities and agricultural practices. The contamination of the river can be attributed to the industrial revolution and insufficient waste disposal methods, leading to ecological deterioration and potential health hazards. The above-mentioned situation highlights the crucial necessity of creating sustainable infrastructure that can efficiently balance economic growth and environmental preservation. It is suggested that the restoration of the Buckingham Canal be given priority, with the implementation of techniques such as phytoremediation, bioremediation, and constructed wetlands to improve water quality. The implementation of more rigorous regulations is crucial in addressing and mitigating the problem of industrial pollution.

The rehabilitation of the canal possesses the capability to address ecological issues and promote communal involvement and recreational pursuits, thereby enhancing the welfare of the adjacent populace. Hence, the restoration of the Buckingham Canal possesses the capability to function as a model for sustainable infrastructure advancement.

## 2.2 Urbanization

The process of urbanization, in which an increasing fraction of the population relocates there to reside, causes cities to grow. The population tends to grow with time. Small sedentary settlements, lonely individuals, and the expansion of agriculture gave grounds for people to band together and create organizations. Many of these communities expanded to become what are now known as cities. This kind of expansion often takes place concurrently with a change in the workforce's demographics. Although urbanization has occurred in all industrialized countries at some point in the past, it is often contrasted with the industrializing and urbanizing nations of the present. The globe is also becoming more urbanized. The population of the planet is likely to keep growing as the twenty-first century progresses. In the future, metropolitan areas' populations will grow. Due to this continual evolution, we are forced to deal with challenging issues as we prepare for the cities of the future. The impact of urbanization on the globe will be felt for a very long time. Urban sprawl is a result of urbanization. Urban sprawl is the dispersion of a city's inhabitants across a growing area of land. Cities typically begin to encroach on considerable areas of once-agricultural land as they expand as a result of the movement from crowded urban centers to less congested suburbs. Sprawl also increases the need for transportation infrastructure, such as roads, since dwellings are typically situated farther away from places of employment and other amenities. It is anticipated that the world population will continue to increase as the twenty-first century goes on. Both the population and the size of urban areas will increase. As we plan for future cities, this ongoing evolution creates severe challenges. For many years to come, the environment will be impacted by how we choose to manage urbanization. (National Geographic Society 2022)



**Figure 3.** Urban Sprawl and Entropy of the study region. (a) The urban sprawl of the observed urbanization of CMA in 2010, 2013, and 2017; (b) Entropy values of urbanization of the study region for five distance-based buffer zones from the State Secretariat

Urbanization has led to a significant increase in the number of pollutants in the Buckingham Canal as shown in (Figure 3). The canal is very contaminated, according to study by the National Institute of Ocean Technology, since adjacent cities and towns dump untreated sewage and industrial trash into it. According to the examination, the water included significant concentrations of coliform bacteria and other pollutants that are bad for the ecology and the quality of the water. (NIOT, 2012).

After the city portion had completely dried out, the Mass Rapid Transport System (MRTS) was supposed to run along the riverbed in the 1980s. The importance of the Canal during the rainy season was pointed out in vain by those who were concerned about the city's storm-water drains. Nevertheless, pillars were erected on the Canal's floor, and the MRTS has since emerged. Since that time, flooding has historically occurred on both sides of the Canal. However, the MRTS pillars' construction ended any real possibility of the Canal being restored. Currently, the MRTS route crosses rivers in a few places while running beside them in many others. As a consequence, there is naturally less space for the water to move, and any extension or dredging would unavoidably be constrained by the structures. as shown in (Figure 4). It is an example of how several government entities work independently without having a clear strategy for what has to be done. (Sriram v 2017)



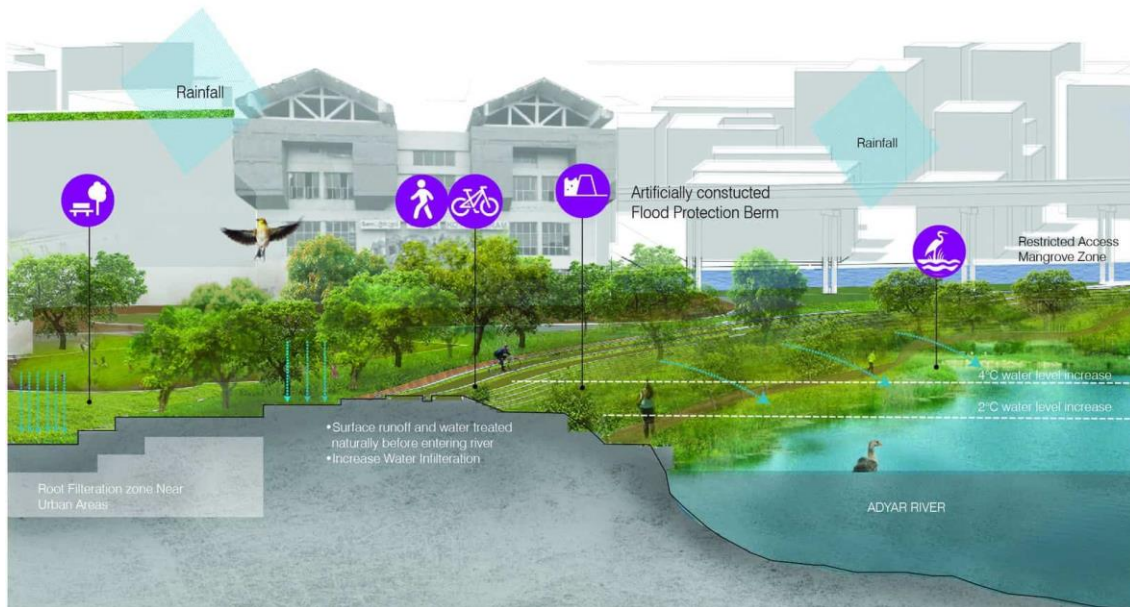
**Figure 4.** The Mass Rapid Transit System shadowing the canal carrying sewage, debris, and filth. (Prithvi Mahadevan, 2017)

Urbanization has resulted in an encroachment on the Buckingham Canal. According to a study by the Indian National Trust for Art and Cultural Heritage, the canal's width has been reduced and water flow has been impeded by the construction of buildings, roads, and other infrastructure. The report also discusses how the encroachment has affected the historical and cultural relevance of the canal (INTACH, 2018).

After significant rainstorms, the Buckingham Canal's invasion has also led to flooding and erosion. The encroachments, according to research by the Indian Institute of Technology, Chennai, had reduced the canal's carrying capacity, which led to flooding in the nearby neighborhoods during heavy downpours. (IIT Chennai, 2017).

## 2.3 Urban microclimate impact

Greater building density and greater height-to-width ratios in urban areas result in cooler daytime temperatures and improved thermal comfort because buildings' shade blocks the sun's harmful rays (Johansson and Emmanuel, 2006). Given the numerous potential and constraints connected with initiatives like the Buckingham Canal restoration, sustainable urban and regional design should concentrate on integrating ecological, social, and economic issues (Calthorpe, 1993) For the restoration of water systems like the Buckingham Canal, adaptive and integrated water management methods, ecosystem restoration, stakeholder involvement, and policy formulation are crucial (Pahl-Wostl et al., 2015). Projects like the restoration of the Buckingham Canal must also include the management and restoration of minor inland waterways, which includes enhancing water quality, restoring habitats, and involving the local community (Trow, 2013).



**Figure 5.** A depiction of the proposed berm and eco-park at the Adyar River

These components include installing a biosphere on each street, installing water squares to collect extra water during heavy downpours, and installing helophytes, floating island plants that clean the canal's water. By including these elements, the canal will improve accessibility and integration with the nearby neighborhoods.



While some of the proposal's many components may only be applicable to only some distance and also evaluating the viability and feasibility of the suggested concepts as shown in (Figure 5). When creating restoration plans for urban water bodies like the Buckingham Canal, it's essential to take special features and the flexibility of treatments into account. (Eyes on the canal, 2018)

## 2.4 Water pollution

Water is a precious resource for all forms of life on the planet. The availability of water is a prerequisite for human survival. It is unlikely for living organisms to flourish on extraterrestrial planets due to the absence of water, which is a vital component for sustaining life as it exists on Earth. Ninety-seven percent of the Earth's total water volume is conserved in the oceans and seas, which are characterized by their salinity and limited usability. Merely 3% of the total water on Earth is believed to be classified as fresh, and out of this fraction, 2% is stored in ice and glaciers, which do not contain any liquid water. The exclusive means of utilization pertains to the mere 1% portion of the available water supply that remains and is stored in reservoirs, channels, and subterranean aquifers. (Gray N.F., 2010). Effective management and sustainable planning are crucial for the continuation of life on Earth. Prior to the onset of the industrial revolution, the notion of water scarcity and pollution was not a prevalent concern. Subsequent to experiencing various health hazards due to water pollution, it emerged as a prominent concern. (Akindele et al., 2020).



**Figure 6.** Microorganisms' contamination of body of water (NRDC, 2023)



With the growth of the population, there is a pressing necessity to facilitate urbanization in response to the heightened demand for resources. Emerging economies are making concerted efforts to facilitate urbanization and augment the number of urban centers. Ensuring the appropriate allocation of land, public spaces, and urban infrastructure is of paramount importance as it directly impacts the quality of life of individuals. Furthermore, prospective disasters are considered in urban planning, and the infrastructure is equipped accordingly. The phenomenon of urban growth exerts a noteworthy impact on the economy by fostering the proliferation of rural regions. Efficient and methodical completion of these tasks contributes to the overall growth of the nation. Urbanization is deemed necessary to meet the demands of human populations. However, this phenomenon has resulted in the accelerated deterioration of underground streams. The utilization of communal water resources by urban inhabitants has led to contamination, which poses a potential threat to environmental health. It is possible that the water is unsuitable for both recreational swimming and consumption due to potential contamination. Urban water pollution can arise from the discharge of sewage and industrial waste, which may contain hazardous materials such as chemicals, grease, oil, and other substances. (Uddin et al., 2021).

The treatment of wastewater has been identified as a crucial environmental protection issue due to the significant volume of effluent, its composition, and the multitude of industries involved. Industrial wastewater is known to contain various contaminants such as heavy metals, dyes, pesticides, herbicides, pharmaceuticals, and other aromatic compounds (Rodriguez-Narvaez et al., 2017)

The present study aims to investigate the physical and chemical properties of silt and water samples collected from Buckingham Canal, with a particular focus on heavy metal contamination. The study's water and sediment samples revealed significant levels of heavy metals such as lead, cadmium, chromium, and mercury, suggesting a severe case of canal contamination (Arumugam et al., 2018)

conducted an analysis of the water quality of the Buckingham Canal utilizing various water quality indicators such as pH, dissolved oxygen, biological oxygen demand, chemical oxygen

demand, and total dissolved solids. The research revealed that the sediment exhibited a high degree of contamination from heavy metals such as cadmium, chromium, and lead.

Additionally, the canal water was observed to be severely polluted, containing notable levels of organic waste, nitrogen, and phosphorus. This presents a significant hazard to both aquatic organisms and human well-being. (Kumar et al., 2009) This research aimed to examine the microbial diversity and antibiotic resistance patterns of bacteria that were obtained from water samples gathered from Buckingham Canal. The research revealed that the bacterial isolates exhibited resistance to multiple antibiotics, implying the existence of antibiotic-resistant bacteria in the canal water. (Nair et al., 2021)

The ecological health and water quality of Buckingham Canal were assessed by researchers through the use of bioindicators such as benthic macroinvertebrates and phytoplankton. The research findings indicate that the canal water exhibited significant levels of contamination, suffered from ecological degradation, and demonstrated low levels of species diversity and population density among benthic macroinvertebrates and phytoplankton. (Balakrishnan et al., 2022)

The extant literature pertaining to water contamination in the Buckingham Waterway indicates that various human activities have significantly contributed to the degradation of water quality in the waterway as shown in (Figure 6). The contamination is characterized by elevated levels of organic matter, nitrogen, phosphate, heavy metals, and antibiotic-resistant bacteria. The pollution has caused significant harm to the canal's ecosystem, thereby posing a grave threat to both aquatic life and public health. Immediate action is necessary to tackle the issue of water pollution in Buckingham Canal through the utilization of appropriate strategies, including enhanced waste management protocols, regular monitoring of water quality, and the adoption of effective pollution control techniques.

## **2.5 Cleaning of polluted canal water**

The mitigation strategies employed to ameliorate the effects of polluted canal water. The discussion centers on the diverse methods centers and approaches that have been previously utilized to tackle this concern. Numerous investigations and scholarly inquiries have been undertaken to examine the efficacy of these approaches, which may be utilized to inform ongoing endeavors aimed at rehabilitating the Buckingham Canal. Several primary sources and significant discoveries from scholarly works are as follows:

### 2.5.1 Constructed wetlands:

A viable and long-lasting solution to the water contamination issue the Buckingham Canal is facing is the construction of wetlands. These are man-made, constructed systems that clean tainted water by imitating natural wetlands' ecological processes.

Wetland vegetation, soil microbial populations, and the physical characteristics of the soil itself work in harmony as the fundamental elements of these systems. These components combine to eliminate various pollutants. For instance, wetlands plants may successfully sequester nutrients and heavy metals from the water by absorbing them. Microbial communities degrade organic compounds and have the ability to change a variety of contaminants into less dangerous ones. By removing sediments and other particle matter, the soil also plays a significant role.



**Figure 7.** Example of constructed wetland (Anderson et al. 2013)

Constructed wetlands are built systems that purify contaminated water by using natural processes including microbial populations, wetland plants, and soils as shown in (Figure 7). The research shows how well-engineered wetlands work to remove a range of contaminants, including heavy metals, nutrients, and organic molecules. To aid with water quality improvement and to create a more sustainable environment, these systems may be put in place along the canal. (Vvmazal et al., 2011)

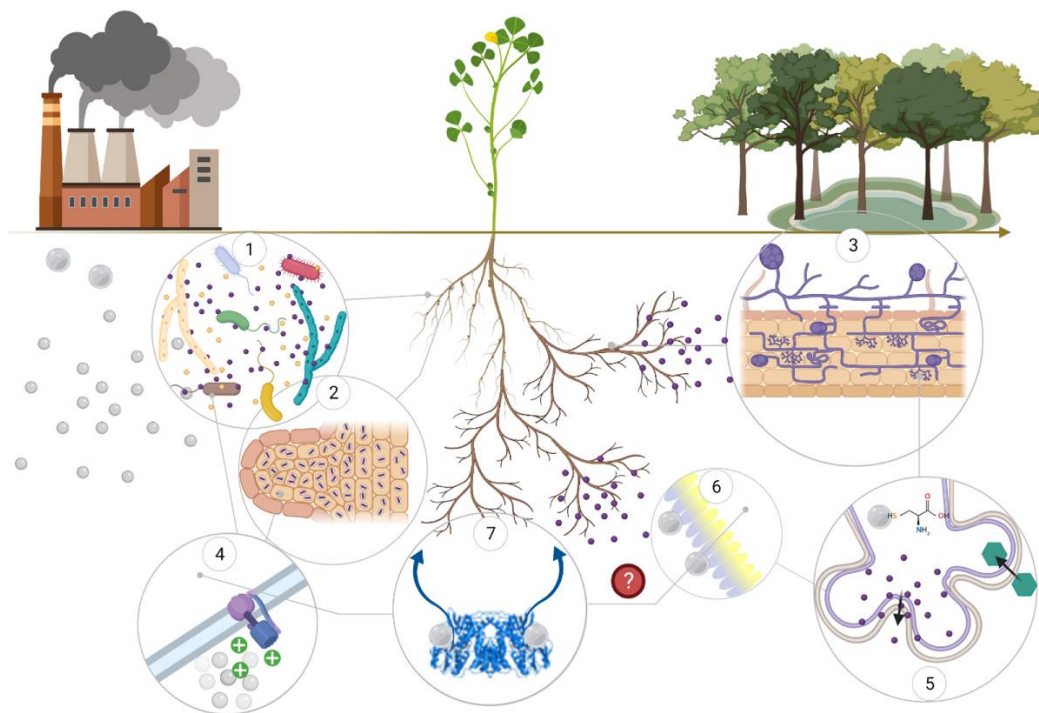
Therefore, adding artificial wetlands to the canal might have many benefits. First, by lowering the quantities of different contaminants, they may greatly enhance the canal's water quality. Second, since wetlands provide as a home for a range of plant and animal species, they may increase the richness of the nearby environment. Finally, they might enhance the canal's overall visual appeal by making it into a lush, lively area that the neighborhood could enjoy.

To build wetlands that are efficient and sustainable in the context of the Buckingham Canal, meticulous planning and design are necessary. This would include picking acceptable spots along the canal, picking suitable wetland plant species, and making sure the microbial

communities are properly established and maintained. To guarantee that these systems continue to operate efficiently over time, monitoring and management are equally crucial.

Overall, a comprehensive and sustainable strategy to restoring the Buckingham Canal may depend heavily on the use of created wetlands, which may have positive effects on the environment, the ecosystem's ecology, and society.

### 2.5.2 Phytoremediation



**Figure 8.** The image shows the how phytoremediation process (IJERPH, 2021)

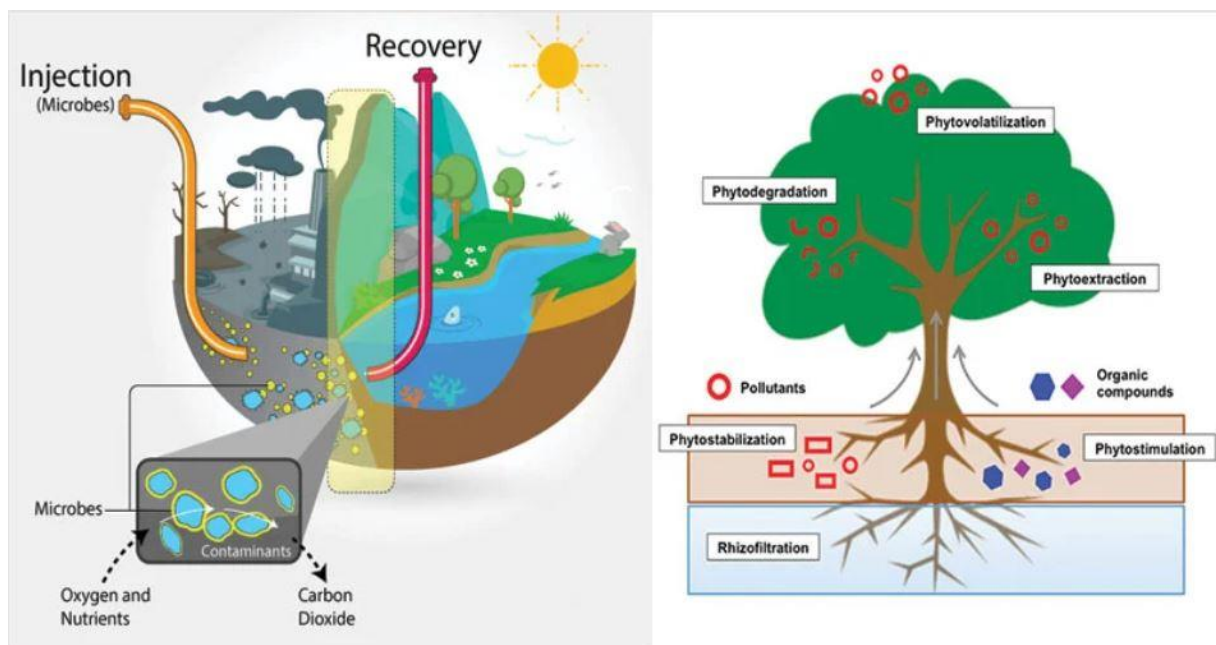
Using plants to remove, stabilize, or degrade pollutants from the environment is known as phytoremediation. some plant species may be used to absorb and store heavy metals and other contaminants from polluted water. The ecology as a whole may be improved and filthy water naturally cleaned up by planting these plants along the canal as shown in (Figure 8). (Ali et al., 2013)

These resources provide a strong framework for comprehending the many techniques and strategies used in cleaning dirty canal water. It is feasible to create a more efficient and long-

lasting plan for raising water quality and reviving the environment by using these methods in the restoration plan for the Buckingham Canal.

