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**Constructed Wetlands: Additional heterogeneous configurations on existing
infrastructures in Silvertown, Alexandra Township, Johannesburg**

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Declaration

I declare that this thesis is my unaided work. It is being submitted to the Faculty of Science for the Doctor of Philosophy degree at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

A handwritten signature in black ink, appearing to be 'Mc [unclear]'.

12 September 2024

Signature

Date

Dedication

♪ *Soul II Soul - I Care* ♪

In loving memory of my sister, ***Lesego Evelyn Raphulu*** whose spirit and love continue to guide me every day. Your memory fuels my determination and inspires my every achievement. Though you are no longer with us, your presence is felt in every step of this journey. As your little brother “Collen”, I am forever grateful for the profound impact you had on my life. This work is dedicated to you, with endless love and gratitude.

Your smile and warmth are deeply missed, “***Nini***”.

(1982-2023)

*Ke makumula dithaka,
Phiri tsa molapo wa mogale.
Ga ba ja ga ba gadime.
Ke magadimela ntweng.*

*Ke ngwana wa bo senkorwana sa mafiri.
Ke ngwana wa bo kiki ke a tshega
Mokhura tshegela nageng,
Naga e ntle ka ditshego.*

*Ke ngwana wa bo pelo beta
Pelo boela bonnong
Se ne o se batla o se bone
O ntseng are
Tlhatlhologanang makumula
A tsebe di mafetla,
Le tle le gopole badidi le barongwa*

Abstract

Greywater disposal is a service issue that has yet to be addressed fully in urban informal settlements of South Africa. Greywater exposure poses great health dangers if this wastewater is disposed of incorrectly. Silvertown proved to lack infrastructure for greywater disposal and showed prevailing evidence of physical exposure to disposed greywater. There are no formally defined manners of greywater disposal in Silvertown. Therefore, there is a need for infrastructural development to support safe greywater collection, disposal, and possible treatment. Heterogeneous Infrastructure Configuration (HIC) scholars have pointed out that empirical work still needs to be done to validate the theoretical arguments that infrastructural growth in the Global South does not emphasise uniformity and standardisation. To address the greywater disposal problem, constructed wetlands (CWs) were implemented in Silvertown (a section of an informal settlement) as a proposed solution for greywater disposal. This study investigated how the CWs integrated with existing infrastructure over three years. A participative, iterative design process was implemented to help create links between the residents and the existing heterogeneous infrastructure. In this research, HIC was used as a theoretical framework to help understand the dynamics that shape the engagement with the CWs by the residents of Silvertown and integration with existing infrastructure. Notably, in the absence of the provision of infrastructure and services, the people of Silvertown have actively constructed the environment around them to provide the required services and infrastructure. It was also evident that “people as infrastructure”, as Simone (2004) phrases it, emerged as a prominent process in the provision of services. A qualitative study which included semi-structured interviews, unstructured interviews, and observations collected over three years was used to collect data from Silvertown. The research findings showed that CWs made significant progress beyond just offering a solution for greywater disposal and the controlled/treated release of contaminated water through integration with related infrastructure and services. However, it was also noted that the effectiveness of the CWs was hindered by challenges such as vandalism and negligence. A collective effort was needed from the service providers and the

residents to ensure the functionality and sustainability of planned infrastructures such as CWs in Silvertown.

Keywords: Informal Settlement, heterogeneous infrastructure configurations, Service Delivery, Greywater, South Africa

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What a journey this research has been starting to build the CWs in 2020 when the COVID-19 pandemic hit the world. It was not easy to collect the necessary data, and ethics protocols had to be followed. Though this was the case, the journey was very fulfilling, especially because the people I had to meet along the way made my research successful despite various challenges. I needed to go deep to the depths of my soul to find inspiration from my high school English teacher Mr Hugh Huggett who was once impressed when I used William Shakespeare's quote ***"If music be the food of love, play on"- Twelfth Night***. Therefore, I did not give up, I was always motivated to continue conducting my research and the melody from *Sounds of Blackness* kept me going.

♪ Sounds of Blackness - I'm going all the way ♪

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¹ URBWAT known as the Accessible greywater solutions for urban informal townships in South Africa, is a project that implements sustainable water solutions in the Alexandra township.