### 2.5.3 Bioremediation

The study examines practical ways to increase the effectiveness of bioremediation. Microbes are utilized in the bioremediation process to alter or break down environmental pollutants. This strategy is considered to be both cost-effective and safe for the environment, as shown in (Figure 9). The kind of toxins present and the ecology in the area, however, could have an influence on how efficient bioremediation is. To overcome these limitations, there are two techniques: biostimulation and bioaugmentation. In a polluted environment, bioaugmentation boosts the ecosystem's capacity for biodegradation by introducing microorganisms that degrade contaminants. Biostimulation, on the other hand, is feeding nutrients to the environment to encourage the growth of regional microbes that degrade contaminants. Whether used alone or in combination, these strategies have the potential to significantly increase the effectiveness of bioremediation operations. (Tyagi et al., 2011)



**Figure 9.** Process of bioremediation (Sagar Aryal, 2022)

#### 2.5.4 Aeration

large-scale municipal wastewater treatment facilities using aeration techniques. The biological treatment of wastewater by aeration is vital because it promotes the development and activity of aerobic bacteria, which are crucial for the breakdown of organic contaminants. These bacteria engage in aerobic respiration, or the metabolism of organic wastes in the presence of oxygen. The process results in carbon dioxide, water, and new biomass, which shows how pollutants are changed into less hazardous compounds and living things. Therefore, efficient aeration is necessary to support these microbial activities. Raisee the amount of dissolved oxygen in the wastewater, it entails adding air or pure oxygen. However, the procedure consumes a lot of energy and greatly raises the cost of running wastewater treatment facilities. (Rosso et al., 2011)

the techniques for aeration optimization, with the dual objectives of improving its efficacy in pollutant degradation and decreasing its energy consumption. They go through contemporary aeration technologies and methods, such as the utilization of effective aeration devices and the improvement of aeration control methods.

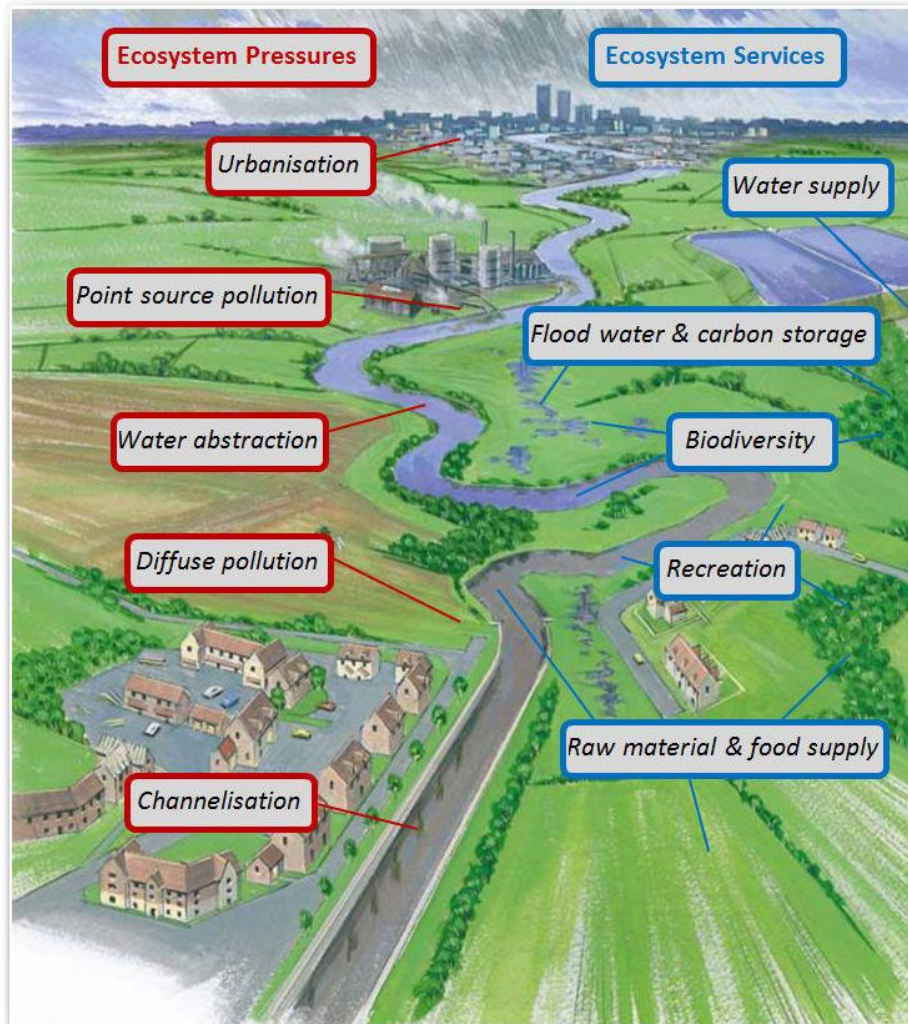
### **2.6 Canal restoration**

For centuries, canals have been a significant part of human society. They have been used for transportation, flood control, irrigation, and navigation. However, owing to neglect, pollution, and a lack of upkeep, many canals have become unusable and in poor condition. The process of bringing these waterways back to life and revitalization is known as canal restoration.the advantages of canal restoration on the environment and society. According to the research, canal restoration may benefit the ecosystem by strengthening biodiversity, water quality, and carbon sequestration, among other things. Additionally, the researchers discovered that canal restoration may benefit society (Siegrist et al. 2020)

The canal restoration may have substantial economic advantages, such as raising property prices, luring visitors, and generating employment in the building and tourism industries. (Gao et al. 2019) It looked at the prospects and problems of canal restoration in China. According to the report, the primary obstacles to canal restoration in China are a lack of financing, a lack of



public involvement, and an absence of cooperation between various government departments. The report also noted possibilities, such as the possibility for canal rehabilitation to boost tourism, enhance cultural heritage, and improve water quality. (Ren et al. 2019)



**Figure 10.** Benefit of canal restoration

Overall, the literature suggests that canal restoration can have many benefits, including ecological, social, and economic benefits as shown in (Figure 10). However, successful canal restoration projects require careful planning, community involvement, and adequate funding.



### 3. CHAPTER THREE: METHODOLOGY

The research on the restoration of the Buckingham Canal will be completed with the help of the data gathering techniques that will be covered in this chapter. There are three sections in this chapter.

**Stage 1:** Gives a basic overview of the canal and the cities around, concentrating on the pollution levels, encroachments, and present circumstances. Gathering information on the canal's water quality, pollution sources, and neighboring population centers is part of this step. For the development of successful restoration solutions, understanding these aspects is essential.

**Stage 2:** Based on elements including pollution levels, encroachments, and flooding susceptibility, a specific portion of the Buckingham Canal is chosen as a case study region. On-site surveys, water flow analyses, evaluations of nearby land use, and assessments of waste disposal practises are all used to gather data for this case study region.

**Stage 3:** Designs a set of survey questions and research materials based on the outcomes from Stages 1 and 2 as well as the findings from the literature study. The purpose of these inquiries is to learn what local stakeholders, professionals, and citizens think about the canal's current condition and future restoration plans. In order to create workable and successful restoration plans for the Buckingham Canal, this knowledge will be essential.

### 3.1 Stage 1

#### 3.1.1 Chaenai And Buckingham Canal

The case study area is located in Chennai, historically Madras, is the capital and largest city of Tamil Nadu state in southern India, located on the Coast of the Bay of Bengal. People often call Chennai the "Gateway to South India." It is a major administrative and cultural center in India.



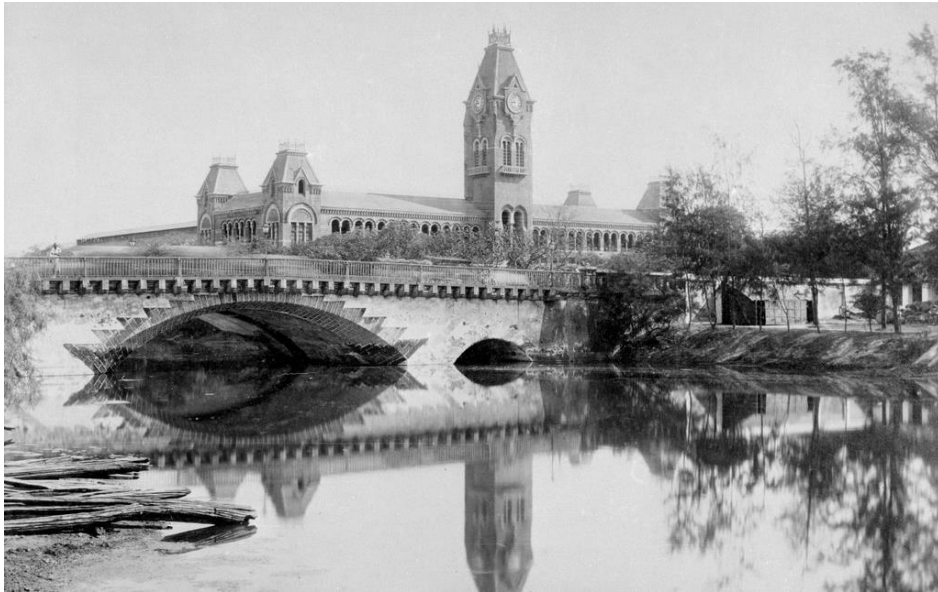
**Figure 11.** Map of India to Tamil Nadu and Chennai map Buckingham canal is highlighted with red circle is shown in red dot (open source)

Its latitude and longitude are  $13.04^{\circ}$  N and  $80.17^{\circ}$  E, and its average elevation is 6 meters. It is a flat coastal plain as shown in (Figure 14). Due to its proximity to the ocean and location on the thermal equator, Chennai has a hot, humid environment with little seasonal fluctuation. With maximum temperatures of roughly  $38^{\circ}\text{C}$ , April, May, and June are the warmest months. However, a few days in May might see temperatures over  $40^{\circ}\text{C}$ . Around  $24^{\circ}\text{C}$  is the typical minimum temperature in December and January. According to Chennai City Population (UA),

there will be 1.15 crore (11.5 million) residents in the city in 2022. Chennai is the fifth-largest metropolitan agglomeration metropolis in India and the 30th-largest city in the world. The position of Chennai makes it convenient for travel by road, train, air, and sea.

### 3.1.2 History of Buckingham Canal

At the height of British colonization in the early 19th century, the Buckingham Canal was being built as shown in (Figure). The Duke of Buckingham and Chandos, the British administrator of Madras at the time, served as the inspiration for the canal's name. The Coromandel Canal, which linked Chennai to the Andhra Pradesh city of Kakinada, was a crucial conduit for the transportation of people and goods along the Coromandel Coast. During the British era, a brackish water canal called the Buckingham Canal was built for interior transportation. Between 1806 and 1897, it was detected three times throughout the Coromandel Coast. The South Buckingham Canal and the North Buckingham Canal are the two parts of the canal. The Buckingham Canal served as a cheap means of transportation for goods such rice, salt, fish, firewood, chunam shells, and charcoal up until 1960. Little passenger boats also utilised it. Locks were put in place where it meets two rivers. The two rivers' tidal levels may be controlled by the canal. The canal's capacity was 5,600 cusecs when it was finished. (Jeyanth K, 2008).



**Figure 12.** The view of the central railway station from the Buckingham Canal (British Library, 1900)

One of India's longest canals, the 796-kilometer-long Buckingham Canal, is currently in danger of disappearing. The canal is steadily degrading as a result of the rising sewage and pollutants entering into it. The canal previously served as a method of transportation and a source of income for the people of Chennai. The storied Buckingham Canal is currently in poor condition. Despite the fact that the canal is littered with garbage and that the little water it contains has been tainted by sewage, it may still have a better future if the government keeps working to rehabilitate the water channel. (K. Venkateshwarlu, 2017)

There are several things that might be blamed for the demise of the Buckingham Canal, including urbanization, industry, and neglect. Residential and commercial construction covered the canal's banks as Chennai expanded. A number of the canal's sections were enlarged, and other spaces were even filled up to make room for the upcoming buildings. In addition, pollution levels increased as a result of the adjacent businesses' rapid expansion. The quality of the water was significantly reduced by the flow of untreated sewage and industrial effluent, which also had a negative impact on the aquatic life in the canal. Solid waste and plastic debris were dumped into the stream, turning it from a clean stream into a threat to the environment, which exacerbated the problem. These factors, together with a lack of

maintenance and attention from the government, led to the canal's decline and transformation into a mere shadow of what it once was. The Buckingham Canal has to be immediately repaired and revitalized in order to preserve its historical, ecological, and social worth. (K. Venkateshwarlu, 2017)



**Figure 13.** hand colored map of the Coromandel Coast of India (d' Anville depicts,1788)

The Buckingham Canal traverses the city via a range of urban settings, from industrial zones to residential neighborhoods, and is an essential component of Chennai's water management and flood control infrastructure.

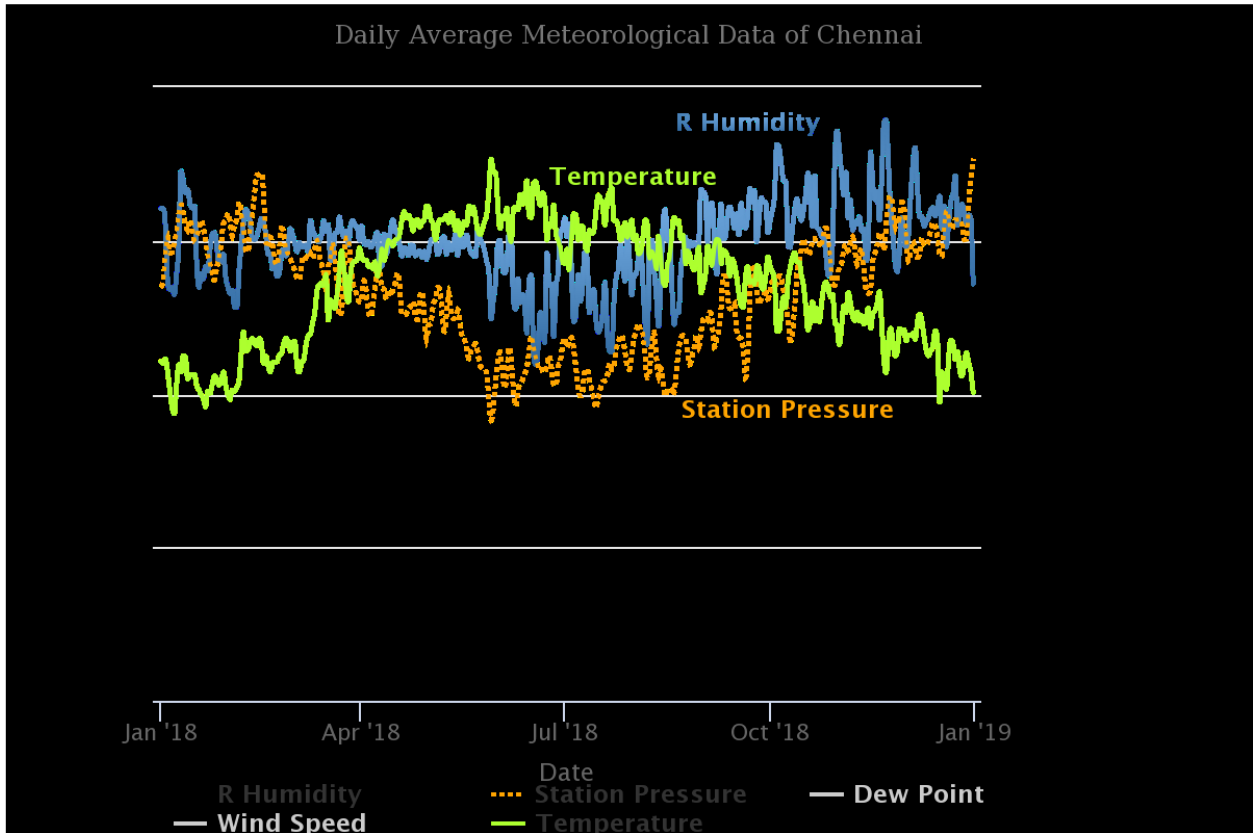
The Buckingham Canal is a sizable man-made canal that runs across numerous areas in Chennai. The canal, which runs along to the eastern Bay of Bengal coastline, is situated midway between the city's coastal and interior sections. It acts as a barrier, separating the interior from the coastal areas. Here is a more detailed description of its location in Chennai:

The Ennore district, known for its port, thermal power plant, and industrial zones, is where the canal passes through on its way to Chennai from the north, near to Ennore Creek.

- The canal continues south past the densely inhabited areas of Korukkupet and Tondiarpet before passing into the industrial districts of Manali, which are home to many petrochemical companies.
- The canal travels through the Washermanpet district and crosses the Cooum River as it heads towards Chetpet and Kilpauk.
- As it travels farther south, it passes through the populous areas and busy business areas of Kotturpuram and Adyar, where it joins the Adyar River.
- The canal finally reaches Besant Nagar, a residential neighbourhood on the coast, before continuing on to the southern regions of Chennai and beyond.
- The Buckingham Canal traverses a range of urban environments, including industrial sectors and residential neighbourhoods, and is an essential component of Chennai's infrastructure for water management and flood control.

### 3.1.3 Chennai climate

Chennai exhibits an average wind velocity of 3.7 meters per second, while the highest wind speed recorded in the region is approximately 11 meters per second. The mean temperature persists at 28.2°C, exhibiting a temperature spectrum of 19°C to 36.7°C. On average, the relative humidity persists at 74.60%, exhibiting a range of 41.7 to 96.9%. The atmospheric pressure at the station exhibits a range between 1007 to 996 hPa, while the mean pressure is calculated to be 1017 hPa. According to the wind rose chart of Chennai, the predominant wind direction is from the northeast, constituting approximately 14.61% of all recorded wind directions as shown in (Figure 14). The canal is influenced by the warm and humid climate of Chennai, which experiences limited seasonal fluctuations owing to its adjacency to the ocean and position on the thermal equator. (Ramachandran et al., 2019)



**Figure 14.** The graph shows the daily variation of meteorological parameters over the year in Chennai.

*Figure 14.* The graph shows the daily variation of meteorological parameters over the year in Chennai.

### 3.1.4 Chennai population data and urban sprawl UN

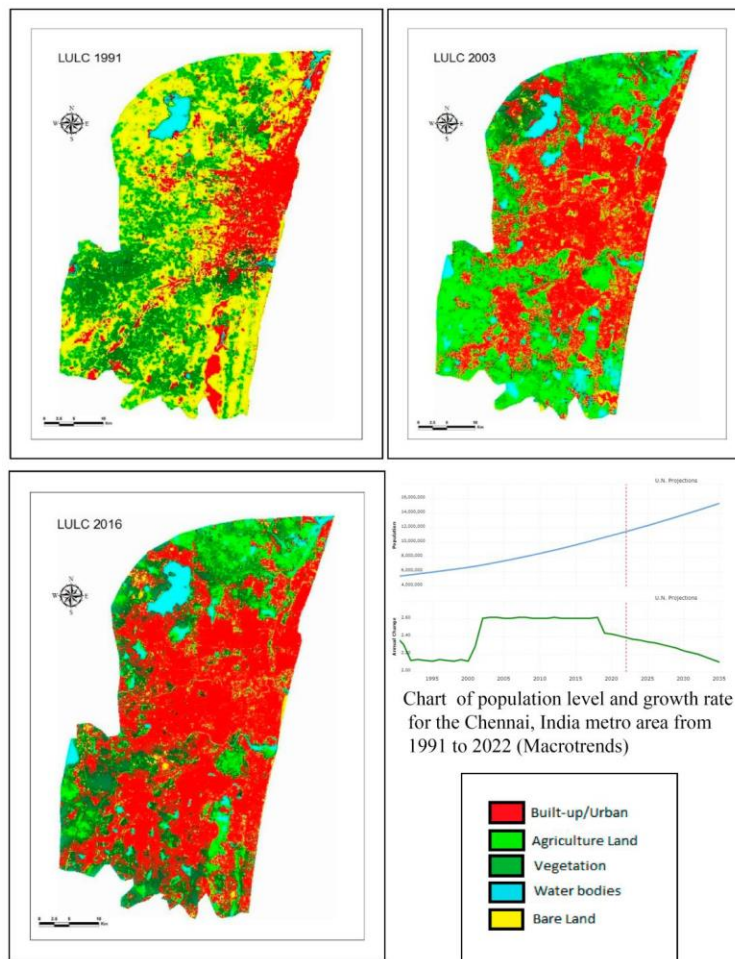
According to the World Population Prospects report by the United Nations, Chennai, formerly referred to as Madras, has exhibited a steady rise in its population, with the metropolitan area's populace estimated to have reached around 11,933,000 in 2023, indicating a 2.39% surge from the preceding year as shown in (Figure 15). (Padmanaban, et al. 2017) the analysis of satellite imagery captured in 1991, 2003, and 2016. The findings indicate that this process has resulted in considerable urban sprawl, particularly in the Kanchipuram and Thiruvalluvar districts. The process of urban expansion has predominantly taken place by encroaching upon unproductive



land. However, the depletion of vital flora and arable land has resulted in a noteworthy influence on urban topographies.

In the context of the Buckingham Canal, it is imperative to comprehend that this expansion of urbanization has a direct impact on the canal's well-being and capacity to endure. The process of rapid urbanization has resulted in the escalation of pollution, encroachment, and disregard towards the canal, thereby causing a shift from its once lively state to a state of neglect and contamination.

The canal is subject to Chennai's hot, humid climate with minimal seasonal variation due to its proximity to the ocean and location on the thermal equator. (Ramachandran et al., 2019)



**Figure 15** Transformation map 1991, 2003 and 2016 of Chennai land use and Landover



### 3.1.5 Chennai flood risk

Megacities' rapid urbanization and population growth, as well as a lack of effective planning and management, make flooding a bigger challenge. Adopting and implementing appropriate water rules can lessen the impact of floods. The National Water Policy (NWP) was created in 1987 and updated in 2012 and 2002, respectively, to reflect significant developments. In 2019, 2008, and 2008, respectively, the southern Indian states of Karnataka, Kerala, and Andhra Pradesh changed their water policies. State of Tamil Nadu (Rekha., et al. 2022)



**Figure 16.** Buckingham Canal, partly dredged taking the floodwaters (Mylapore time, 2021)

Chennai, the capital of the Tamil Nadu state, is known as the "Gateway to South India" because to its 43 km of coastline. Three rivers, the Cooum, Adyar, and Kosasthalaiyar, run through the Chennai city, which has a total area of around 178.20 sq. km. The Buckingham Canal, which connects 16 smaller canals and four reservoir tanks, including Red Hills, Cholavaram, Poondi, and Chembarambakkam, connects all three rivers. The current research is focused on studying the effects of floods along the Adyar watershed, which spans an area of 330 sq. km between latitudes  $13^{\circ}1'8.513''\text{N}$  and  $13^{\circ}3'29.645''\text{N}$  and longitudes  $80^{\circ}11'9.106''\text{E}$  and  $80^{\circ}15'54.819''\text{E}$ . In the summer, Chennai City experiences temperatures of  $40^{\circ}\text{C}$  and

typical rainfall amounts of 400 mm and 700 mm from the North-East and South-West monsoons, respectively. Adyar River specifics are shown in 17

<b>River</b>	<b>Adyar</b>
Origin	Adanur Tank Near Guduvancherry
Location Of Confluence With Bay Of Bengal	Adyar Mouth
Total Length In km	42.5
Length In City Limits In km	15
Length In CMA In km	25
Bed Width In meter	10.50 To 200
Anticipated Flood Discharge/Capacity In cusecs	60000/39000
Flood Discharge In 2005 In cusecs	55000
Flood Discharge From Chembarambakkam In 2015 In cusecs	29000
(Source: Chennai Metro Water Supply and Sewage Board, CMWSSB)	

**Figure 17.** Flood detail table (CMWSSB)

Floods have been a problem on the Adayar River's banks since 1976. Due to the el-nino effect in 2015, Chennai had its greatest rainfall, amounting to roughly 1612.10 mm, which caused a severe flood. Guindy, Adyar, Velacherry, T-Nagar, Ashok Nagar, Tambaram, Guduvancherry, and Chennai International Airport are a few of the prominent places heavily impacted by flooding during the flood event. Overabundant precipitation was found to be the main cause of the floods in Chennai. Extreme rainfall was seen on November 8–9, November 16–17, and November 30–December 1, which contributed to the tragedy. Figure 3 depicts the rainfall recorded at the Chembarambakkam reservoir gauge station of the Adayar River Watershed as well as the discharge of stormwater from various points in Chennai. (Surampudi, et al. 2017)

### 3.1.6 Impact of encroachments

The Corporation has identified a total of 28,000 buildings that are slated for demolition along the waterway. It is anticipated that the Chennai Corporation and other relevant agencies will commence efforts to enhance the cleanliness of Buckingham Canal in the city. This will involve the elimination of solid waste, prevention of the amalgamation of sewage from stormwater drains, and the eradication of encroachments. The process of urbanization has led to the encroachment of the Buckingham Canal. As per research conducted by the Indian National Trust for Art and Cultural Heritage, the canal's breadth has been diminished and the water flow has been obstructed due to the erection of edifices, thoroughfares, and other related infrastructure. The report additionally examines the impact of encroachment on the historical and cultural significance of the canal. (Eyes on the canal, 2018)

The process of urbanization has led to the encroachment of the Buckingham Canal. As per research conducted by the Indian National Trust for Art and Cultural Heritage, the width of the canal has been diminished and the water flow has been obstructed due to the erection of edifices, thoroughfares, and other forms of infrastructure. The report additionally examines the impact of the encroachment on the historical and cultural significance of the canal. The phenomenon of urbanization has resulted in the encroachment of the Buckingham Canal. According to a study carried out by the Indian National Trust for Art and Cultural Heritage, the width of the canal has been reduced and the flow of water has been impeded as a result of the construction of buildings, roads, and other types of infrastructure. The report further investigates the effects of the encroachment on the historical and cultural significance of the canal. (INTACH, 2018).

The present research investigates the consequences of encroachments on the Buckingham Canal in Chennai, encompassing their effects on the adjacent ecosystem and the broader ecology. According to the study, encroachments have had a notable impact on the navigability of the canal, resulting in flooding and associated problems. The research findings indicate that encroachments have resulted in a decline in the ecological worth of the canal, thereby impacting the indigenous biodiversity of the area This study examines the ramifications of

encroachments on the Buckingham Canal in Chennai, including their impact on the local ecosystem and ecology. The research claims that encroachments have significantly damaged the canal's navigability, leading to floods and other related issues. The research findings indicate that encroachments have resulted in a decline in the ecological significance of the canal, thereby impacting the regional biodiversity as shown in figure 18. (jishamoli, et al.2014)



**Figure 18.** encroachments along the Buckingham Canal.

The present discourse concerns the issues and resolutions pertaining to the Buckingham Canal. The Buckingham Canal in Chennai is beset by a multitude of issues, among which encroachments represent just one facet. This essay examines the legal and administrative frameworks governing the canal and proposes various measures to address the issue of encroachment, such as the creation of green spaces along the canal banks and public education campaigns aimed at promoting the preservation of the canal. (Srinivasan, et al.2013)

The Buckingham Canal Restoration Project in Chennai is currently encountering challenges with encroachments. According to the paper, encroachments pose a significant obstacle to the restoration effort due to their adverse impact on water quality and canal flow. The research provides several suggestions for mitigating the problem of encroachments, including the

removal of non-compliant constructions and the creation of verdant areas adjacent to canal margins. (Arun kumar, et al. 2018)

In general, the aforementioned studies underscore the adverse impacts of encroachments on the Buckingham Canal in Chennai and offer numerous solutions to address the issue. The proposed restoration project from Kasturiba Nagar aims to improve the navigability and ecological value of the canal by addressing encroachments.

### 3.1.7 Industrial sewage on the canal

The discharge of industrial wastewater into the canal.

Insufficient provision of adequate sewage treatment infrastructure: In numerous sectors, the availability and proper utilization of sewage treatment plants (STPs) may be inadequate. Consequently, incomplete or insufficient processing of industrial waste results in its discharge into the canal, thereby contributing to pollution. Untreated residential sewage is also introduced into the canal, alongside industrial waste. This exacerbates the problem of pollution as shown in figure 19

The canal is frequently utilized as a site for the disposal of solid waste, resulting in the accumulation of debris that disrupts the natural hydrological processes, leading to the stagnation of water and an increase in the concentration of pollutants. Unsanctioned construction and encroachments along the canal have resulted in the disruption of the natural flow of water and contributed to the problem of pollution. Prominent climate adaptation strategies that are based on natural processes. Water pollution can lead to canal congestion. The drainage system in Chennai City comprises canals, which unfortunately are often utilized as receptacles for waste disposal by the general public. This practice poses a significant risk of contamination and damage to the drainage system. The acquisition and examination of data pertaining to the nearby vicinity could potentially provide insights into the impact of industrial waste on the Buckingham Canal and facilitate the development of pragmatic pollution mitigation approaches.



The objective is to gather data pertaining to the quantity and composition of industrial sewage that is being discharged into the canal. To obtain this information, various methods can be employed such as conducting interviews with local business proprietors, analyzing industrial licenses, and assessing the quality of the water supply through testing.

Formulate a comprehensive pollution control strategy based on the findings obtained from the data analysis. In order to effectively mitigate the issue of industrial sewage discharge and improve pollution control measures along the canal, it is imperative that the plan delineate specific actions to be taken. Several measures have been implemented to mitigate the negative impact of industrial effluent discharge, solid waste contamination, and canal preservation. These measures include the establishment of STPs and other treatment facilities to treat industrial effluent, the construction of trash traps to prevent solid waste contamination, and the promotion of public awareness regarding the importance of canal preservation.

The process of monitoring involves closely observing the pollution levels of the canal and implementing appropriate modifications to pollution management strategies as needed. The establishment of a monitoring program by the project team is a viable option to oversee the levels of pollution, quality of water, and effectiveness of pollution control techniques.



**Figure 19.** Untreated sewage pumped into Buckingham Canal (CMWSSB)

To address this issue, several measures can be taken

**Strict enforcement of regulations:** Authorities should enforce environmental regulations strictly and ensure industries are operating in compliance with the law. Industries not adhering to the rules should face penalties and be required to implement necessary measures to prevent pollution. **Improve sewage treatment facilities:** Both industrial and residential sewage treatment facilities should be upgraded to meet current standards. This would help in preventing untreated waste from entering the canal.

**Public awareness campaigns:** Organizing public awareness campaigns can educate people about the importance of proper waste disposal and discourage them from dumping solid waste in the canal.

### 3.1.8 Pollution control and garbage disposal

The pollution control and waste management system for the proposed Kasturiba Nagar to Thiruvanmiyur MRTS Buckingham Canal Restoration Project: baseline assessment Make a baseline evaluation of the canal's current degree of pollution. This investigation may include testing the quality of the water, making visual observations, and mapping pollution hotspots. The assessment will provide a clear picture of the canal's size and pollution sources. **Plan to reduce pollution:** Make a thorough pollution control plan based on the findings of the baseline assessment. The specific actions that will be taken to address solid waste pollution, untreated sewage discharge, and industrial effluents should be included in the plan. These remedies can include building waste management facilities, placing garbage traps at strategic locations, and treating untreated sewage and industrial effluents.

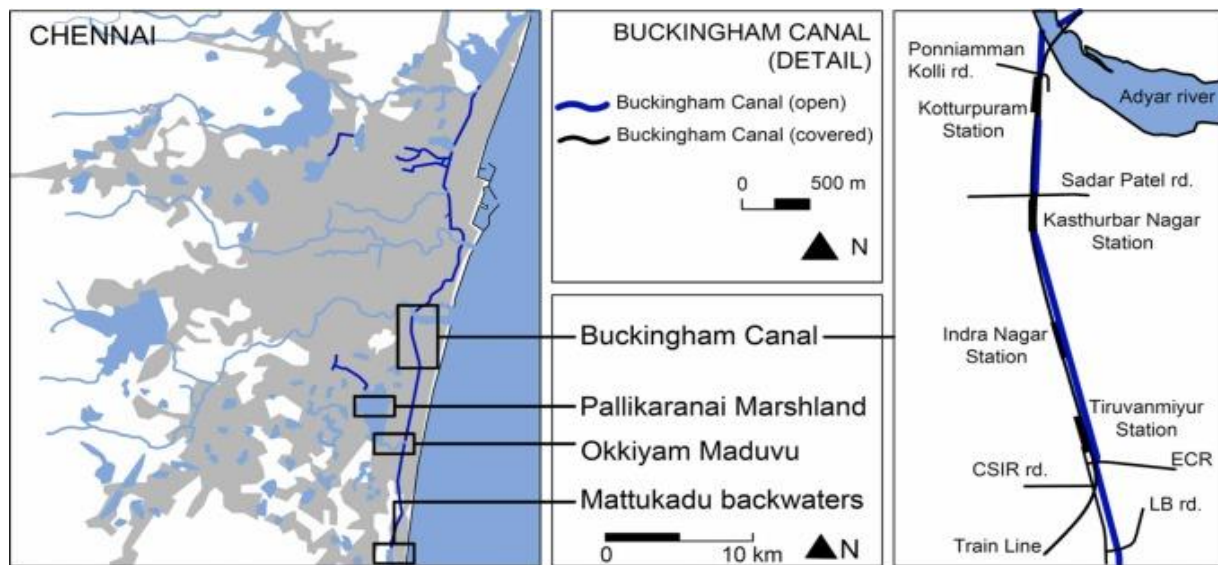
**Waste management:** Assist non-governmental groups and members of the local community in clearing out trash dumping sites, creating public restrooms, and educating people about the importance of the canal.

Overall, the proposed Buckingham Canal restoration project's approach to waste management and pollution control should consist of a thorough plan that addresses the canal's unique pollution concerns. To effectively control pollution and enhance the ecological health including waste management, treatment facilities, green infrastructure, and monitoring.

### 3.2 Stage 2

#### 3.2.1 Local area data collection and analysis 2km stretch

The selected site connects Kasturiba Nagar MRTS and Thiruvanmiyur MRTS, two important transit hubs in Chennai, along a two-kilometer stretch of the Buckingham Canal. This canal portion passes through many densely populated areas as well, making it an important commercial and transportation hub for neighboring settlements as shown in figure 20.

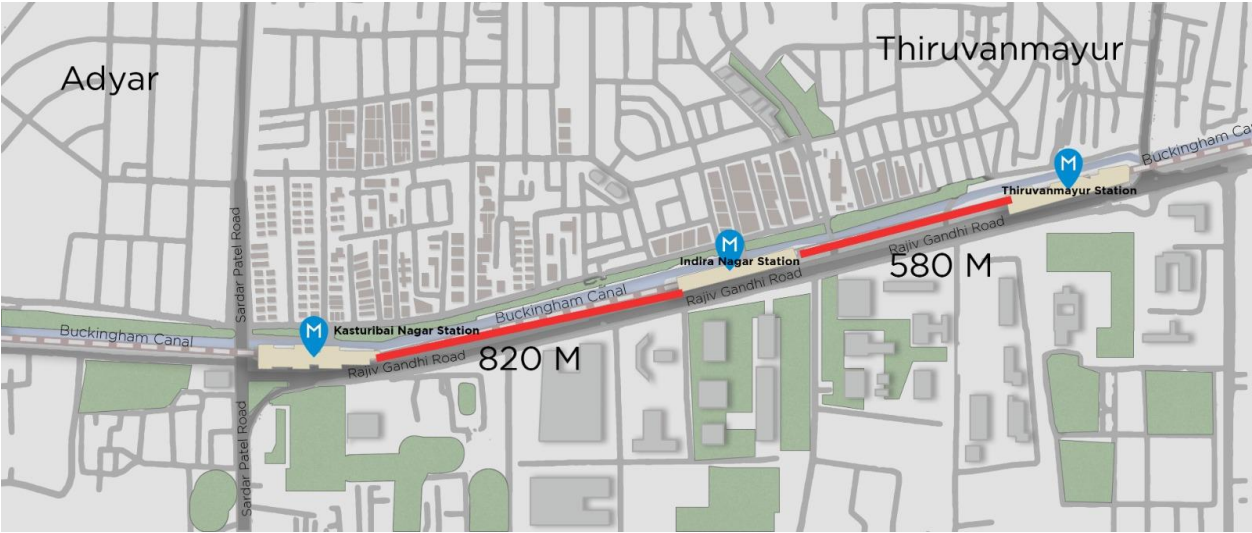


**Figure 20.** Detail location of Buckingham canal (Sánchez, et al. 2023)

As a result of encroachments, pollution, and sedimentation, the chosen place needs urgent rehabilitation. The repair of this section of the canal will provide an opportunity to revive the local economy via tourism and other related activities, in addition to improving the area's ecological stability. It is hoped that the restoration of this section of canal would complement and assist nearby initiatives like the Smart City programmed and the Coastal Management Program. This might ensure the long-term viability and improved efficacy of the restoration efforts.

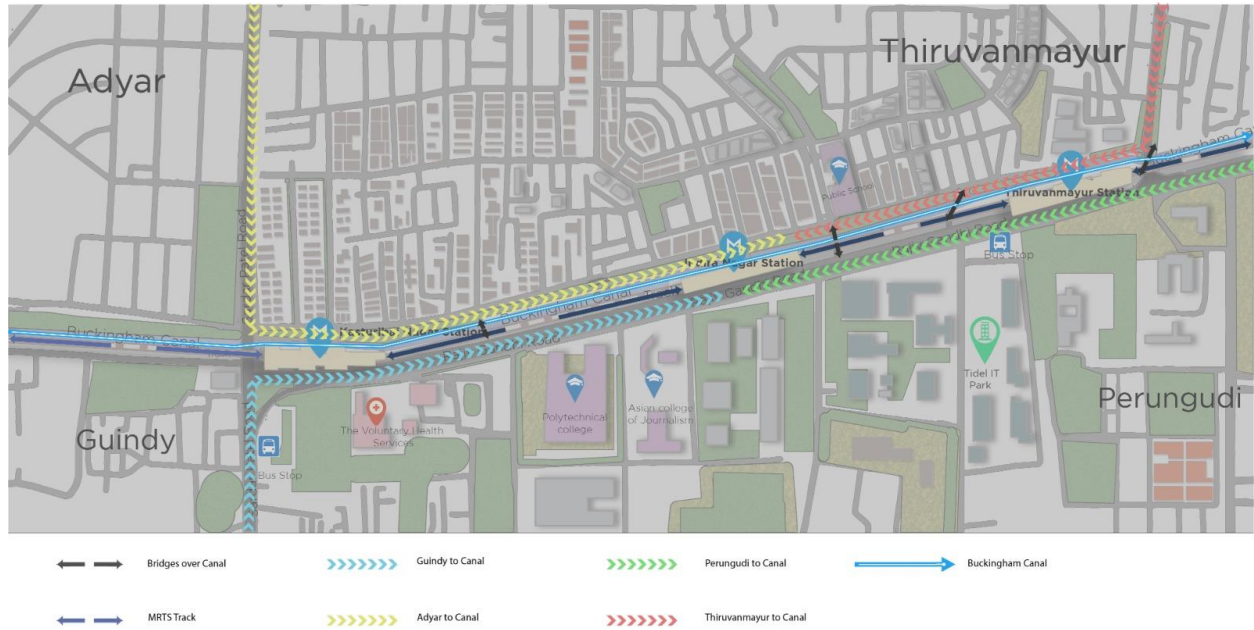


The region is home to a number of settlements with fishermen, merchants, and residents. It is feasible to make the final design idea more inclusive and sustainable by taking into consideration the requirements and objectives of various groups throughout the design process.