Being a student at the University of the Witwatersrand has always been an honour and I can safely say that “*Scientia et Labore or Through Knowledge and Work*”, as a “*Kudu*” I now have the “*Wits Edge*”. The Bernard Price building has been a home for me from my first day at university as an undergrad, both literally and figuratively. The people from the School of Geography, Archaeology, and Environmental Studies (GAES) have, over the years, turned into good friends and mentors. In my PhD journey, the work that I have produced would not have been completed to satisfaction without the help and support from people from the School of Geography such as Clinton Nyathi, Lennox Boateng, Lusizo Nqasha, Kamogelo Mohuli, Khanyo Ngubo, Sisanda Mkhize, Kutlwano Taole, Mpho Gegana, Julia Ndoli-Musyoka, Serge Kubanza, Natanya Alexander, Mary Evans, Raesa Moolla, Mulala Simatele, Mpho Thobejane, Tumelo Mathe, Yusurf Mansoor, Jasper Knight, Ngonidzashe Mangoro, Craig Sheridan, Cletah Shoko, Iqra Atif, Stefan Grab, Jennifer Fitchett, Siyabonga Zikhali, Nothando Maloleka, Melva Mvunge, Paida Mhangara, Mohammed Altoom, Cher Petersen, Elhadi Adam, Sibusiso Manxiwana, Zizipho Keli, Einstein Ramulifho, Simone Dahms-Verster, Wendy Phillips, Nonkululeko Dlamini, Rebecca Lekone, Boitumelo Mokgoja, Firidaus Mononyane, Takalani Malivhadza, Dzunani Ngobeni, Palesa Molefe, Martha Sithole and Moloko Makoeng. These people made Bernard Price a conducive workplace, and the hope is that this culture will continue.

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My research journey did not start with this PhD. I grew up in Makapanstad village and water access was a challenge I encountered but it intrigued me. The generation

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Table of Contents

Declaration.....	i
Dedication.....	ii
Abstract.....	iii
Acknowledgements.....	v
Table of Contents.....	x
List of Acronyms	xiv
List of Figures.....	xv
List of Tables	xvii
Chapter 1. Introduction	1
1.1. Introduction.....	1
1.2. Background.....	1
1.3. Problem Statement	2
1.4. Research Aim.....	3
1.5. Overarching Research Question.....	4
1.6. Research Objectives.....	4
1.7. Outline of the Thesis	5
Chapter 2. Literature Review	7
2.1. Introduction.....	7
2.2. Millennium Development Goals and the Sustainable Development Goals	8
2.3. Towards sustainable urban sanitation	14
2.4. Characteristics of greywater in an urban environment	15
2.5. Informal settlements.....	17
2.6. The precarious conditions in the informal settlements	18
2.7. Infrastructure as the backbone of a community	20
2.8. Global North vs. Global South development standards	21
2.9. Global South infrastructural configurations.....	22
2.10. Why has informal settlement infrastructure not developed	23
2.11. Neo liberalism’s impact on the infrastructural inequalities	24
2.12. Right to the city.....	25
2.13. People as infrastructure.....	27

2.14. Lefebvre: The Production of Space	28
2.15. Political Ecology	31
2.16. Participatory approach	33
2.17. Constructed Wetlands	36
2.18. Heterogeneous infrastructure configurations (HIC).....	37
2.19. Previous HIC studies.....	40
2.20. Informal settlements as an example of heterogeneous infrastructure configurations	45
2.21. The Silvertown research - a different heterogeneous infrastructure configuration	46
2.22. Conclusion	51
Chapter 3: Methodology	52
3.1. Introduction.....	52
3.2. Positionality	52
3.3. Study Area	54
3.3.1. The context of Alexandra township	55
3.3.2. Alexandra today	57
3.3.3. The context of Setswetla	60
3.3.4. The context of Silvertown.....	61
3.4. Research Methods.....	62
3.4.1. Qualitative research methods	62
3.4.2. Case study research.....	63
3.4.3. Sampling methods.....	63
3.5. Data collection methods.....	67
3.5.1. Ethnographic observation	67
3.5.2. Photo Ethnography.....	69
3.5.3. Focus groups	71
3.5.4. Structured interviews	72
3.5.5. Unstructured interviews	77
3.5.6. Personal and reflexive journal.....	78
3.6. Data analysis	79
3.6.1. Narrative analysis.....	79
3.6.2. Ethical consideration.....	82
3.6.3. Limitations	84
3.6.4. Conclusion	86
Chapter 4. Results	87
4.1. Introduction.....	87