**Figure 21.** Location of case study area (Author 2023)

The southern region of Chennai, Tamil Nadu, India is the suggested location for the design proposal of the Buckingham Canal rehabilitation project from Kasturiba Nagar MRTS to Thiruvanmiyur MRTS. The Kasturiba Nagar MRTS is situated in the South Chennai neighbourhood of Adyar as shown in figure 21. The Adyar River, which empties into the Bay of Bengal, is located nearby. Thiruvanmiyur MRTS is situated near to the seaside in the southern portion of Chennai. The section of the Buckingham Canal that runs between these two MRTS stations is the suggested location for the design plan. With numerous important arterial roads crossing through the neighborhood, including the East Coast Road (ECR), Rajiv Gandhi Salai (OMR), and the Adyar Bridge, the property is well linked by road and rail. The Thiruvanmiyur MRTS station, which is a component of the Chennai Mass Rapid Transit System, is the closest railway station. The planned location is a significant economic and academic hub in the area due to its proximity to several significant university institutions, research facilities, and business parks.



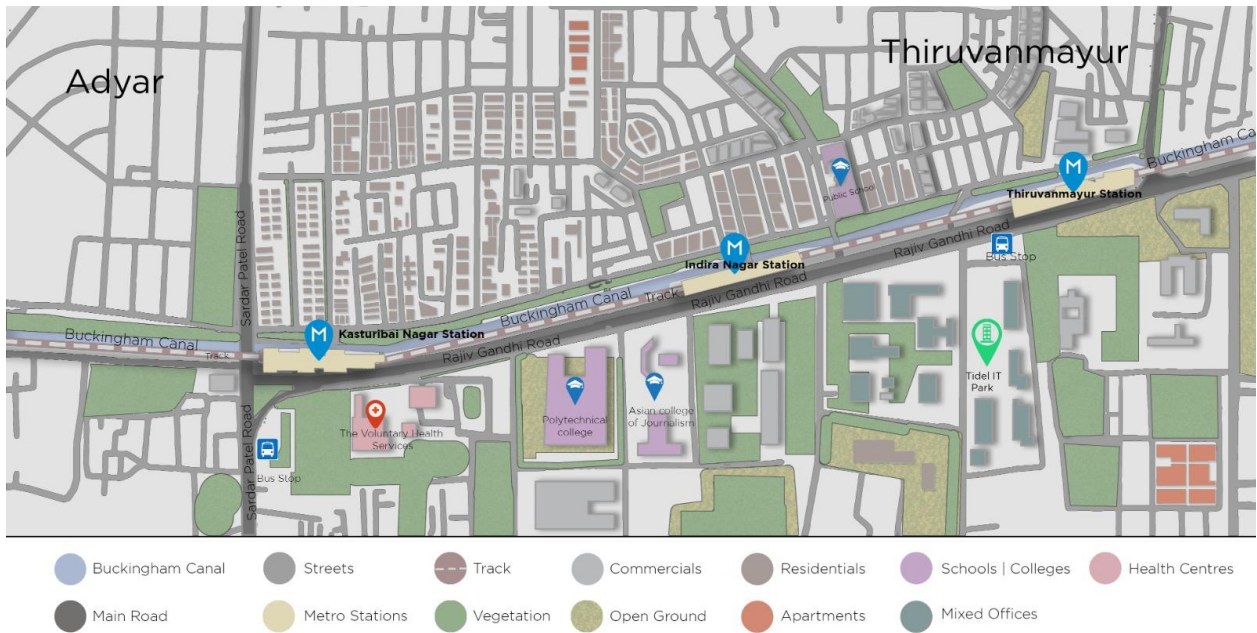
**Figure 22.** Access to study Area KNK Road (Author 2023)

### 3.2.2 Building typology

The Buckingham Canal rehabilitation project's planned site, which runs from Kasturiba Nagar MRTS to Thiruvanniyur MRTS, is essentially a transit corridor, hence there aren't many different building types immediately on the site.

However, a variety of structures, including residential, commercial, educational, and medical institutions, surround the site. There are several high-rise flats, gated communities, and independent homes in the adjacent neighbourhoods of Kasturiba Nagar, Kotturpuram, and Thiruvanniyur. While some of the nearby structures are new and well-maintained, others are outdated and in need of rehabilitation.

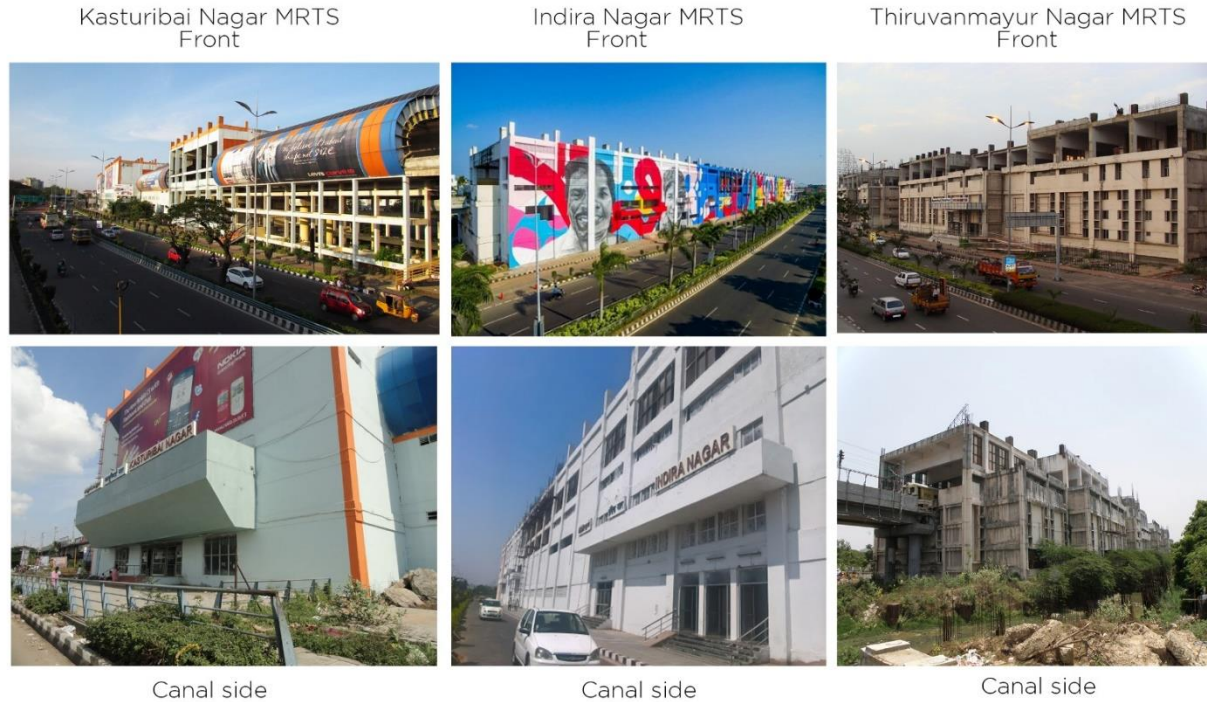
The location is also near to a number of educational institutions, including the Indian Maritime University, Anna University, and IIT Madras. These institutions are housed in a variety of structures, including as academic buildings, research facilities, libraries, and offices as shown in figure 22.



**Figure 23.** Building typology (Author 2023)

The property is also near to a number of medical institutions, including the Adyar Cancer Institute and Fortis Malar Hospital. These facilities include a variety of structures, such as medical facilities, research centers, and office buildings.

In conclusion, the proposed site for the Buckingham Canal restoration project from Kasturiba Nagar MRTS to Thiruvanniyur MRTS is surrounded by a variety of building types, including residential, commercial, educational, and healthcare facilities. However, there are few building typologies directly on the site. The restoration project is probably going to improve the local community’s-built environment, making it more appealing and sustainable as shown in figure 23.



**Figure 24.** Famous Landmarks of the study area (Author 2023)

The Kasturibai Nagar MRTS Station is located in the vibrant Kasturibai Nagar region of Chennai and serves as a crucial transportation hub and prominent landmark within the city's Mass Rapid Transit System. The prominence of the station can be attributed to its strategic location, which is situated amidst a variety of educational institutions, commercial establishments, and residential areas. The station's architectural design, while primarily utilitarian in nature, possesses an innate allure that serves as a reflection of the municipality's communal infrastructure as shown in figure 24.

The Indira Nagar MRTS Station, situated in the bustling locality of Indira Nagar, is a prominent landmark within the city. The location is situated in a heterogeneous land use area that encompasses residential, commercial, and recreational spaces, resulting in a vibrant centre of commotion. The proximity of the station to the Buckingham Canal confers a distinctive characteristic to its geographical placement. The station has gained recognition for its recent



incorporation of vibrant murals on its edifice, which depict and celebrate the indigenous art and culture of the region.

The Thiruvanmiyur MRTS station is a prominent geographical feature situated in the southern region of Chennai. The significance of this transit point is attributed to its adjacency to residential colonies, tech parks, and educational institutions in the vicinity. Furthermore, the station's close proximity to Thiruvanmiyur beach renders it a pivotal junction for both the indigenous populace and visitors who aspire to relish the scenic splendor of the coastal region.



Health Centres

Schools & Institutes

IT Park

**Figure 25.** Famous Landmarks of the study area (Author 2023)

The stretch of the Buckingham Canal spanning 2 kilometres between Kasturibai Nagar MRTS and Thiruvanmiyur MRTS stations is encompassed by a dynamic amalgamation of academic establishments, medical centres, and technology hubs.

The region is through to numerous esteemed educational institutions, establishing it as a noteworthy centre for education. Educational institutions such as Bala Vidya Mandir, A School, and Bharathiya Vidya Bhavan are renowned for their exceptional academic benchmarks. In addition, the region boasts various establishments of tertiary education, such as the Indian Institute of Technology Madras (IIT Madras), a distinguished engineering institution in India, and Anna University, recognised for its technical and architectural curricula.

The local area boasts several top-tier hospitals within its healthcare facilities. The Apollo Speciality Hospital located in Taramani provides a wide range of healthcare services that cover multiple specialties. Fortis Malar Hospital is a prominent multi-speciality medical facility renowned for its state-of-the-art medical and surgical provisions.

The region is noteworthy for its adjacency to the Taramani IT corridor, a thriving centre of technology enterprises and entrepreneurial ventures. The vicinity is home to prominent IT Parks such as Tidel Park, Ramanujan IT City, and SP Infocity. The technology parks in this region serve as a host to numerous prominent multinational companies in the IT and ITES sectors, thereby establishing the area as a noteworthy centre for employment opportunities.

To summarise, the region adjacent to the Buckingham Canal serves as a vital transport hub and a pivotal junction within the urban infrastructure that encompasses educational, healthcare, and IT amenities. The heterogeneous assortment of establishments contributes to the dynamic nature of the area and provides a variety of amenities to both its inhabitants and tourists as shown in figure 25.

### 3.2.3 Surface coverage

Since the surface has been covered Given the facts available, the canal's surface coverage may be the greatest, since the water surface is its most obvious feature. The canal's water surface is expected to encompass between 70 and 80% of the planned site's area. The vegetation along the canal likely covers 10 to 20% of the surface area. Green areas will be developed along the canal banks as part of the rehabilitation plan, which may promote increased plant growth.

Hardscaping components such as retaining walls, bridges, and paved and unpaved paths may account for 10 to 20% of the canal's surface area.

Residential and commercial districts: Because the planned site is largely a transit corridor, the business and residential districts along the canal are expected to have a moderate surface covering. The surface area of the business and residential sectors along the canal, on the other hand, is estimated to be between 5 and 10% of the total surface area as shown in figure 26.

It is crucial to remember that these estimations, which are based on the facts at our disposal, may change depending on where you are along the canal. The planned restoration project is expected to have a considerable influence on the canal's surface covering, with a greater emphasis on building sustainable and environmentally friendly surfaces that enhance the area's ecological health.



**Figure 26.** Surface coverage (Author 2023)

### 3.3 Stage 3

#### 3.3.1 Survey questions

In order for individuals to understand the Buckingham Canal restoration project's significance and relevance before responding to the survey questions, a short description of it is provided in the first part. This section goes on to provide background data on the participants' gender, age, and location as well as how these aspects of their life connect to the initiative to restore the canal.

The questions in the second portion are concerned with Chennai's Buckingham Canal as it is right now. It is crucial to understand how the canal's state impacts people's lives, what issues they encounter as a result of its deterioration, and how the restoration of the canal can possibly enhance their standard of living.

Questions on the overall second portion are concerned with Chennai's Buckingham Canal as it is right now., such as for commuting or entertainment, open the third segment. After that, it discusses case studies including infrastructure and canal restoration as well as what can be done going forward to repair and preserve the canal to lessen the impacts of urban heat islands and enhance the environment.

A number of photographs are included in the fourth portion of the poll to add interest and gauge responses to various Buckingham Canal-related situations.

Participants are shown pictures of restored canals and green architectural styles in a global setting in the fifth portion. To find out how interesting these restoration examples are to participants, questions are posed and participants' responses are watched.

The optimal situation for the case study region is determined by asking questions after the presentation of four distinct canal restoration plan images in the sixth phase. A plan for the particular area will be suggested to restore the canal, reduce heat and pollution, and enhance human health and comfort based on the participants' level of confidence, the scenario they picked, and their comments. This design may be recommended for more sections of Chennai's Buckingham Canal using the same approach.



# 4. CHAPTER FOUR: RESULTS

## 4.1 Demographic Overview: Location, Gender, Age Group, and Occupation

The next series of questions asked regarding the participant's basic information produced a total of 43 responses, with 69.8% of men and 27.9% of women responding. 67.3 percent of participants were from Chennai, while 32% came from the city's periphery, as indicated in figure 27.

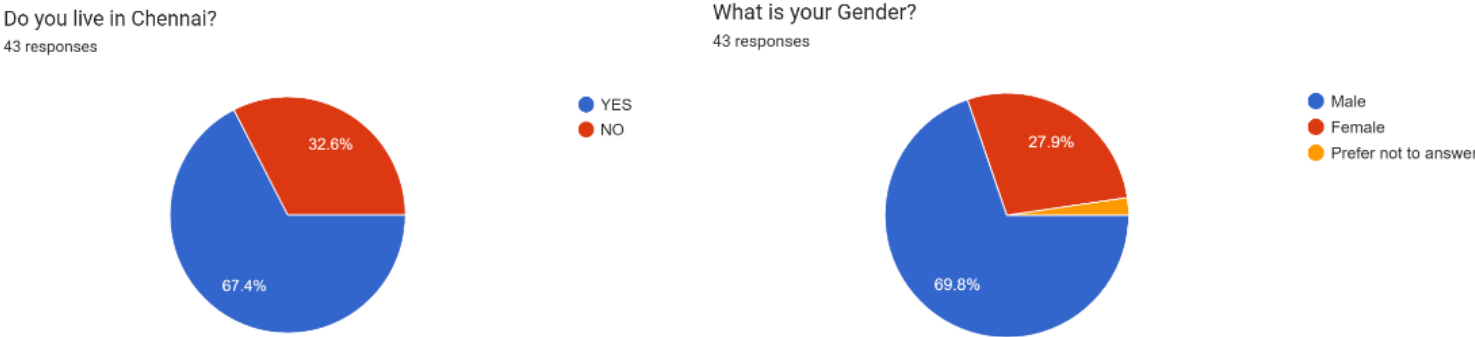


Figure 27. Participants location and the Gender responses

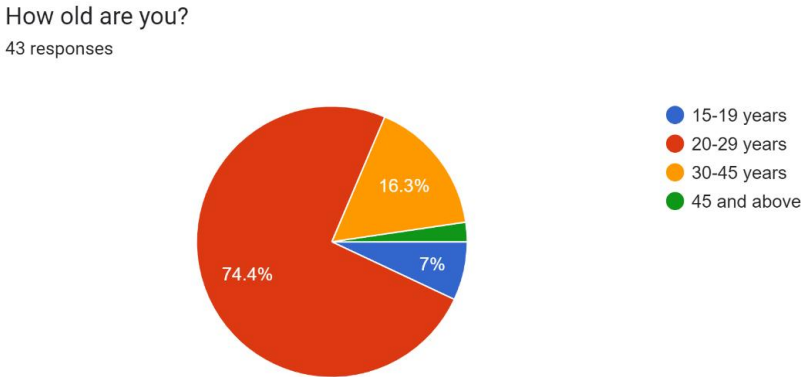
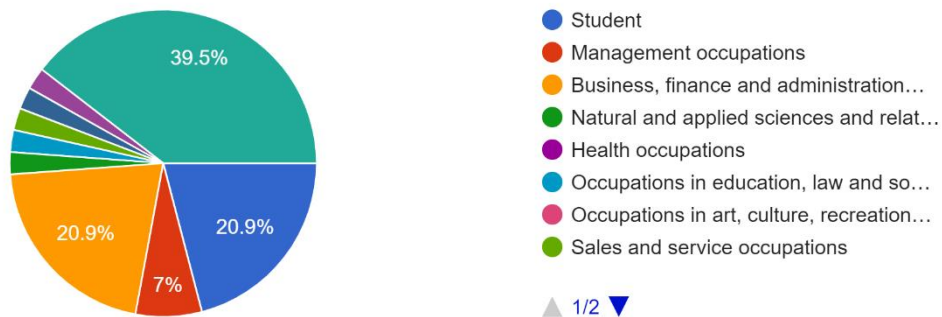


Figure 28. Age group responses

The age group of 20 to 29 years provided the bulk of the replies. This suggests that younger people are highly represented in the poll findings, possibly because they are more used to using digital surveys and social media platforms. There are considerable contributions from other age groups, such as those between the ages of 15 and 19, 30 to 45, and 45 and above, in addition to the main age group. The poll will capture a broad variety of viewpoints, experiences, and opinions about the Buckingham Canal restoration project thanks to the survey's diversified age representation. results are listed below in figure 28.

To which category does your occupation belong?

43 responses



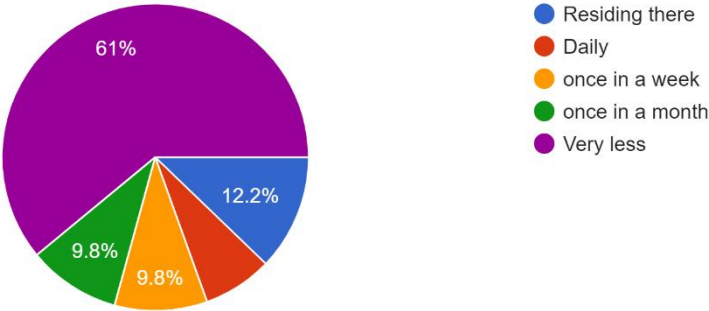
**Figure 29.** Occupation category

The survey respondents' distribution according to their jobs, which showed that the majority of respondents were workers and students. Those who were not employed, such as retirees or stay-at-home mothers, had a comparatively low participation rate. Although the respondents' range of occupations was wide, the design, construction, and real estate industries accounted for a significant part of replies, or 50%, of all responses. Furthermore, 20% of the participants worked in industries connected to business, as shown in figure 29.

Due to their professional involvement in the built environment and urban planning, those who work in the architectural, construction, and real estate industries may be more interested in the Buckingham Canal restoration project than the general public. This can be advantageous since their knowledge and experience might be quite helpful for the repair strategy.

To make sure that the survey findings provide a complete picture of the thoughts and requirements of the community, it is crucial to take into account the viewpoints of people from different professions and walks of life. However, it is important to consider the perspectives of other professions and individuals from various walks of life to ensure that the survey results represent a comprehensive view of the community's opinions and needs. Including diverse voices can lead to more inclusive and effective restoration strategies that cater to a wider range of stakeholders

How often do you visit Buckingham Canal?  
41 responses



**Figure 30.** visit to the canal

According to the poll findings, just 13% of respondents live close to the Buckingham Canal, and 61% of respondents visit it only sometimes. The canal's present level of pollution may be assigned to the low number of daily and weekly visitors, which probably deters people from visiting the region. as shown in figure 30.