4.2.	The geography of Alexandra and Setswetla in relation to work.....	87
4.3.	The hierarchical structure of Setswetla and Silvertown.....	90
4.3.1.	Transitional power of councillors in Ward 109 across the URBWAT project.....	93
4.3.2.	Ward Councillor.....	94
4.3.3.	Ward Governor	95
4.3.4.	Ward Committees	96
4.3.5.	Setswetla community leadership.....	97
4.3.6.	The Community Leadership Forum (CLF): Setswetla.....	98
4.3.7.	The Community Leadership Forum (CLF): Silvertown	99
4.4.	Silvertown past and current existence.....	101
4.5.	Hierarchical system of how services are accessed.....	107
4.6.	Services provided in Silvertown.	110
4.6.1.	Water.....	110
4.6.2.	Electricity	115
4.6.3.	Solid waste removal service.....	119
4.6.4.	Blackwater sanitation services	123
4.7.	Services not provided by the municipality for Silvertown.....	127
4.7.1.	Housing	127
4.7.2.	Safety and security	130
4.7.3.	Greywater services.....	133
4.8.	Service delivery promises.	142
4.9.	Setswetla design workshops.....	143
4.9.1.	Purpose of the Setswetla Workshops?	144
4.9.2.	Workshop outcomes.....	145
4.9.3.	Design solutions from the design workshops.....	153
4.10.	Phase 1 building in Silvertown	156
4.10.1.	Construction of the CWs.....	156
4.10.2.	Construction process of the CWs.....	157
4.10.3.	State of the CWs	159
4.10.4.	The suitability of CWs	160
4.10.5.	Types of materials that get disposed.	161
4.11.	Formal observational evaluation of Phase 1	163
4.12.	Phase 2 building in Silvertown	164
4.12.1.	The building of the wall and the improved entrances	164
4.12.2.	A ramp and staircase at the entrance of Silvertown.....	166
4.12.3.	The enhancement of the gully	168

4.12.4. Phase 2 Construction of the CWs.....	176
4.12.5. The state of CWs.....	178
4.12.6. The suitability of the CWs	182
4.13. Formal observational evaluation of Phase 2	184
4.14. Conclusion	185
Chapter 5. Discussion	187
5.1. Introduction.....	187
5.2. Added knowledge to the body of work on heterogeneous infrastructure configurations.	187
5.2.1. The uniqueness of the case study of Silvertown	187
5.2.2. HIC investigation longitudinally.....	192
5.2.3. Introducing HIC into development approaches that are already diverse.	194
5.2.4. HICs are continually constructed.....	196
5.3. Summary of main arguments and contribution to the literature.....	199
5.4. Comparisons between Phase 1 and Phase 2.....	202
5.4.1. The building processes.....	202
5.4.2. CWs and solid waste	203
5.5. Reflections on the design workshops.....	205
5.6. Iterative design process	206
5.7. The extent of wastewater disposal in Silvertown.....	208
5.8. Obstacles that impede the CWs' ability to function well.....	210
5.8.1. External challenges to the CWs	210
5.8.2. Challenges affecting the CWs from behavioural interactions.....	211
5.9. The contestation of space.....	214
5.10. The complex dynamics of shared space.....	215
5.11. Municipality responsibilities.....	218
5.12. System interactions	219
5.12.1. Multiple interacting service systems at play	219
5.12.2. Interconnections outside of the constructed wetland system	221
5.12.3. Interconnections with the constructed wetland system	225
5.13. People made the infrastructure work.....	228
5.14. URBWAT project development going beyond the research priorities.	229
5.14.1. Additional infrastructure implementations in Phase 2	229
5.15. Political ecology of greywater management.....	231
5.16. Did the CWs make a difference in Silvertown?.....	233
5.17. Limitations	236

5.18. Recommendations for Further Research.....	238
5.19. Chapter Conclusion.....	239
Chapter 6. Conclusion.....	240
Chapter 7. References	243
Chapter 8. Appendices	275
8.1 Appendix A: Unstructured interviews records.....	275
8.2 Appendix B: Data collection instruments for Silvertown participants	283
8.3. Appendix C: Ethics approval documents.....	288
8.4. Appendix D: Millennium Development Goals, Targets and Indicators.....	289

List of Acronyms

ANC	African National Congress
ARP	Alexandra Renewal Project
CoJ	City of Johannesburg
COVID-19	Coronavirus Disease 2019
CW	Constructed Wetland
DA	Democratic Alliance
EFF	Economic Freedom Fighters
EIA	Environmental Impact Assessment
ERF	Erven
GAES	Geography, Archaeology, and Environmental Studies
HIC	Heterogeneous infrastructure configurations.
ID	Identification Document
MDGs	Millennium Development Goals
NGOs	Non-Governmental Organisations
SDGs	Sustainable Development Goals
UN	United Nations
URBWAT	Accessible greywater solutions for urban informal townships in South Africa