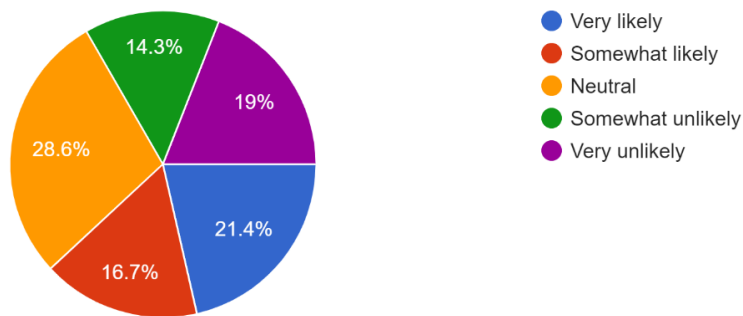
These results provide insightful information for the repair process. In order to make the canal more appealing and accessible to the community, it is important to address pollution and other environmental problems, as shown by the large number of respondents who visited the canal only sometimes. It is also crucial to take into account the requirements of the 13% of respondents who live close to the canal. Since the health of the canal directly affects their everyday life, consideration of their input should be given top priority while creating the restoration plan.

Enhancing the canal's environment as a whole has the potential to attract more tourists, help the neighborhood's inhabitants, and make the canal a lively, appealing public area. The restoration project has the potential to provide a healthier, more pleasurable environment that encourages people to visit the canal more regularly, building a closer link between the community and this priceless urban resource by tackling pollution and other urgent challenges.

## 4.2 Public Opinion on the Buckingham Canal and its Impact on Chennai's Social movement and Recreational Activities.

How do you feel the Buckingham Canal, along the MRTS Stations impact your travel?

42 responses



**Figure 31.** Usage of mass rapid transport system

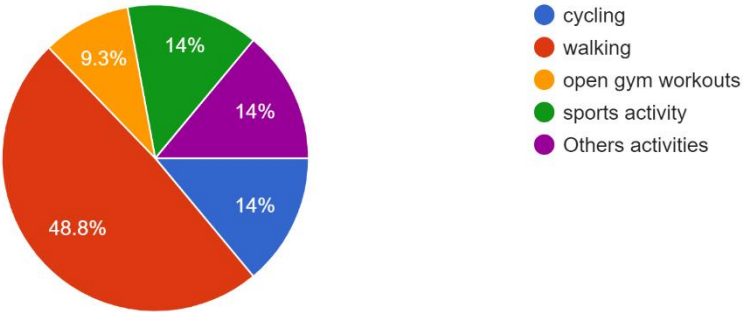
The next question was about the usage of MRTS the majority of the people were impacted because of the polluted canal

The physical infrastructure of the MRTS might also be impacted by the dirty canal, which would have an effect on how it is used. For example, if the canal is close to the MRTS tracks, the pollution may harm the train's infrastructure or interfere with its operation. This can cause MRTS service delays or disruptions, which would make it less dependable and less attractive to prospective customers as shown in figure 31.

In conclusion, the contaminated Buckingham Canal may have a variety of effects on MRTS use, including deterring users, harming the infrastructure, and changing how the community is

seen as being safe and clean. Restoring the canal could be able to lessen these effects and raise the region's MRTS system's allure and dependability.

What type of Recreation activity do you usually partake?  
43 responses



**Figure 32.** Responses for Recreational Activities

The next question was about the recreational Activities along the canal. The survey results indicate that the Buckingham Canal provides a wide range of recreational activities for visitors, amidst its scenic surroundings and tranquil ambiance. The results indicate that walking was the most favored activity among the respondents, with a preference rate of 48%. This suggests that the canal is perceived as an attractive and peaceful destination for relaxed walks. The canal functions as a suitable retreat for individuals in search of relaxation and an opportunity to appreciate the natural environment, thereby offering respite from the fast-paced lifestyle of urban areas.

The versatility of the canal as a space for energetic pursuits is exemplified by the fact that 14% of respondents reported enjoying cycling and other sports activities. The canal's routes offer a splendid prospect for cycling enthusiasts to traverse through the picturesque landscape. The canal offers a diverse array of outdoor activities, including sports such as frisbee, soccer and other recreational games. According to the survey results, 10% of the participants engage in open gym workouts, indicating that the canal provides an opportunity for fitness enthusiasts who prefer to exercise in a natural environment. The provision of outdoor fitness facilities or

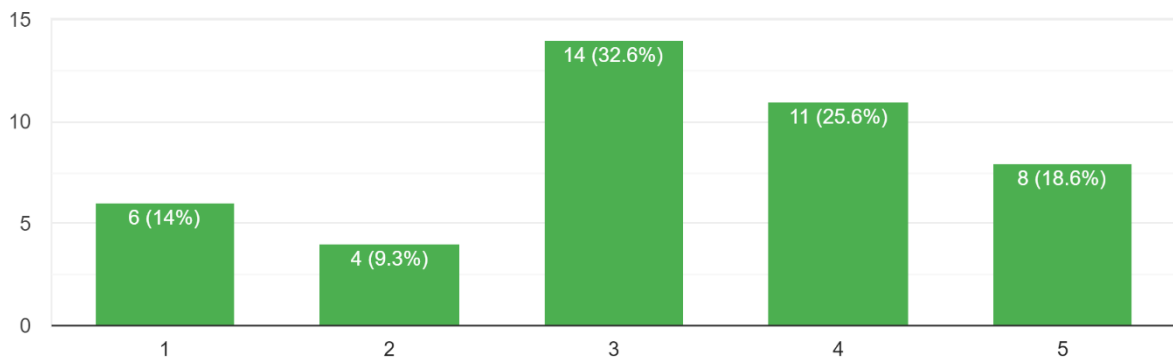
workout apparatuses adjacent to the canal enhances its appeal to individuals who aspire to uphold their physical fitness.

Furthermore, it is noteworthy that a considerable proportion of participants (14%) opted for "Other activities," indicating that the Buckingham Canal presents a plethora of varied leisure pursuits. The available activities encompass a range of interests and preferences, such as photo zones, outdoor art galleries, yoga, picnicking, or leisurely relaxation by the water. as shown in figure 32

#### 4.2.1 Movement

How will you rate the social activity and people movement Along B-canal.

43 responses



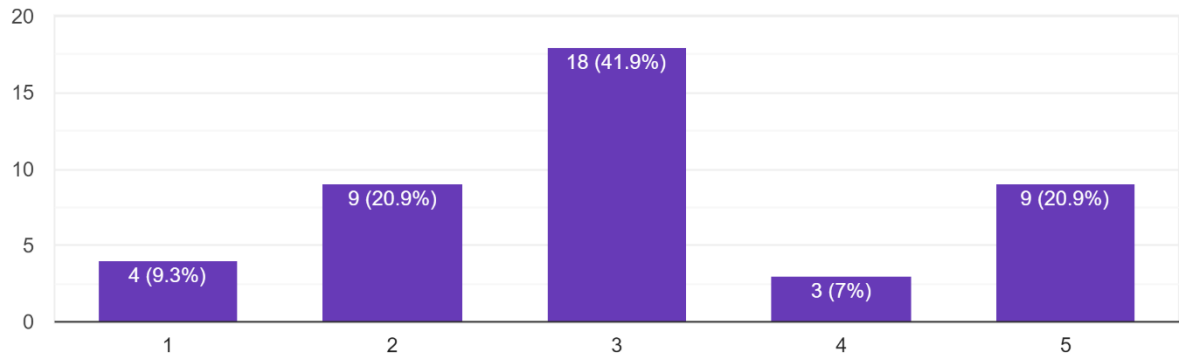
**Figure 33.** Responses for Movement along the canal

The Buckingham Canal runs through numerous key neighborhoods of Chennai, including Saidapet, Adyar, and Thiruvanmiyur. These areas are heavily inhabited and act as commercial and residential centers, which might result in increased traffic and involvement along the canal. Furthermore, the presence of institutions such as schools, universities, hospitals, and IT industries in these locations may result in a substantial number of people utilizing the canal for commuting or other reasons on a regular basis. as shown in figure 33.

## 4.2.2 Crime rate result

How safely do you feel when walking along B-Canal During Day.

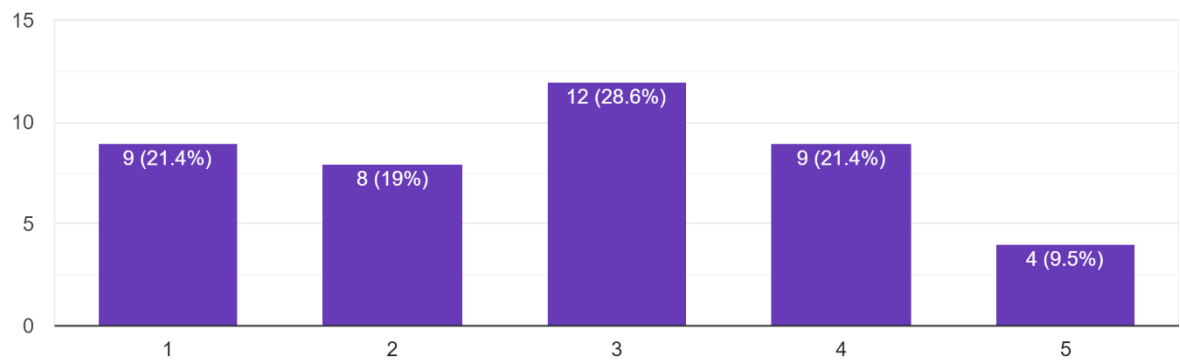
43 responses



**Figure 34.** Responses for safety during day

How safely do you feel when walking along B-Canal During night.

42 responses



**Figure 35.** Responses for safety during Night

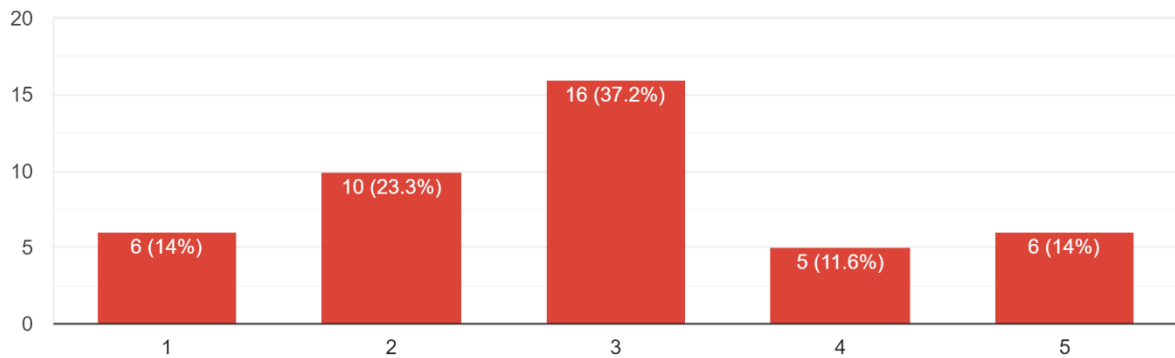
Movement along the canal seen as more dangerous at night than during the day owing to issues including insufficient light, a lack of security measures, and less visibility was the next question. The canal and its surroundings may be less secure at night due to inadequate

infrastructure, such as poorly illuminated walkways, a lack of security officers, or a lack of surveillance equipment. This could make people less likely to use the canal or take part in activities there after dark.

It is crucial to remember that this feeling of risk at night may change based on elements like the precise position along the canal, the season, and the level of criminal activity in the neighborhood. Personal experiences, cultural standards, and societal prejudices may also have an impact on how dangerous something is seen to be as shown in figure 34 & 35.

Overall, while creating plans for the repair and rejuvenation of the Buckingham Canal, it is crucial to take possible safety implications of the canal and its surrounding infrastructure into account, especially at night. By putting in place measures like better lighting, security guards, and surveillance systems, the area may become safer and more secure, attracting more people to utilize it and participate in activities along the canal.

Do you feel crime rate along B canal and its neighbourhood area  
43 responses



**Figure 36.** Responses for crime rate

According to the results of your survey, the majority of respondents believe that constructing pedestrian walkways and other amenities along the Buckingham Canal site area from Kasturibai Nagar MRTS to Thiruvanmiyur MRTS stretch would improve social vibrancy and help reduce crime rates in the area. as shown in figure 36.

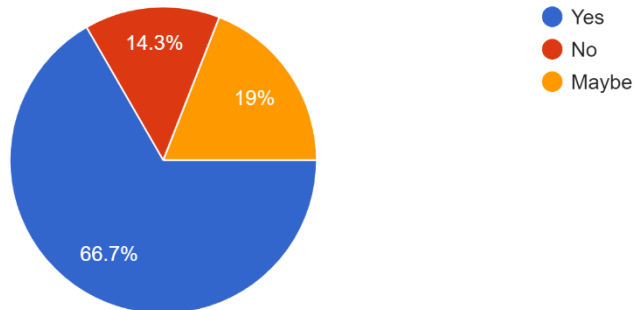


The restoration project may encourage more people to take a walk and interact with the canal by concentrating on establishing accessible pedestrian pathways, developing a feeling of community and increasing the number of "eyes on the street." Interaction and passive observation may create a safer atmosphere, eventually discouraging criminal activities. Other facilities, such as lounging places, green spaces, and well-lit locations along the canal, may also add to social liveliness. These aspects combine to produce appealing and friendly locations for people to congregate, participate in different activities, and enjoy their surroundings. This enhanced public visibility and feeling of ownership may deter criminal action even further, producing a positive feedback loop that strengthens safety and social cohesiveness.

Furthermore, the survey findings highlight the need for a complete strategy for canal restoration that includes not only ecological factors like water quality improvement and biodiversity increase but also urban design and social dimensions. By addressing the community's concerns and wants, the restoration project may assure its long-term success while also instilling a feeling of responsibility in local inhabitants, who will be more inclined to actively participate in conserving and maintaining the canal and its surrounding environment.

Do you feel Residents and Business community are affected by the poor maintenance of b canal and waste disposal in them?

42 responses



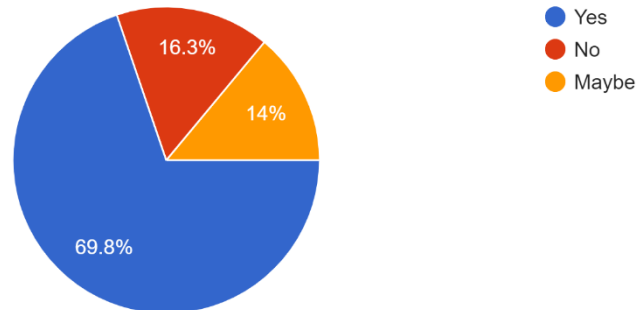
**Figure 37.** Responses to the poor Maintenance of b canal

According to the survey findings, 66.7% of respondents felt that the poor management of Buckingham Canal and the area's trash disposal practices have an impact on the inhabitants and business community. Furthermore, 69.8% of respondents agree that the Buckingham Canal's repair and rehabilitation will benefit both residents and businesses along the canal.

These results indicate that the community believes that the existing status of the canal and trash management practices have negative repercussions for nearby residences and businesses. This impression underlines the necessity for a thorough restoration strategy that not only tackles the canal's environmental challenges but also considers the project's social and economic repercussions as shown in figure 37.

Do you feel Restoration and rehabilitation of B-Canal will improve Residents and Business community along B-canal.

43 responses



**Figure 38.** Responses improvement of restoration of B-Canal

According to the poll findings, a large majority of respondents agree that repairing and renovating the Buckingham Canal would benefit the community. This conclusion demonstrates the community's support for a restoration project and emphasizes the possibility for good outcomes such as increased property prices, more commercial possibilities, improved public health, and a higher quality of life for people as shown in figure 38.

### 4.2.3 Measure cleaning results

What measures do you think should be taken to restore the Buckingham Canal?

43 responses



**Figure 39.** opinion about the measure on restoration

According to the survey findings, restoring the Buckingham Canal is a complicated challenge that requires a multifaceted strategy. The majority of respondents (40%) feel that all recommended actions should be done concurrently in order to successfully solve the canal's difficulties. Cleaning and dredging the canal, establishing pollution control measures, imposing stronger controls on companies around the canal, and fostering public involvement and community engagement are all part of these activities.

Cleaning and dredging the canal (16.5% response) is critical to its health and water flow. Regular hand or mechanical removal of silt, trash, and garbage may considerably improve the canal's overall condition. Another key part is the implementation of pollution control measures (9.5% response), which include purifying sewage and industrial effluents before they reach the canal, establishing suitable waste disposal systems, and encouraging eco-friendly practices in adjacent neighborhoods.

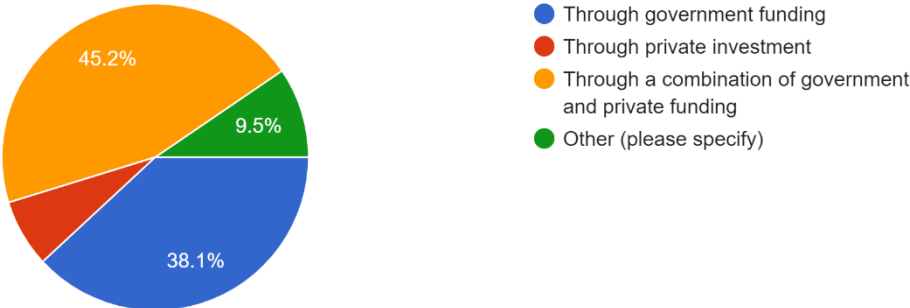
Furthermore, implementing stronger controls on companies along the canal (14% reaction) may help to reduce industrial pollution and safeguard the canal's environment. This may be accomplished by conducting frequent inspections, enforcing penalties for noncompliance, and prosecuting repeat violators harshly. Encouraging public involvement and community

engagement (20.5% response rate) is also critical to the canal's long-term viability. Through awareness campaigns, clean-up efforts, and educational programs, local communities, NGOs, and other stakeholders may be involved in the restoration process, fostering responsible behavior and environmental stewardship as shown in figure 39

In conclusion, restoring the Buckingham Canal will need a thorough and coordinated strategy. We can restore the canal to its former beauty and ensure its long-term preservation by combining cleaning initiatives, pollution control, stringent regulatory enforcement, and community involvement.

#### 4.2.4 Funds result

How do you think the restoration of the Buckingham Canal should be funded?  
42 responses



**Figure 40.** Funds for the restoration

The survey's findings show that the majority of respondents support a collaborative approach to finance the Buckingham Canal restoration. A mix of government and private financing is the ideal way, as backed by 45% of respondents. This strategy emphasizes the necessity of involving several stakeholders, including public and commercial institutions, in a collaborative effort to conserve this vital waterway.

Government financing, which is supported by 38% of respondents, emphasizes the importance of the public sector in resolving environmental problems and maintaining public assets. This

money might come from national or regional budgets, international organization grants, or environmental programmers expressly designed for restoration. Public financing may help enforce legislation and monitor pollution control measures to ensure their efficacy and compliance.

Private investment, which is supported by 7% of respondents, represents the opportunity for industries and enterprises, particularly those located near the canal, to contribute financially to its repair. Voluntary donations and required corporate social responsibility (CSR) activities may be successful methods of obtaining private money. Furthermore, public-private partnerships (PPPs) may facilitate collaboration between government agencies and private companies, supporting innovation and effective resource allocation.

Finally, 10% of respondents chose "Other," implying that additional financing sources should be investigated. These may include crowdfunding initiatives, contributions from individuals or non-governmental organizations, and assistance from international organizations dedicated to environmental protection. Such extra resources may not only assist in funding restoration work, but also involve the larger community and create awareness about the necessity of conserving the Buckingham Canal as shown in figure 40.

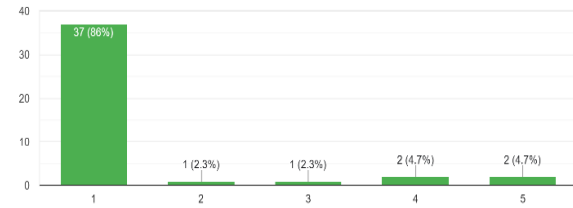
In conclusion, the poll findings show that a collaborative funding model incorporating government and corporate funds as well as other sources is the most preferred option for financing the Buckingham Canal restoration. Adopting this plan allows stakeholders to collaborate to guarantee enough resources are available to meet the problems connected with the canal's restoration and long-term viability.

## 4.3 Street scenario

### 4.3.1 Street scenario



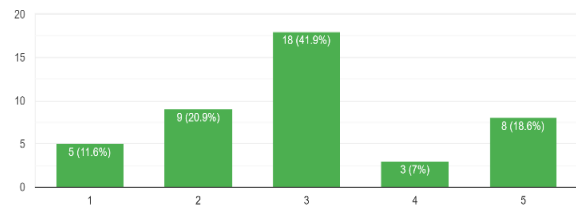
1. How appealing do you find this situation?  
43 responses



**Figure 41.** Street scenario Before



2. How appealing do you find this situation?  
43 responses



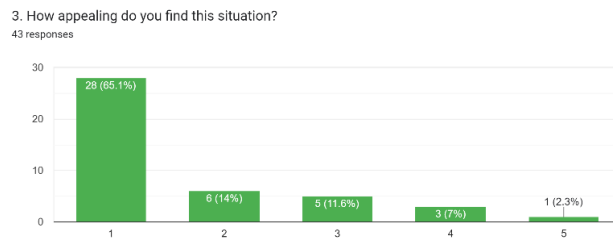
**Figure 42.** Street scenario after

The comparative photographs depicting the area in proximity to the Kasturibai Nagar Mass Rapid Transit System bridge crossing offer a compelling representation of the continuing obstacles and prospective remedies concerning the issue of contamination in the Buckingham Canal. The first image, which depicted a polluted view, elicited a limited reaction, potentially suggesting that individuals have become desensitized to the polluted condition of the canal or may feel daunted by the enormity of the issue.

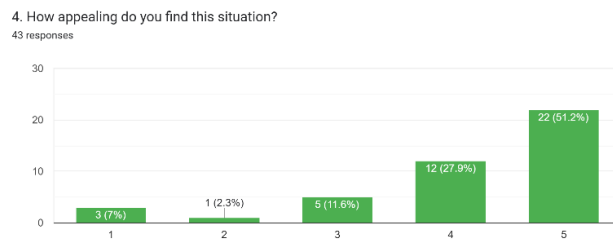
The second image, which portrays a cleanup event that occurred recently, elicited a moderate level of interest in contrast to the first image. This indicates that individuals tend to be more involved and invested when presented with proactive measures aimed at addressing the issue. Nevertheless, the transient effect of the cleanup occurrence underscores the necessity for

enduring and sustainable resolutions. In order to attain sustainable enhancements, it is imperative to not only perform canal cleansing but also to implement social programs and community involvement endeavors in the vicinity of the canal. Through this approach, the canal has the potential to serve as a central hub for communal engagement, fostering a greater sense of commitment towards its conservation and upkeep as shown in figure 41 & 42.

#### 4.3.2 Bridge scenario Before & After



**Figure 43.** Bridge scenario Before



**Figure 44.** Bridge scenario After

The before and after photographs underneath the MRTS bridge in Thiruvanniyur show a stark difference between the canal's dirty condition and its potential for transformation into a well-kept and appealing place. The first picture, which depicted garbage and sewerage streaming into the canal, was deemed unappealing by 75% of poll respondents. This reply suggests that people are aware of the harmful effect of pollution on the canal and the need of taking immediate action to remedy the issue.



The second picture, which included a children's play area and a well-kept environment, had a significantly more favorable reaction, with 75% of respondents finding it appealing. When properly cared for and maintained, the canal has the potential to function as a thriving communal place as shown in figure 43 & 44.

The large disparity in survey answers highlights the need of investing in canal repair and upkeep, as well as encouraging social and recreational activities in its vicinity. The community will become more active and committed to protecting the canal's cleanliness and well-being by making it into an enticing environment for children and families.

4.3.3 Canal scenario Before & after

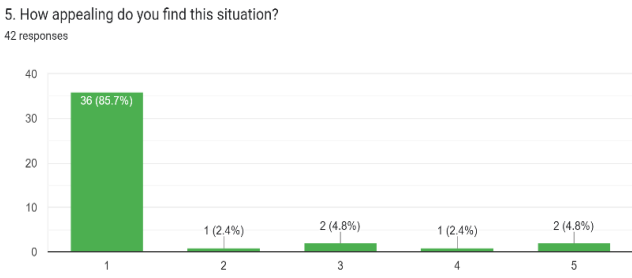


Figure 45. Bridge Scenario Before

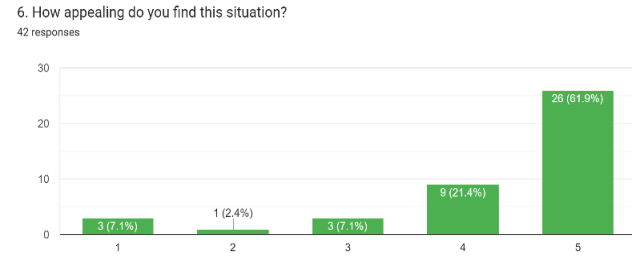


Figure 46. Bridge scenario After

The pictures presented in figures 45 and 46 demonstrate a noteworthy transition of the Buckingham Canal from its present condition to the intended configuration. The initial depiction (Figure 45) of the canal exhibits indications of disregard and contamination, along

with observable indications of infringement and misapplication. The depiction illustrates an environment that has undergone degradation and is presently underutilized in its capacity to make a meaningful contribution to the community.

In contrast, the image presented in the 'after' state (as depicted in figure 46) showcases a renewed perspective for the canal, which includes a designated pathway for pedestrians and a separate track for cyclists. The design exemplifies a space that is both inclusive and dynamic, serving to not only address environmental concerns but also enhance the community's worth. The proposed initiative offers the potential for an improved ecological landscape, resulting in enhanced well-being and a higher standard of living for the nearby populace.

The proposed transformation was met with a predominantly favourable response, indicating the community's inclination towards an ecologically sustainable and socially inclusive environment. The proposed alteration of the canal from its current state represents a noteworthy advancement towards sustainable urban development and the enhancement of community welfare.

Comparision



**Figure 47.** Response towards the three different scenarios along the canal

In this survey, the participants were provided with three distinct images that exhibited possible designs for the Buckingham Canal region. The initial image portrayed a pathway adjacent to the canal, furnished with seating arrangements. The subsequent depiction showcased a cycling lane in conjunction with the aforementioned walkway and seating provisions. Lastly, the third illustration solely exhibited a pedestrian walkway.

According to the survey findings, a significant proportion of respondents, accounting for 53.7% of the sample, expressed a preference for the design that integrated a pedestrian walkway furnished with seating arrangements alongside the canal, in addition to a separate cycling lane. The aforementioned statement implies a significant inclination towards versatile leisure areas that accommodate diverse preferences and encourage physical fitness and well-being. The incorporation of a dedicated cycling lane adjacent to the pedestrian walkway and seating zones presents supplementary prospects for physical activity and alternate means of transportation, thereby augmenting the overall attractiveness of the area.

Conversely, 36.6% of respondents opted for the blueprint that showcases a pedestrian pathway accompanied by resting spots, albeit lacking a designated cycling lane. This alternative presents a welcoming setting for individuals to partake in canal activities, unwind, and engage in social interactions. It may particularly attract those who favor a serene atmosphere or possess restricted enthusiasm towards cycling.

Finally, it can be observed that merely 10% of the participants opted for the alternative featuring solely a walkway, thereby signifying that the majority of the respondents place significance on the incorporation of seating areas and other supplementary facilities to establish a more captivating and comfortable environment along the canal

The survey results indicate that the restoration and revitalization of the Buckingham Canal should prioritize the creation of multi-functional spaces that can accommodate diverse interests and preferences. The option that garners the highest level of popularity entails the integration of a pedestrian walkway, designated seating areas, and a cycling path. This amalgamation would result in the formation of a vibrant and welcoming communal area that caters to the interests of a significant portion of the populace. By considering these preferences, the restoration initiative can optimize its potential influence and cultivate a heightened sense of pride and ownership among the community members.

In order to foster social engagement in the vicinity of the canal, a range of tactics may be employed, including:

Regular cleanup events can be organized to encourage a sense of ownership and responsibility for the cleanliness of the canal. Local residents, schools, and organizations can be involved in these frequent cleanup drives. the implementation of recreational spaces such as parks, walking trails, and cycling paths along the canal has the potential to draw in tourists and augment the canal's allure as a central location for outdoor leisure pursuits.

Organizing community events, such as cultural festivals, art exhibitions, and environmental workshops, can foster a sense of community and increase awareness regarding the significance

of preserving the canal. promoting the development of environmentally conscious enterprises, such as sustainable cafes or retail establishments, can foster greater community engagement and enhance public interest in the preservation of the canal.

The implementation of educational programs in schools and community centers can serve as a means to educate individuals about the ecological significance of the canal and the adverse effects of pollution. This can potentially cultivate a sense of accountability and stewardship among the populace.

Through the implementation of these strategies, the Buckingham Canal has the potential to evolve into a vibrant social and recreational hub, thereby augmenting community participation and cultivating a sentiment of esteem and responsibility. Consequently, this will engender a more enduring and ecologically viable resolution for preserving the sanitation and holistic well-being of the canal.

## **SURVEY CONCLUSION**

The findings of the survey indicate a significant inclination among people towards the rehabilitation and conversion of the Buckingham Canal into an appealing, hygienic, and dynamic leisure area. According to the respondents, the optimal strategy to finance the restoration efforts would be a blend of public and private funding. The participants also demonstrated a keen inclination towards diverse leisurely pursuits, including but not limited to walking, cycling, and engaging in sports activities, thereby underscoring the canal's potential as a central location for outdoor recreational activities.

The comparative images displayed in the survey are potent reminders of the existing condition of pollution in the canal and the possibility of favorable transformation through community-led initiatives. The results of the survey indicate that individuals exhibit a distinct inclination towards properly maintained and appealing areas situated along the canal. This underscores the necessity of allocating resources towards the revitalization of the canal, enhancing its infrastructure, and fostering social and leisurely pursuits.

The Buckingham Canal has the potential to become a sustainable and enjoyable environment for both residents and visitors through the implementation of pollution control measures, infrastructure improvements, and social initiatives. This can be achieved by prioritizing community engagement and fostering a sense of ownership and pride among stakeholders. In the end, the collaborative attempt will make a significant contribution towards the enduring conservation and rejuvenation of this invaluable metropolitan watercourse.

## **5. CHAPTER FIVE: DESIGN & DISCUSSION**

Based on the data obtained from the survey findings and consultations with experts, the proposed design for the rehabilitation of the Buckingham Canal centres on a 2km segment that spans from the Kasturibai Nagar MRTS to the Thiruvanmiyur MRTS stations. This locality offers the potential to establish a dynamic, captivating, and enduring communal area that accommodates the requisites and inclinations of the indigenous populace. The principal aims of the design encompass the establishment of spaces that serve multiple functions, the integration of pathways featuring seating arrangements and cycling routes, and the formation of a milieu that achieves equilibrium between serenity and liveliness.

Commence the design process by conducting an analysis of the current conditions and limitations present along the 2km canal stretch. This analysis should encompass factors such as the canal's width, the extent of available space for development, and any pre-existing infrastructure that must be accounted for. Assess the feasibility of incorporating the suggested design components, including pedestrian walkways, seating arrangements, and bicycle routes, within the given limitations, while simultaneously considering factors such as inclusivity, security, and ecological considerations.

Subsequently, it is recommended to investigate diverse layout alternatives and arrangements for the suggested components, while bearing in mind the necessity to establish a consistent and unified design that amplifies the overall encounter for users. It is recommended to employ landscape design principles in order to establish a cohesive linkage among the walkways, seating areas, and cycling paths. Additionally, it is suggested to integrate features that commemorate the distinctive character and identity of the vicinity.

During the development of design concepts, it is imperative to engage in collaborative efforts with architects, engineers, and urban planners to ensure that the proposed ideas are both practical and sustainable, while also being well-suited to the local context. The input and recommendations provided by stakeholders can aid in the enhancement and optimization of the design, thereby increasing the likelihood of attaining the intended goals and satisfying the community's expectations.

After the refinement and optimization of the design, it is recommended to involve the community once more in order to disseminate the proposed concepts and obtain feedback. This will afford an opportunity to ascertain that the design is congruent with the community's vision and to attend to any apprehensions or recommendations that may surface. Integrate the provided feedback into the ultimate design proposal, implementing any requisite modifications or enhancements to the strategy.

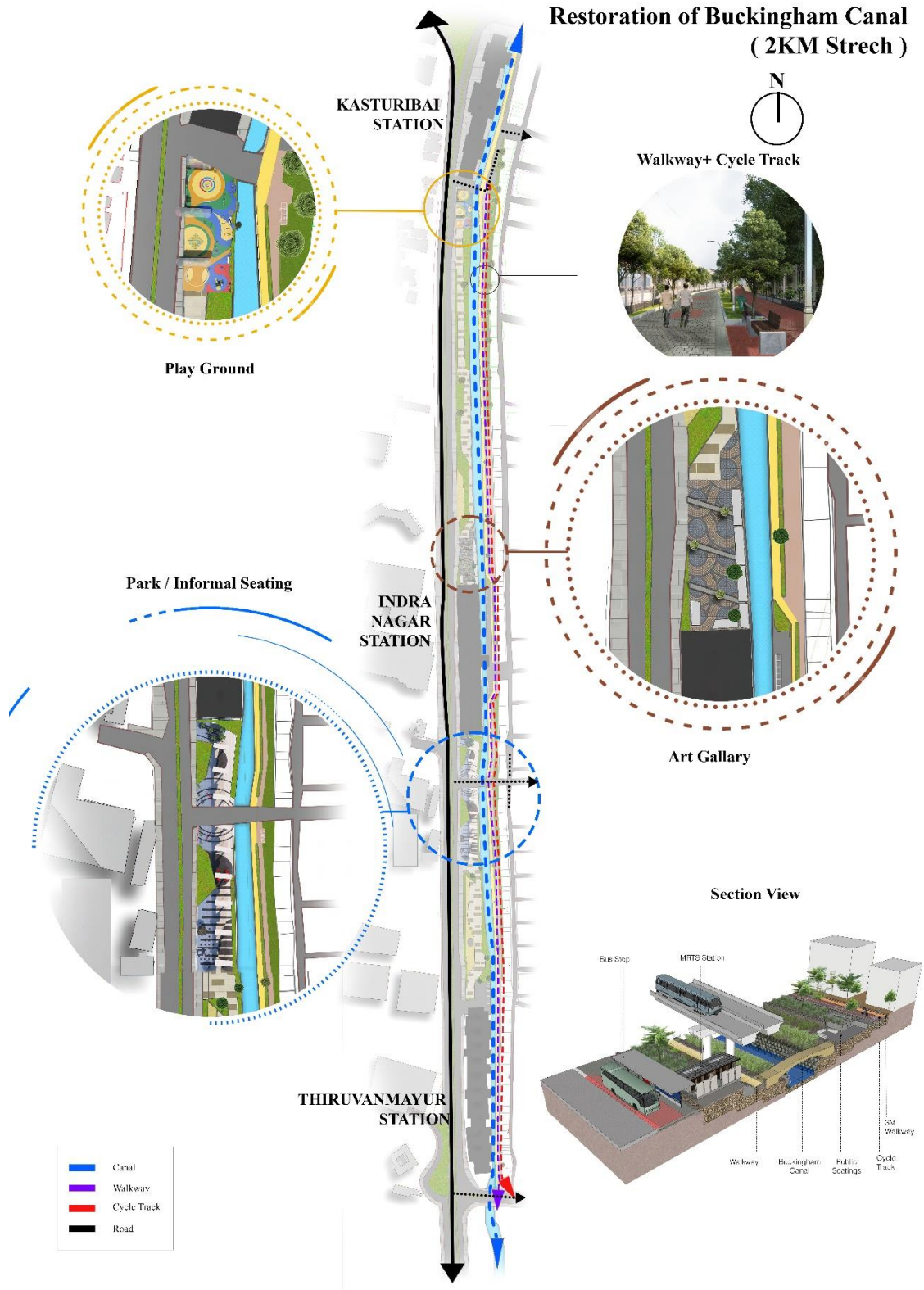
Upon receipt of a completed design proposal, the subsequent course of action involves deliberating on the challenges and prospects of implementation, encompassing financial considerations, community backing, and plausible ecological ramifications. Through the consideration of pertinent factors and the formulation of a comprehensive restoration plan for the 2km stretch of the Buckingham Canal spanning from Kasturibai Nagar MRTS to Thiruvanmiyur MRTS stations, the project can proceed with the assurance that it will establish a dynamic, interactive, and enduring communal domain that caters to the requirements of the populace and fosters the general rejuvenation of the locality.

The restoration of the Buckingham Canal holds promise for substantial enhancement of the well-being of nearby inhabitants, conservation of the region's ecological viability, and delivery of a diverse range of advantages pertaining to social, economic, and environmental aspects. Drawing from the favorable reception of the park in close proximity to Thiruvanmiyur and the knowledge acquired through consultations with specialists, my dissertation advocates for a holistic strategy aimed at rejuvenating the canal and its environs. This project entails the development of a 2km cycle and walkway stretch, a children's park in close proximity to the Kasturibai Nagar MRTS, an open art gallery adjacent to the Indira Nagar MRTS, and an expansion of the Thiruvanmiyur park that includes photo zone activities and seating areas along the river.





# Restoration of Buckingham Canal ( 2KM Strech )



**Figure 48.** design proposal for the 2KM strach

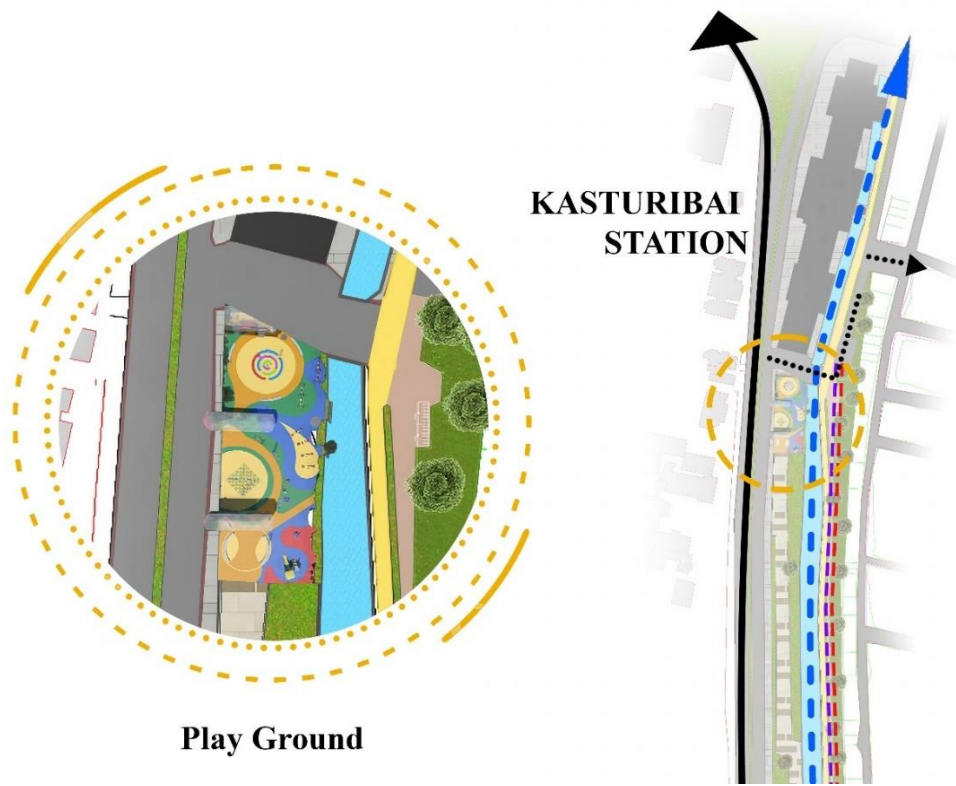
The 2-kilometer cycle and pedestrian pathway will function as a crucial linkage and leisure area for inhabitants, fostering a more healthful way of life and stimulating alternative transportation methods. The integration of sustainable materials and landscaping elements into the design of the walkway and cycle path will result in a harmonious fusion with the natural surroundings, thereby augmenting the visual allure of the vicinity. To ensure a secure and comfortable experience for all users, the path will be equipped with benches, lighting, and signage.