List of Figures

Figure 1: Henri Lefebvre Spatial Triad model.....	29
Figure 2 (A): Map showing Alexandra township in relation to Johannesburg city, Gauteng province and South Africa	54
Figure 2 (B): Map outlining Silvertown, Setswetla informal and greater Alexandra township.	55
Figure 3: The formation of Alexandra Township as a freehold zone.	56
Figure 4: A photo showing the layout of Sandton (left) and Alexandra (right)	58
Figure 5: Map outlining Ward 109, Setswetla and Silvertown.....	61
Figure 6: Timeline of data collection.....	67
Figure 7: Hierarchical structure of Setswetla and Silvertown	91
Figure 8: Map of ward 109.	93
Figure 9: Map highlighting Silvertown and Setswetla	98
Figure 10: Community leadership forum structure in Silvertown.	100
Figure 11: Silvertown Community leadership forum (7)	100
Figure 12: Image indicating the section in Silvertown and the extended infrastructures like the soccer pitch and the Greenhouse settlement.	103
Figure 13: Silvertown expansion over the years: November 2006 (A) and September 2022 (B)	105
Figure 14: A broken tap at the site of CW1 before building.	113
Figure 15: A communal tap with a lock placed around the tap.	113
Figure 16: Illegal electricity connections in Silvertown.....	116
Figure 17: Skip bin collection.....	121
Figure 18: Skip bin full to the brim in Silvertown.....	122
Figure 19: A sequence of toilets drained in Silvertown.....	125
Figure 20: Placement of the chemical toilets in Silvertown.	126
Figure 21: Illustration of the combination of the erected shacks in Silvertown and the brick houses that have been built.	128
Figure 22: People putting gates around their homes in Silvertown.	133
Figure 23: Open spaces for greywater disposal	136
Figure 24: Developed and paved gully in Setswetla (A). A gully that has turned into a bigger stream overtime in Silvertown (B).....	137

Figure 25: Drains adjacent to a communal tap.	138
Figure 26: Tight space between the houses in Silvertown.....	141
Figure 27: Illustration of the areas of the communities that attended the design workshops.	143
Figure 28: Drawings made by the residents during the design workshops.....	147
Figure 29: Narrow passage in Masinwini (A). Communal tap in a cramped space (B)	148
Figure 30: Sequences of channelled disposed water into the Jukskei River in Old Setswetla	150
Figure 31: Paved areas around the tap in Giyani	151
Figure 32: Tap by NewStand (A), Trench in New Stand running towards Jukskei River (B)	152
Figure 33: Photo showing one of the drawings made in the design workshop....	153
Figure 34: Washing being done at CW2 in phase1.....	162
Figure 35: A photo showing a ramp (A) staircase (B), and wall (C) built in Silvertown.	167
Figure 36: A built wall to separate the CW2 and the makeshift gully.....	169
Figure 37: The newly improved CW1. Extend platform used for walking (A) and the cemented gully on the side (B).....	171
Figure 38: Graphic designs of the improved models of CW1 and CW2	173
Figure 39: Flooded CW2 (A) and Flooded CW1 (B)	174
Figure 40: A sequency of water flows ultimately result in the flooding and destruction of CW2.	176
Figure 41: Washing activity taking place at CW2	184
Figure 42: Illustration of related service and infrastructure systems in Silvertown.	220

List of Tables

Table 1: Demographic statistics of Alexandra Township.....	59
Table 2: Categories of the photos	70
Table 3: Phase 1 Structured interview records	74
Table 4: Phase 2 Structured interview records	76
Table 5: Activity type in relation to site use	164
Table 6: Activity type in relation to site use Phase 2.....	185

Chapter 1. Introduction

1.1. Introduction

The issue of sanitation is a problem that has many layers in the context of informal settlements in South Africa (Pan et al. 2015). Local governments and municipalities need to pay more attention to addressing the problem of greywater disposal in informal settlements. The effective management of greywater in these regions is of paramount importance. It warrants significant attention due to its potential to constitute a substantial public health hazard to individuals residing in these communities (Carden et al. 2018). There is a recurring problem of people polluting their areas because there are few facilities to dispose of greywater safely. In this thesis, an argument is made that the dynamics of ecological and environmental trends are shaped by many political, economic, social, and cultural factors, which in turn have reciprocal effects on these spheres (Minch 2011). Due to the lack of greywater facilities, informal settlements tend to create a situation where greywater is disposed of in several informal ways. Therefore, this study looks to understand the greywater disposal situation in Silvertown, a portion of an informal settlement, and the dynamics formed from the introduction of CWs as an intervention to address the collection and treatment of greywater. Data collected from Phases 1 and 2 relating to the design, building, and use of the CWs helped to understand how the CWs acted as additional heterogeneous infrastructure configurations (HICs) in a community that was already using informal means of living.