The restored section of the canal will feature green spaces and recreational amenities, including pedestrian walkways, bicycle lanes, public parks, and art galleries, with the aim of fostering community involvement and guaranteeing the long-term maintenance of the canal.

The proposed design incorporates both technological and ecological solutions to achieve a holistic and enduring strategy for the rehabilitation of the Buckingham Canal. The proposal attempts to bring back the Buckingham Canal by not only mitigating the pollution concerns but also establishing communal areas adjacent to the canal, thereby converting it into a thriving and significant component of the urban milieu.

### **5.1 First proposal**

The proposed children's park in the vicinity of Kasturibai Nagar MRTS is expected to offer a secure and appealing environment for families to congregate, engage in recreational activities, and establish a connection with the natural world. The park's layout is intended to accommodate a diverse range of age groups, featuring environmentally sustainable play structures, expansive areas for recreational activities, and shaded seating arrangements for parental supervision and caretaking. Through the incorporation of pedagogical components and avenues for juvenile acquisition of knowledge regarding the ecosystem, the park will cultivate a sentiment of responsibility and admiration for the innate world.



**Figure 49.** Childrens park and play area near Kasturibai MRTS



**Figure 50.** Aerial view of the children's park





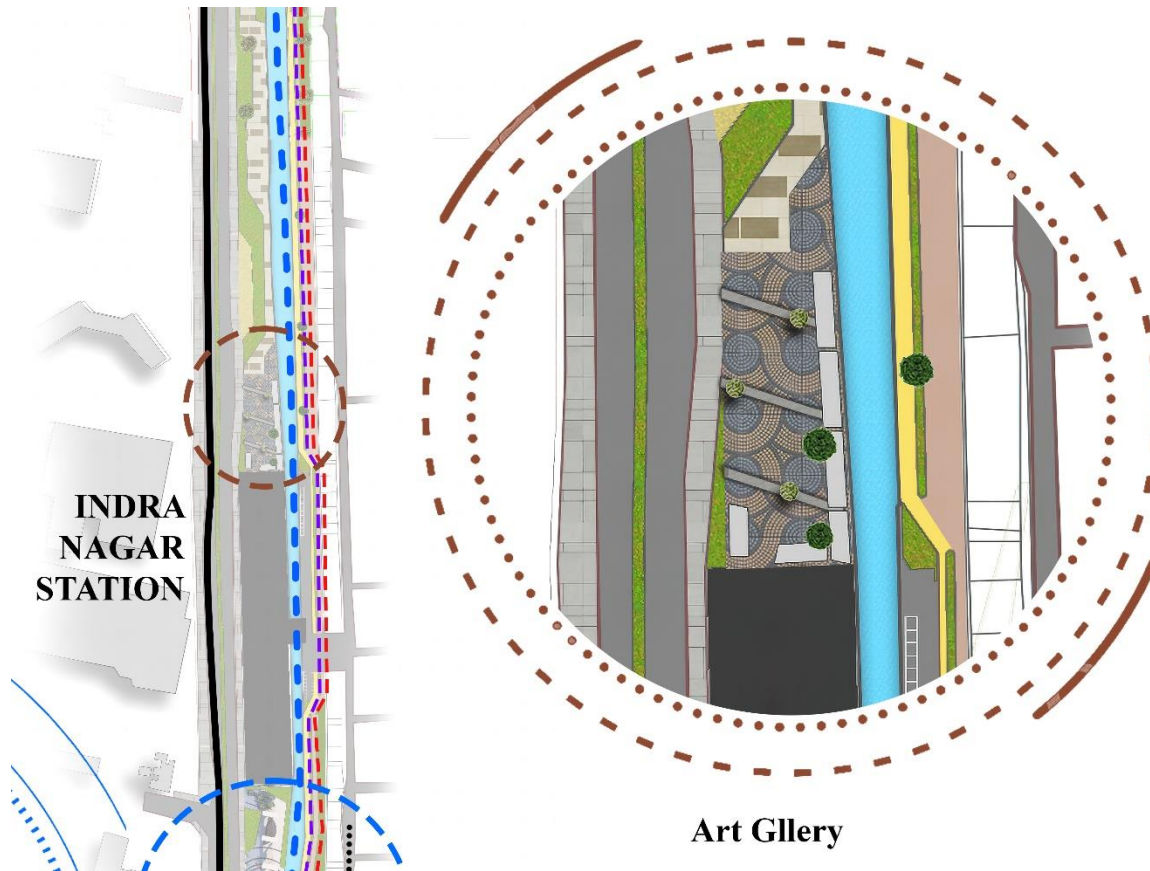
Figure 51. Children's play area 3D view 1



Figure 52. Children's play area 3D view 1

## 5.2 Second proposal

The proposed design entails the creation of an accessible art gallery in close proximity to the Indra Nagar MRTS station. This gallery would serve as a dynamic platform for regional artists to exhibit their artistic ingenuity and originality. The impetus for this project arises from the recent efficacious implementation of artwork on the buildings of Indra Nagar MRTS, which garnered a highly favourable reaction from the populace.



**Figure 53.** Open art gallery next to Indra nagar MRTS

The gallery endeavors to commemorate the cultural heterogeneity of the indigenous populace and facilitate the cultivation of a collective sentiment of communal gratification. The spatial configuration will be meticulously planned to facilitate a diverse range of artistic expressions, encompassing sculptures, murals, and installations. The proposed initiative is expected to enhance the canal area's cultural and aesthetic worth by offering visitors an immersive and user-friendly encounter.



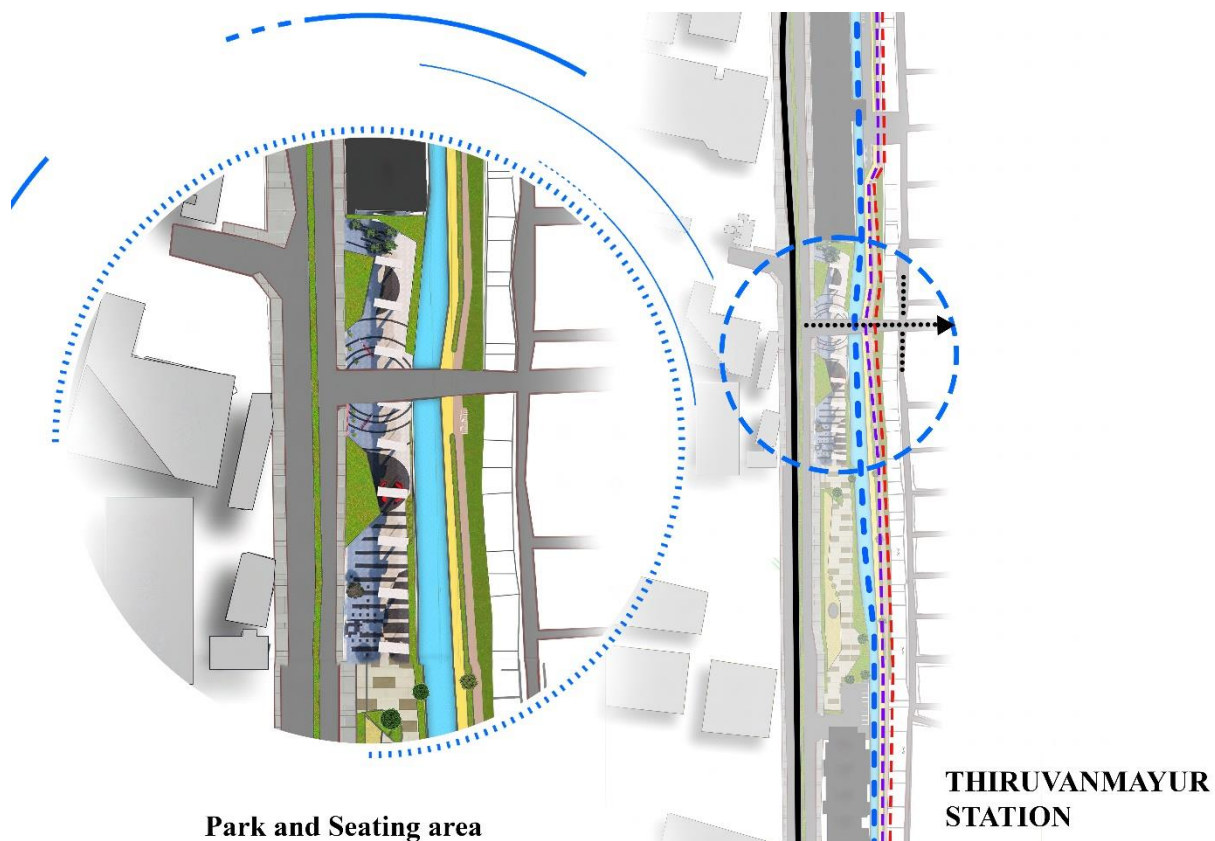


**Figure 54.** Open art gallery view

The provision of a venue for artistic expression and community engagement through the open art gallery is expected to not only enhance the aesthetic appeal of the canal but also foster local cultural development and communal participation. The aforementioned statement is consistent with the overarching objective of converting the Buckingham Canal into a dynamic, interactive, and enduring public area that embodies the distinctive character and cultural diversity of the neighboring populace.

### 5.3 Third proposal

The expansion of the Thiruvannmiyur park is expected to augment the recreational amenities available along the canal. The incorporation of designated areas for photography and seating arrangements is expected to incentivize tourists to capture the aesthetic appeal of the renovated canal and its environs, thereby promoting tourism and cultivating a feeling of communal gratification. The provision of seating areas is expected to create a tranquil environment that promotes relaxation, introspection, and social interaction, thereby enhancing the bonds between inhabitants and guests.



**Figure 55.** Park and seating are near thiruvannmayur junction

The discourse pertaining to my dissertation ought to encompass the diverse obstacles and prospects linked to the suggested plan for reinstatement. The involvement of community engagement is imperative for the success of the project. By engaging residents in the planning and implementation process, a sense of ownership and responsibility for the canal's ongoing



preservation can be established. Incorporating sustainable and environmentally conscious design principles throughout the project can effectively reduce its environmental footprint and foster enduring ecological sustainability.



**Figure 56.** Aerial view of Thiruvananthapuram junction



**Figure 57.** Ortho view of Thiruvananthapuram junction

It is imperative to conduct an analysis of the potential economic, social, and environmental advantages that the restoration project may offer. These benefits may encompass a rise in property values, an enhancement in the quality of life for inhabitants, and the promotion of a more robust ecosystem. It is imperative to conduct a comprehensive investigation into the obstacles associated with obtaining financial resources and backing from diverse stakeholders, including governmental bodies, private financiers, and community members. Additionally, the enduring upkeep and administration approaches necessary to guarantee the viability and triumph of the rehabilitation endeavors must be thoroughly examined. The thesis will underscore the significance of community participation, sustainable design, and strategic

planning in the rejuvenation of the Buckingham Canal, an urban watercourse. The plan will be comprehensive and all-encompassing.

The proposed developments possess the capacity to revolutionize the region into a lively, captivating, and enduring communal area, serving as an exemplar for comparable rehabilitation initiatives in other metropolitan settings



**Figure 58.** 3D view of thiruvanmayur junction 1



**Figure 59.** 3D view of thiruvanmayur junction 2

## 5.4 Sewage Treatment Plants

The proposed plan to tackle the persistent problem of water pollution in the Buckingham Canal places significant emphasis on the strategic placement of Sewage Treatment Plants (STPs) as a critical component. The objective of the design is to effectively mitigate the deleterious contaminants present in industrial and residential wastewater, prior to its release into the canal, with the ultimate goal of augmenting the overall quality of water.

The Chennai Metropolitan Water Supply and Sewerage Board (Metro Water) has been implementing preemptive measures to cater to the sewage treatment requirements of the city. An important initiative that has been undertaken involves the creation of additional Sewage Treatment Plants (STPs) in diverse areas, such as Sholinganallur (Indian Express, 2018).

Sholinganallur is a quickly developing region of Chennai that is experiencing a significant increase in population, resulting in substantial wastewater generation. The Sewage Treatment Plant (STP) located in Sholinganallur assumes a crucial function in the treatment of sewage

owing to its significant capacity. The proposed plan entails the integration of the STP with the Buckingham Canal, potentially serving as a catalyst for the canal's revitalization efforts.

The diversion of treated wastewater from the Sholinganallur Sewage Treatment Plant to the canal can guarantee the entry of solely treated and non-polluting water into the canal network. The implementation of this measure has the potential to substantially reduce pollution levels, thereby promoting a more salubrious and hygienic canal ecosystem. In addition, the processed water derived from the Sewage Treatment Plant (STP) can serve as a supplementary source of water for the canal's water stream, particularly in arid seasons, thereby aiding in the preservation of the canal's water equilibrium.

The canal's water quality and ecological health could be further improved by strategically linking other existing or planned Sewage Treatment Plants (STPs) in the vicinity of Sholinganallur. Through the integration of these municipal initiatives with our proposed strategy, our objective is to generate a synergistic outcome in which the collective impact surpasses the cumulative effect of individual measures. The aforementioned methodology guarantees optimal allocation of resources while simultaneously maximizing the potential for restoration of the canal.

The incorporation of Sewage Treatment Plants (STPs) into the canal restoration strategy not only presents a feasible approach for wastewater management, but also converts a possible ecological threat into a valuable asset for the revitalization of the canal. The implementation of a comprehensive and enduring strategy exemplifies the fundamental principles of urban resilience and establishes a pathway towards a more hygienic and salubrious Buckingham Canal.

## **5.5 Canal-side Urban Forest, Cycling and Pedestrian Pathway**

The proposed design aims to revitalize the 2km segment of the Buckingham Canal into a dynamic and versatile urban area that enriches the surroundings and elevates the standard of living for nearby inhabitants. The elimination of encroachments along the canal is a crucial element of this transformation. The implementation of the proposed enhancements can be facilitated by the liberation of a significant amount of space along the banks of the canal.

The objective of the project is to construct a cycling lane that is 3 meters in width, alongside a pedestrian pathway that is also 3 meters wide, both of which will run parallel to the canal for a distance of 2 kilometers. The purpose of these pathways is to offer secure and easily accessible routes for transportation modes that do not involve motor vehicles. This initiative aims to promote healthier and more sustainable lifestyles among the nearby community. The pathways will additionally provide an exclusive leisure area where both inhabitants and tourists can appreciate the picturesque allure of the canal and its environs.

Furthermore, a green space consisting of indigenous trees will be established adjacent to the canal, in addition to the walkways. The urban forest is expected to fulfil various purposes. From an environmental perspective, the addition of this space to the city will have a positive impact by increasing the amount of greenery, which in turn can improve air quality and promote biodiversity. Additionally, it can serve as a natural habitat for indigenous wildlife in the area. The presence of trees can contribute to the regulation of temperatures within a given region, thereby establishing a microclimate that is characterized by lower temperatures and increased comfort. The urban forest is expected to offer a tranquil and appealing environment for leisure and rejuvenation, thereby enhancing the physical and psychological health of the inhabitants.

The incorporation of the urban forest is expected to contribute to the enhancement of water quality in the Buckingham Canal. The tree roots will function as inherent filtration systems by assimilating contaminants and impeding their ingress into the canal. Furthermore, the existence of trees is expected to mitigate soil erosion along the canal embankments, consequently decreasing sedimentation in the canal.

The proposed plan entails the amalgamation of the bicycle path, pedestrian pathway, and urban forest components into a unified design that elevates the visual allure of the canal vicinity. The selection and placement of trees will be subject to meticulous evaluation to ensure their harmonious integration with the pathways and provision of sufficient shading while avoiding any obstruction of the canal views. Likewise, the configuration of the



walkways will strive to serve utilitarian purposes while also possessing aesthetic appeal, integrating features such as resting spots, illumination, and wayfinding markers.

The proposal for the Buckingham Canal's design envisions an urban space that has been transformed to achieve a harmonious balance between environmental conservation and the fulfilment of social and recreational requirements. The potential of this project lies in its ability to revitalize and reclaim the canal, thereby improving the urban landscape of Chennai and enhancing the quality of life for its inhabitants.

## **6. CHAPTER SIX: RECOMMENDATION AND CONCLUSION**

### **6.1 Recommendations:**

The imperative for heightened monitoring and regulation of both industrial and residential wastewater discharge into the canal is a matter of utmost importance. The proposed measures entail the implementation of pollution regulations, imposition of penalties on offenders, and routine monitoring of both industrial and residential zones that release effluents into the canal.

The implementation of supplementary Sewage Treatment Plants (STPs), particularly in regions with elevated levels of wastewater production, would effectively alleviate the release of unprocessed sewage into the canal. The possibility of enhancing the waste management capacity of the canal can be investigated by connecting the pre-existing Sewage Treatment Plants (STPs), such as the one situated in Sholinganallur, to the canal.

It is recommended that public awareness campaigns be implemented to underscore the significance of the canal and the ramifications of pollution. The engagement of indigenous communities in the process of canal restoration and conservation would additionally bolster the durability of these endeavors.

The establishment of green spaces and recreational amenities alongside the canal has the potential to promote community involvement and integrate the canal into everyday routines, thereby incentivizing its upkeep. Possible academic rewrite: The proposed infrastructure may comprise various facilities, such as sidewalks, bike lanes, and supplementary features.

## 6.2 Conclusion

The study provided significant insights into the diverse facets of urban water management, spanning from the preliminary investigation of the Buckingham Canal to the formulation of an all-encompassing strategy for its revitalization. The analysis of the present state of the canal, the origins of its contamination, and the consequences of these contaminants on the canal's ecological system have emphasized the significance of a methodical, all-encompassing, and integrative strategy for the administration of water resources.

The canal, formerly a thriving aquatic route, presently serves as a poignant testament to the consequences of urbanization and disregard. The findings of the study indicate that the present condition of the canal is not an inevitable outcome of urbanization. Rather than being a simple problem, this issue can be tackled by utilizing a blend of inventive, enduring, and comprehensive approaches.

The proposed plan for the restoration of the Buckingham Canal involves the implementation of several measures, such as the installation of Sewage Treatment Plants (STPs), construction of waste interception devices, and establishment of a continuous monitoring mechanism. These measures are aimed at addressing the issue of pollution and restoring the canal's ecological well-being, thereby demonstrating a strong commitment towards environmental conservation. Nevertheless, the conceptualization of the canal surpasses its mere revitalization in terms of its tangible infrastructure. The project involves the conversion of the canal into a dynamic communal area that fosters community engagement, advocates for eco-friendly practices, and elevates the standard of living for the urban populace.

The proposal to construct a 2km expanse of walkways and bike lanes, a play area for children, and an uncovered exhibition space for art, underscores the capacity of the canal to function as a bustling center of communal engagement. The project endeavors to achieve a harmonious coexistence between the community's requirements and the conservation of the canal's ecological system by incorporating these constituents into the canal's topography.



The results of this investigation emphasize the pivotal significance of community engagement in the accomplishment of the undertaking. The canal's long-term sustainability is contingent upon the crucial factors of public awareness and participation. The public engagement strategy that has been proposed involves educational initiatives and community involvement opportunities. This strategy is aimed at fostering a sense of ownership and responsibility among the residents towards the canal.

The rehabilitation of the Buckingham Canal has the potential to serve as a model for comparable endeavors in other regions of the city and beyond. The present project has yielded valuable insights that can guide future endeavors aimed at reconciling urban development with environmental conservation. These insights include the imperative of adopting a holistic strategy for mitigating pollution, the significance of community participation, and the potential of natural resources to augment urban areas.

Ultimately, the Buckingham Canal serves as more than a mere aquatic route, but rather as an emblem of the urban area's history, a manifestation of its contemporary state, and a guiding light for its forthcoming trajectory. The rehabilitation of the canal presents a prospect to retrieve a fragment of the municipality's legacy, to showcase its dedication to ecological stability, and to envisage a tomorrow where metropolitan expansion and environmental assets coalesce in concordance. The study has not only furnished a blueprint for the rehabilitation of the canal but has also underscored the capacity of such endeavors to revolutionize the urban terrain.