1.2. Background

The urban shanty town/ “slum”, or informal settlement as it is called in South Africa, is a common feature in many modern cities in the developing world. They typically arise from rapid urbanisation in a socio-political environment that cannot supply housing and the associated infrastructure (Huchzermeyer et al. 2011). Once an informal settlement is established, it is challenging to change, even for the better, since change often requires the removal of people. This leads to a dense urban settlement, sometimes consisting of tens of thousands of people, with minimal access to sewage or greywater treatment. According to UN-Habitat (2014), 881 million or 29.7% of urban dwellers in the developing regions of the world were in “slum”, while in Sub-Saharan Africa, 55.9% of urban dwellers lived in “slum”. In South Africa, according to Stats SA records in 2011, there were between 1.1 and 1.4 million families, or 2.9

and 3.6 million people living in informal settlements (Stats SA 2016). These settlements are typically defined as having inadequate infrastructure, most notably water and sanitation. The first goal within UN SDG 6 is “universal and equitable access to safe and affordable drinking water for all” by 2030 (Desa 2016). When it comes to South Africa, there have been some improvements. According to Stats SA, 88.6% of South African households had access to piped water in 2017 (Stats SA 2018). However, this pace of development has not been matched by the intrinsically linked second and third goals of adequate and equitable sanitation and hygiene for all. Only black water (i.e., sewage) has been considered, so while pit latrines or communal ablutions have primarily replaced open defecation, the unintended consequences of tap water services without greywater collection and treatment include rivers of untreated greywater coursing through dense, informal settlements.

1.3.Problem Statement

The problem is that even though the provision of water, blackwater sanitation, and electricity has generally been provided in informal settlements (legally or illegally), the same cannot be said about the accessibility of the provision of ways to dispose of greywater. It seems that when it comes to sanitation in informal settlements, the solution for black water has been addressed through the provision of mobile toilets (chemical toilets, ventilated improved pits, and pit latrines), however, there is no proper solution for greywater. This research aims to see how people will engage with CWs as infrastructure configurations are built to augment their current or past disposal methods. It will be important to understand how people will relate to the CWs as there could be different dynamics involved such as the engagement, views, and association and various stakeholders.

Some studies have indicated that green infrastructure (GI) can be an alternative in low-income urban areas (Adegun 2019; Diep et al. 2019). Therefore, the research intends to see how residents will relate to a GI through CWs. HIC will be used as the theoretical framework for this study. Related case studies presented in Schindler et al. (2019) and Sseviiri et al. (2020) have looked at the demand, awareness, and everyday use of infrastructure that has been established to address a particular problem. Therefore, this research aims to understand how people related to the CWs as a concept in an informal settlement context. This is important as

in HIC there still is work needed to understand the different kinds of risks and strategies of the people engaging with HIC in different contexts (Lawhon et al. 2018). The problem of greywater disposal and treatment is a cause for concern as this could pose an immediate threat to the residents living in Setswetla as well as to the adjacent Jukskei River system. Therefore, it is up to the residents in Setswetla's informal settlement to make sure they take ownership of their environment. In a pilot study by the research team in 2019 it was discovered that the people of Setswetla have already been finding various ways to dispose of their greywater. This research will look at how these existing methods of disposal will be augmented or disrupted with the development of the CWs. The primary aim of this research is to understand what dynamics shape the engagement with CWs by the residents of Setswetla as it relates to the HIC.

1.4. Research Aim

Informal settlements like Silvertown tend to have greywater disposal problems due to the unofficial settlement setup and the need for more services. More emphasis should be placed on resolving greywater disposal issues, particularly inside informal settlements. This phenomenon merits considerable study because it poses a severe public health risk to persons living in these communities. Greywater is domestic wastewater that has not had direct contact with human waste. Greywater can come from washing machines, dishwashers, showers, and kitchen sinks. Most greywater streams generate effluents that are low in suspended particles and turbidity and high in dissolved pollutants (Ghaly et al. 2021). In Silvertown, greywater runs freely through the environment, leading to potential health and hygiene issues for residents. Long-term exposure to untreated greywater can reduce water permeability and capillarity, which makes it a potential health risk (Vuppaladadiyam et al. 2019). Therefore, this research followed and evaluated a larger project to install nature-based greywater collection and treatment systems in an unplanned urban settlement. Considering the intricate nature of the subject matter, it is imperative to be mindful of the interaction dynamics within interconnected service systems. In addition to look at the methodologies and procedures employed by the project team throughout this intervention spanning four years (2019-2022).

According to Armitage et al. (2009) the community-focused greywater management system developed in Cape Town required more community commitment and an understanding of how

greywater mixes with stormwater, blackwater sanitation, and solid waste removal. Using the Johannesburg case study of Silvertown, the objective is that the information gleaned from this research and its critical review will help people understand the complex interplays of greywater disposal. This study intends to assess the HIC of greywater disposal when utilising CWs. The main objective was to document the Silvertown community's involvement in developing the CWs through the design, building, use, and redesign phases. Firstly, this was achieved by analysing the data collected by the URBWAT project during the design workshops to understand where the community stands with the proposed wetland project. Second, once the building started, documentation of the participatory, iterative design, the assessment of the building, the use of the CWs, reflection and feedback, and re-building/extending the CWs was provided. This was achieved through structured and unstructured interviews and focus groups with the Silvertown community and various stakeholders, including community leadership, ward councillors, and the project team. Structured and unstructured observations complemented the interviews and focus groups. The utilisation of HIC was the theoretical underpinning to facilitate modelling the research investigation in Silvertown. Silvertown HIC served as a case study to analyse the introduction of CWs as a complementary solution to the infrastructure that was already used for greywater disposal.

1.5. Overarching Research Question

What are the dynamics of adding constructed wetlands as a solution to the problem of greywater disposal, collection, and treatment in the urban informal settlement of Silvertown?

1.6. Research Objectives

To answer this question, my research objectives were fourfold:

The project's main objective was to document the development of the CWs through the phases of design, building, use, and redesign in Silvertown.

1. To document how residents of Silvertown disposed of their greywater before and after the development of the CWs.
2. To understand the extent of using the other infrastructure and services in Silvertown and get an idea of how the CWs fared.
3. To examine how the CWs officially integrate with existing greywater removal mechanisms in Silvertown.
4. To understand the dynamics that formed from the existence of the CWs in Silvertown.

1.7. Outline of the Thesis

Chapter 2: Literature Review

This study is positioned in the literature review, which offers a comprehensive and deep perspective on the body of knowledge around infrastructure, greywater, and sanitation. Various topics include informal settlement, infrastructure development, sanitation, political ecology, and HIC. I start by giving an overview of the United Nations' concepts of developmental goals and their achievements over the years, as well as how sustainable developmental goals could be achieved. I particularly contrast and talk to the work on informal settlement in developing countries and the present precarious conditions. Concerning informal settlement, I outline the backbone of infrastructure: the society. The research then brings to light the work of Lefebvre's right to the city as it relates to Silvertown's past, present, and future oppression and development. I then follow this by tying political ecology to access to resources. Greywater in Silvertown showed a lack of access to infrastructure due to political, economic, social and environmental power. There is a look into understanding the participatory approach and the constructed wetlands. I conclude this section by analysing the framework of HIC, which is the guideline for the steps that the research project will take and outline the contribution to the scholarship presented already.

Chapter 3: Methodology

This chapter details all the methods used to fulfil the aim of the study. The chapter overviews the processes involved in acquiring and analysing data. This starts by claiming my position in the project. The background of the study follows this, contextualising Alexandra Township, Setswetla and Silvertown. The methods used are clarified and applied to the study in the next step. Qualitative research methods were used: non-probability sampling, ethnographic observation, structured and unstructured interviews, photo ethnography, focus groups and reflective journal. Narrative analyses were applied to the data analysis. The chapter concludes by discussing the ethical considerations and limitations which the study faced.

Chapter 4: Results

This chapter presents all the results produced to fulfil the research questions, aims, and objectives. It starts by presenting the history and current structures operated in Setswetla and Silvertown for life to make sense to the community living there. In analysing greywater, the chapter lays out the services provided and those not provided. That is concluded by the main result data, which details the design, build and use of the CWs in Silvertown.