## REFERENCE

- Akindede, E.O., Omisakin, O.D., Oni, O.A., Aliu, O.O., Omoniyi, G.E. and Akinpelu, O.T.** (2020). Heavy metal toxicity in the water column and benthic sediments of a degraded tropical stream. *Ecotoxicology and Environmental Safety*, 190, p.110153.  
<https://www.sciencedirect.com/science/article/pii/S0147651320308266>
- Anderson, J.C., Carlson, J.C., Low, J.E., Challis, J.K., Wong, C.S., Knapp, C.W. and Hanson, M.L.** (2013). Performance of a constructed wetland in Grand Marais, Manitoba, Canada: Removal of nutrients, pharmaceuticals, and antibiotic resistance genes from municipal wastewater. *Chemistry Central Journal*, 7(1), pp.1-15.  
<https://doi.org/10.1186/1752-153X-7-54>
- Arivoli, S., Dhinamala, K., Persis, D., Meeran, M. and Pandeewari, M.** (2018). Analysis of physicochemical water quality parameters of Buckingham Canal, Chennai, Tamil Nadu, India. *International Journal of Zoology Studies*, 3(1), pp.226-231.  
[https://www.researchgate.net/publication/341978521\\_Analysis\\_of\\_physicochemical\\_water\\_quality\\_parameters\\_of\\_Buckingham\\_Canal\\_Chennai\\_Tamil\\_Nadu\\_India](https://www.researchgate.net/publication/341978521_Analysis_of_physicochemical_water_quality_parameters_of_Buckingham_Canal_Chennai_Tamil_Nadu_India)
- Arumugam, G., Rajendran, R., Ganesan, A., & Sethu, R.** (2018). Bioaccumulation and translocation of heavy metals in mangrove rhizosphere sediments to tissues of *Avicennia marina*—A field study from tropical mangrove forest. *Environmental Nanotechnology, Monitoring & Management*, 10, 272-279.  
<https://www.sciencedirect.com/science/article/pii/S2215153217302027>
- Badura, T., Lorencov´a, E.K., Ferrini, S.** (2021). Public support for urban climate adaptation policy through nature-based solutions in Prague. *Landsc. Urban Plan.* 215, 104215.  
<https://doi.org/10.1016/j.landurbplan.2021.104215>
- BenDor, T.K., Metcalf, S.S. and Paich, M.** (2011). The dynamics of brownfield redevelopment. *Sustainability*, 3(6), 914-936.

<https://doi.org/10.3390/su3060914>

**Bloesch, J., and U. Sieber** (2003). The morphological destruction and subsequent restoration programs of large rivers in Europe, *Arch. Hydrobiol.*, 14(3), 14, 363–385.

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2014WR016874>

**Calthorpe, P.** (1993). *The next American metropolis: Ecology, community, and the American dream.* Princeton architectural press.

**Chin, A., et al.** (2009). Linking theory and practice for restoration of step-pool streams. *Environmental Management*, 43(4), 645–661.

<https://doi.org/10.1007/s00267-008-9171-x>

**Chu, E., Anguelovski, I., Carmin, J.A.** (2016). Inclusive approaches to urban climate adaptation planning and implementation in the Global South. *Climate Policy*, 16(3), 372–392.

<https://doi.org/10.1080/14693062.2015.1019822>

**Devendran, A.A. and Gnanappazham, L.** (2019). Comparison of urban growth modeling using deep belief and neural network based cellular automata model: A case study of Chennai metropolitan area, Tamil Nadu, India. *Journal of Geographic Information System*, 11(1), pp.1-16.

[https://file.scirp.org/Html/10-8403259\\_89960.htm](https://file.scirp.org/Html/10-8403259_89960.htm)

**d'Anville depicts** (1788). Hand colored map of the Coromandel Coast of India.

**Erell, E., Pearlmutter, D., and Williamson, T.** (2012). *Urban microclimate: Designing the spaces between buildings.* Routledge.

**Eyes on the canal** (2018). Revive Buckingham Canal and make Chennai climate-proof. Retrieved from: <https://chennai.citizenmatters.in/eyes-on-the-canal-competition-results-buckingham-canal-climate-resilience-urban-flooding-7943>

- Frantzeskaki, N., McPhearson, T., Collier, M.J., Kendal, D., Bulkeley, H., Dumitru, A., Walsh, C., Noble, K., van Wyk, E., Ordóñez, C., Oke, C., Pint'er, L.** (2019). Nature-based solutions for urban climate change adaptation: Linking science, policy, and practice communities for evidence-based decision-making. *BioScience*, 69(6), 455–466.  
<https://doi.org/10.1093/biosci/biz042>
- Gao, Q., Xu, J., and Bu, X.H.** (2019). Recent advances about metal–organic frameworks in the removal of pollutants from wastewater. *Coordination Chemistry Reviews*, 378, 17-31.  
<https://doi.org/10.1016/j.ccr.2018.07.003>
- Ghofrani, Z., Sposito, V., Faggian, R.** (2017). A Comprehensive Review of blue-green infrastructure concepts. *International Journal of Environmental Studies*, 6, 15–36.  
<https://doi.org/10.24102/IJES.V6I1.728>
- Gupta, A.K., Nair, S.S.** (2011). Urban floods in Bangalore and Chennai: Risk management challenges and lessons for sustainable urban ecology. *Current Science*, 100(11), 1638–1645.
- Indian National Trust for Art and Cultural Heritage (INTACH).** (2018). Conservation of the Buckingham Canal: A Heritage Perspective. Retrieved from: <http://www.intach.org/about.php>
- Indian Institute of Technology, Chennai (IIT Chennai).** (2017). Study on Encroachments and Flooding along the Buckingham Canal. Retrieved from:  
[https://cag.gov.in/webroot/uploads/download\\_audit\\_report/2017/Report\\_No\\_4\\_of\\_2017\\_-\\_Performance\\_Audit\\_of\\_Flood\\_Management\\_and\\_Response\\_in\\_Chennai\\_and\\_its\\_Suburban\\_Area.pdf](https://cag.gov.in/webroot/uploads/download_audit_report/2017/Report_No_4_of_2017_-_Performance_Audit_of_Flood_Management_and_Response_in_Chennai_and_its_Suburban_Area.pdf)
- IHS** (2018). Study for the XV Finance Commission on Urban Infrastructure and Resilience. Draft Final Report. Indian Institute for Human Settlements, 110 pp. Retrieved from:  
[https://fincomindia.nic.in/writereaddata/html\\_en\\_files/fincom15/StudyReports/Urban%20infrastructure%20development%20and%20resilience%20building%20by%20ULBs%20pdf](https://fincomindia.nic.in/writereaddata/html_en_files/fincom15/StudyReports/Urban%20infrastructure%20development%20and%20resilience%20building%20by%20ULBs%20pdf)
- Int. J. Environ. Res. Public Health** 2021, 18(5), 2435.  
<https://doi.org/10.3390/ijerph18052435>

**Jishamoli, B.** (2018). Slums of Chennai around the Buckingham Canal—with special reference to Govindaswamy Nagar. *International Journal of Current Humanities & Social Science Researches (IJCHSSR)*, 2(2), pp.15-15.

**Johansson, E., and Emmanuel, R.** (2006). The influence of urban design on outdoor thermal comfort in the hot, humid city of Colombo, Sri Lanka. *International Journal of Biometeorology*, 51, 119-133.

<https://link.springer.com/article/10.1007/s00484-006-0047-6>

**Kumar, A. Y., & Reddy, M. V.** (2009). Assessment of seasonal effects of municipal sewage pollution on the water quality of an urban canal—a case study of the Buckingham canal at Kalpakkam (India): NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>, BOD, COD and DO. *Environmental monitoring and assessment*, 157, 223-234.

<https://doi.org/10.1007/s10661-008-0526-y>

**Krishnamurthy, R., and Desouza, K.C.** (2015). Chennai, India. *Cities*, 42, 118–129.

<https://doi.org/10.1016/j.cities.2014.09.004>.

**Lee, C.C., and Sheridan, S.C.** (2015). Synoptic climatology: An overview. Reference module in earth systems and environmental sciences.

**Martos, A., Pacheco-Torres, R., Ordóñez, J., and Jadraque-Gago, E.** (2016). Towards successful environmental performance of sustainable cities: Intervening sectors. A review. *Renewable and Sustainable Energy Reviews*, 57, 479–495.

<https://doi.org/10.1016/j.rser.2015.12.095>.

**Martuzzi, M., Pasetto, R., and Martin-Olmedo, P.** (2014). Industrially contaminated sites and health. *Journal of Environmental and Public Health*, 2014.

**Morandi, B., Piégay, H., Lamouroux, N., and Vaudor, L.** (2014). How is success or failure in river restoration projects evaluated? Feedback from French restoration projects. *Journal of Environmental Management*, 137, 178-188.

<https://doi.org/10.1016/j.jenvman.2014.01.015>

**Mukwaturi, M., and Lin, C.** (2015). Mobilization of heavy metals from urban contaminated soils under water inundation conditions. *Journal of Hazardous Materials*, 285, 510-518.

<https://doi.org/10.1016/j.jhazmat.2014.11.019>

**Mukwaturi, M., and Lin, C.** (2017). Influence of urbanization and anthropogenic activities on trace metal accumulation in sediments of urban river systems. *Environmental Science and Pollution Research*, 24(22), 18361-18372.

<https://doi.org/10.1007/s11356-017-9243-4>

**Nair, S.** (2003). Environmental changes and the seasonal nature of urban vulnerability: A case study of Chennai, India. *Disasters*, 27(3), 224-238.

<https://doi.org/10.1111/1467-7717.00231>

**Naresh, P. and Sundaram, S.** (2016). Hydrologic Analysis of the Urban Watershed: A Case Study of Chennai, India. *Proceedings of the 13th International Conference on Urban Drainage*, 1-8.

**Nelson, A., et al.** (2009). A global map of urban extent from nightlights. *Environmental Research Letters*, 4(3), 034011.

<https://doi.org/10.1088/1748-9326/4/3/034011>

**Nikolić, N., Marisavljević, D., and Ristić, M.** (2013). The role of peri-urban open spaces in climate change mitigation in settlements. *Procedia Environmental Sciences*, 17, 754–762.

<https://doi.org/10.1016/j.proenv.2013.02.094>

**Niranjani, K., Sreekesh, S., Venkatramanan, S., Chandrasekaran, N., and Basu, H.** (2013). A review on the study of the relationship between street geometry and urban air quality. *Building and Environment*, 59, 640–649.

<https://doi.org/10.1016/j.buildenv.2012.09.015>

**NIOT**, (2012). National Institute of Ocean Technology

**Pandey, M., and Nagrajan, R.** (2016). Water quality status of Buckingham Canal, east coast of India. *Pollution*, 2(2), 243-253.

**Pauleit, S., et al.** (2005). Land use, climate change, and ecosystem services. *Urban Ecosystems*, 8, 21–37.

<https://doi.org/10.1007/s11252-005-8201-5>

**Pfeffer, K., W.** (2006). Urban planning and climate change. *Landscape and Urban Planning*, 75(1–2), 187–196.

<https://doi.org/10.1016/j.landurbplan.2004.10.022>

**Ravindranath, N. H., and Balachandra, P.** (2004). Urban energy transition in India: Imperatives for achieving energy efficiency in residential buildings. *Energy Policy*, 32(11), 1349-1366.

[https://doi.org/10.1016/S0301-4215\(03\)00140-6](https://doi.org/10.1016/S0301-4215(03)00140-6)

**Sharma, P. and Sharma, A.** (2016). Waterlogging situation and adaptive capacity in the city of Chennai. *International Journal of Scientific Research and Management*, 4(2), pp.3591-3598.

**Shearman, P., and Smith, R.** (2007). The climate change challenge and urban planning: Implications for practitioners. *Planning Practice and Research*, 22(3), 317–330.

<https://doi.org/10.1080/02697450701560339>

**Silva, J., et al.** (2019). Integrated urban water management planning: A new paradigm for sustainable cities. *Water*, 11(8), 1590.

<https://doi.org/10.3390/w11081590>

**Singh, A.** (2017). Urbanization and mega-cities in Asia: Challenges and implications for sustainable development. In H.-C. Pörtge (Ed.), *Handbook of environmental chemistry: Urbanization and sustainability* (Vol. 65, pp. 1–23). Springer.

## **APPENDICES**



# Appendix 1

Survey 1, online questionnaire can be referred in the link attached below

[https://docs.google.com/forms/d/1PRwqkzFK\\_02VMYMTcRoykN0InIRxDy5sOrVhUfxtCPQ/edit](https://docs.google.com/forms/d/1PRwqkzFK_02VMYMTcRoykN0InIRxDy5sOrVhUfxtCPQ/edit)

This survey focuses on a particular portion of B canal, The stretch between Chennai's Kasturibai Nagar till Thiruvanmayur stretch. Along which Chennai's vital MRTS Stations are situated.

1. Do you live in Chennai?

Mark only one oval.

- YES  
 NO

[https://docs.google.com/forms/d/1PRwqkzFK\\_02VMYMTcRoykN0InIRxDy5sOrVhUfxtCPQ/edit](https://docs.google.com/forms/d/1PRwqkzFK_02VMYMTcRoykN0InIRxDy5sOrVhUfxtCPQ/edit)

1/21

5/18/23, 5:13 PM

SURVEY ON BUCKINGHAM CANAL

2. What is your Gender?

Mark only one oval.

- Male  
 Female  
 Prefer not to answer

3. How old are you?

Mark only one oval.

- 15-19 years  
 20-29 years  
 30-45 years  
 45 and above

4. Which one describes you best?

Mark only one oval.

- Student  
 Worker

## Appendix 2

Expert: Arvind Krishnan

Affiliation: Architect

Date of Interview: April 1, 2023

Summary: As part of my research, I had the privilege of interviewing Arvind Krishnan, a respected architect, on April 1, 2023. Our discussion focused on the design proposal for the children's park near Indra Nagar MRTS. Mr. Krishnan shared valuable insights on incorporating play equipment, landscaping, and creating an engaging space that caters to the needs of the surrounding residential neighborhood.

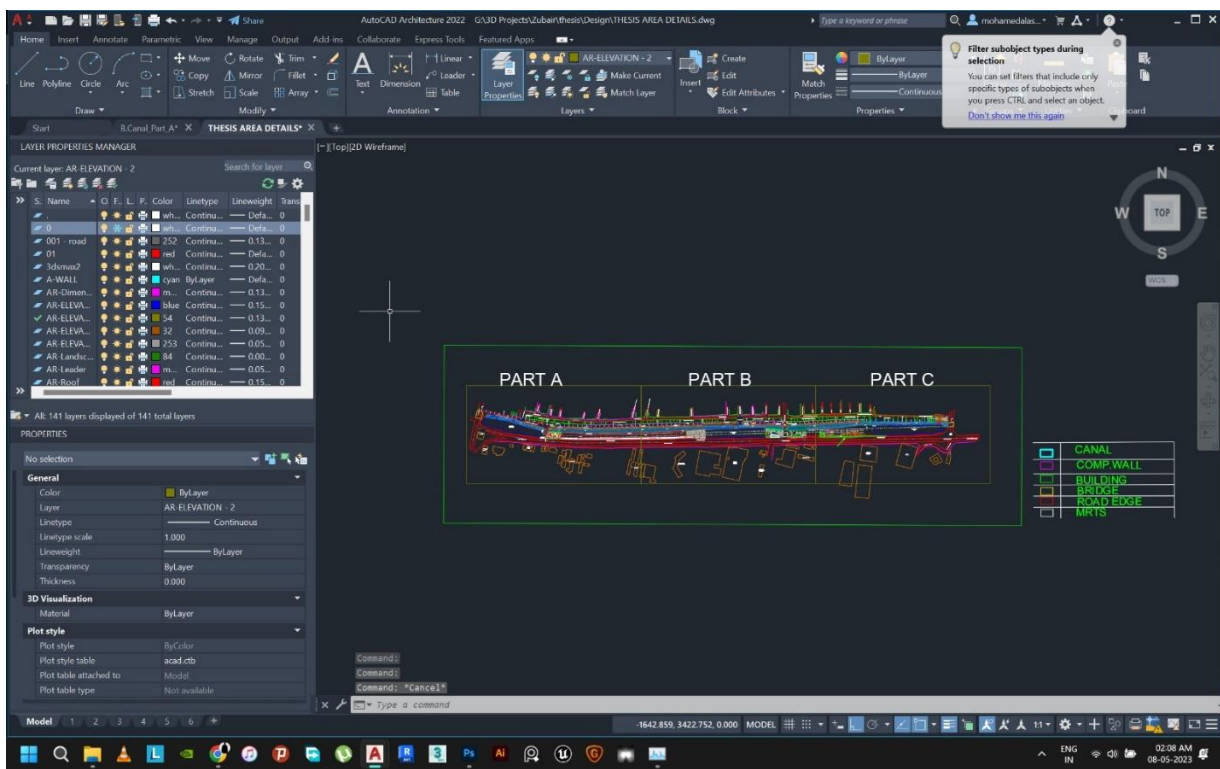


Expert: Al Ashiq

Affiliation: Civil Engineer

Date of Interview: April 15, 2023

Summary: On April 15, 2023, I conducted an interview with Al Ashiq, an experienced civil engineer. Mr. Ashiq's expertise and previous involvement in the development of the Buckingham Canal were invaluable to our discussion. We explored site photography and structural design considerations along the canal, ensuring the integration of functional and visually appealing elements into the proposed design.

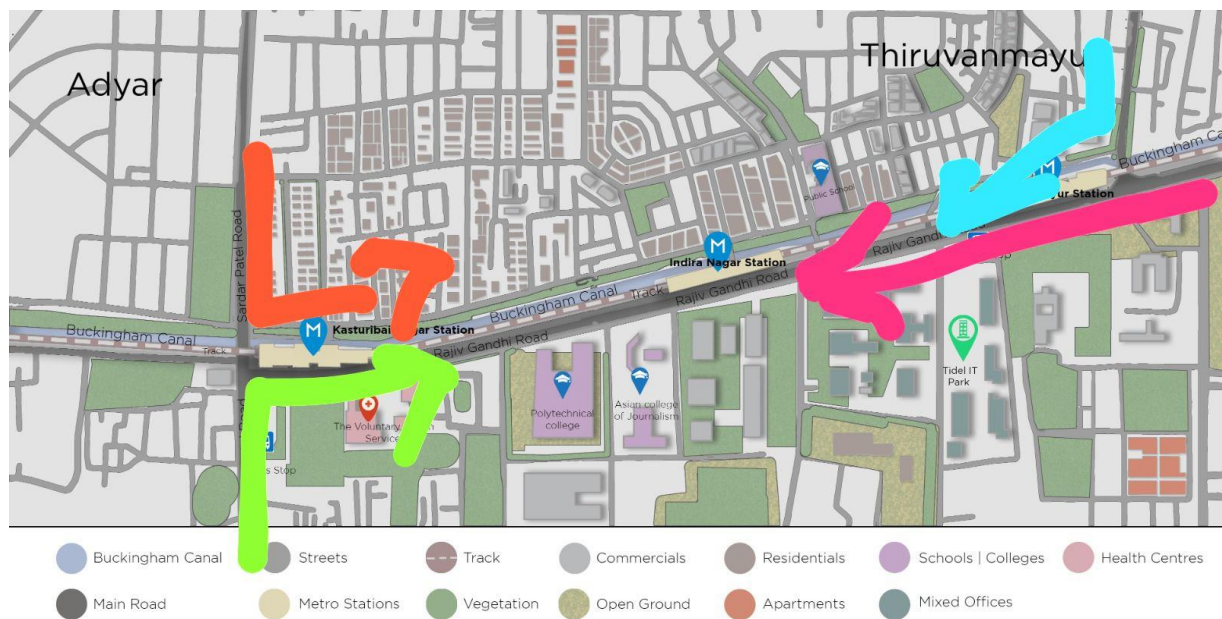


Expert: Viswanathan

Affiliation: Landscape Architect

Date of Interview: April 5, 2023

Summary: On April 5, 2023, I had a stimulating conversation with Viswanathan, a renowned landscape architect. Mr. Viswanathan, with his vast experience in landscape architecture, provided valuable guidance. Our discussion centered around incorporating elements of activity and vibrancy throughout the canal stretch, creating a dynamic environment that fosters community engagement and enjoy



**Thank you**