Chapter 5: Discussion

This chapter discusses the research findings, what the study aimed to find, and the literature presented. Firstly, there is a discussion of the knowledge that this study has added to the body of work of HIC, which was the guiding framework. The main arguments from the literature are summarised. The chapter then discusses what was found in the result and presents it chronologically. This is followed by the relation and communication of the result to some of the main literature of the study, like “political ecology” and the “people as infrastructure”. The chapter concludes by discussing the elements that shaped how the results were produced and analysed, along with a discussion of limitations and recommendations.

Chapter 2. Literature Review

2.1. Introduction

This chapter examines the different bodies of literature associated with urban sanitation and greywater infrastructure. The section will start by looking at the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), as they were methods set by the United Nations to achieve important social priorities. Sanitation is critical to this research and is one of those priorities. After this, the chapter takes a deeper look, reviewing literature worldwide on sanitation, followed by direct literature looking towards sustainable urban sanitation. As CWs are a type of GI, the literature briefly looks at the potential of GI as an approach to development and the components that can determine it. The context of this research is an informal settlement (Silvertown) in an urban developing country (South Africa); therefore, giving the characteristics of greywater and informal settlements, respectively, is necessary. Linking sanitation and informal settlements, this chapter then looks at the lack of infrastructure in informal settlements. Next, the chapter examines whether the Global North infrastructural configurations, installed in the colonial past, have stood the test of time in the Global South. The chapter then examines why the informal settlement infrastructure has yet to develop. Answering this question requires looking at the impact of colonialism and neoliberalism in structuring human rights to access resources. In understanding how unfair competition for resources affects developing countries, the chapter then outlines how people can be considered as part of “infrastructure” to organise social relations. This ties in with Lefebvre’s triad spatial model relating to the production of space. Space contestation in the context of South Africa, especially concerning informal settlements like Silvertown’s environmental degradation, is situated in political ecology, which is outlined in relation to HIC. The chapter then highlights the importance of participatory approaches since these build on how one constructs community infrastructure with the residents’ help. Finally, this literature chapter concludes by looking at the framework of the study, which sets the tone for profiling the greywater disposal system in Silvertown.

The Millennium Development Goals (MDGs), agreed to in 2000, maintained a retroactively narrow focus on poverty reduction. In contrast, the Sustainable Development Goals (SDGs), agreed to in 2015, include new themes that reflect an approach that sees the environment, economy, and society as integrated systems rather than separate competing pillars. For

example, urban areas, water and sanitation, energy, and climate change are all prominently featured (Woodbridge 2015). Poverty has persisted in Global South countries, particularly in Africa since colonisation, and continues to this day. According to urban geography, the development delivered to the Global South nations has remained the same to bring about progressive development. Work from Akinloye (2018), Fehling et al. (2013), and McCloskey (2015) has demonstrated that the MDGs failed to meet their objectives, prompting the introduction of the SDGs. The underlying theoretical framework of HIC corresponds to previous research on southern urbanism, which challenges the uniformity of modern development (Lawhon et al. 2018). HIC is based on political ecology in connection to sustainable development; understanding the consequences of SDGs on the environment and people necessitates paying attention to the power dynamics that affect how all SDGs are understood and implemented throughout the Global North and Global South (McDermott et al. 2019).

2.2. Millennium Development Goals and the Sustainable Development Goals

Before 2000, the MDGs originated through activities, objectives, and various development conferences (Durokifa et al. 2018). The United Nations adopted the Millennium Declaration, which commits member countries to a new global partnership to reduce extreme poverty, establishing precise targets with a 2015 deadline (Saarinen et al. 2011).

The United Nations Millennium Development Goals (MDGs) were as follows with 21 targets (see attached document (appendix D) in the appendix with the goals, targets and indicators)

- Eradicate extreme poverty and hunger (Goal 1).
- Achieve universal primary education (Goal 2).
- Promote gender equality and empower women (Goal 3).
- Reduce child mortality (Goal 4).
- Improve maternal health (Goal 5).
- Combat HIV/AIDS, malaria, and other diseases (Goal 6).
- Ensure environmental sustainability (Goal 7).

- Develop a global partnership for development (Goal 8).

(Saarinen et al. 2011, 201).

The MDGs were intended as a primary motivator to enhance development efforts in and on behalf of impoverished nations. The resultant attention on MDGs and the increases in funding and aid to address MDGs indicate that the MDGs may claim significant accomplishments on that front (Easterly 2009). Eight goals were established to alleviate poverty and human deprivation worldwide, with specific targets and quantitative indicators to be met within 15 years from 2000 (Hulme 2009). Sanitation was embedded in Goal 7 (Environmental Sustainability) which was to halve the proportion of the population without access to safe water and basic sanitation. However, before the set 2015 deadline, it was evident that most Sub-Saharan Africa (SSA) nations still needed to meet the MDGs for most indicators (Oya 2011). It was also said by (Blair 2005; World Bank 2005) that Africa was behind the most in terms of progress, and would fail to reach any of the MDGs by 2015. It was also pointed out that the goals were highly attainable if leaders of developing countries were cautious and willing to channel all required resources to achieve the goals' accomplishment (Ajiye 2014). In other countries, internal problems delayed the progress towards achieving the goals. In one example, Nigeria was falling behind because of bureaucracy, poor resource management in the healthcare system, sequential healthcare worker industrial action, and Boko Haram's insurgency (Oleribe et al. 2016). In terms of other goals, was the MDG campaign a success? Former Secretary-General of the United Nations, Ban Ki-Moon, reported that by the end of 2015, extreme poverty was eradicated (UNDP 2017). Over the previous two decades, extreme poverty had been decreased dramatically. In 1990, over half of the developing world's population lived on less than \$1.25 per day. However, by 2015, that proportion had been reduced to 14% (UNDP 2017). As much as the other goals were not reached by 2015, the same can be said about the embedded sanitation goal. The MDG sanitation objective failed by a large margin as many people did not have access to improved sanitation by the end of 2015 (2.37 billion) when compared to 2.45 billion in 1990, and sanitation coverage slipped to below 50% in 47 countries (Unicef 2016).

The relationship between the issue of fulfilling service delivery backlogs, uneven distribution of services, and unhappiness with sanitation services in informal settlements in South Africa necessitate a deeper examination of equity, as outlined in this PhD research. These aims have not been met in informal communities which lack sanitation, garbage management, and water access amongst other service. The government has promised “the provision of a basic sanitation facility which is easily accessible to a household, the sustainable operation of the facility, including the safe removal of human waste and wastewater from the premises where this is appropriate and necessary, and the communication of good sanitation, hygiene and related practices” (Pan et al. 2018, p. 30). Although the policy demands these provisions, South Africa still had failed to meet the MDG by halving the number of people without improved sanitation according to (WHO/UNICEF 2015). The remaining challenges are twofold: environmental sustainability and severe inequality.

The Sustainable Development Goals (SDGs), to be reached by 2030, attempted to extend these challenges because the relevant MDG targets lacked precision and clarity (Vandemoortele 2018). Some scholars argued that MDG 7 placed too “little attention on environmental concerns,” notably climate change (McMichael et al. 2004). Others argued that Goal 7.C, access to clean drinking water and basic sanitation, overlooks local issues such as infrastructure, distance, security, pricing, pollution, and a basic grasp of hygiene and sanitation (Dar et al. 2011; James 2006). Others have argued that Goal 7.D — improving the lives of at least 100 million slum dwellers – is too modest, addressing just 7% to 9% of estimated slum dwellers by 2020 (Langford 2010). The case of informal settlements like in South Africa, where sanitation has not reached equality status is one such example.

The SDGs superseded the MDGs in 2015 (Beik et al., 2021), as stated by the United Nations General Assembly, which adopted the 17 targets. The UN meticulously prepared the SDGs to meet all goals by 2030 adequately (Allen et al. 2017). SDGs are not designed to replace MDGs but are meant to supplement them (Allen et al. 2017). Some SDGs targets are improvements to the previous MDGs, while others are entirely new to this new framework (Mishra et al. 2023). SDGs’ global agenda call was for an integrated approach to development to revisit how societies are built and includes marginalised populations more effectively. Allen et al. (2017)

noted that SDGs' success or failure will primarily depend on national implementation. However, the SDGs reflect a significantly more integrated, and holistic agenda than the MDGs.

The move from MDGs to SDGs served as a blueprint for achieving a more equitable future for all and, in the case of water and sanitation services, ensuring the availability and sustainable management of water and sanitation for all as encapsulated in SDG 6 (Pereira et al. 2021). With the adoption of the SDGs, governments have committed to ensuring universal and equitable access to water and sanitation for all by 2030, reducing inequalities in access to drinking water and sanitation, and providing high levels of water and sanitation service in terms of quality, accessibility, and reliability (Mvongo et al. 2022). Meeting SDG 6 objectives necessitates a fundamental rethinking of the urban sanitation sub-sector (Schrecongost et al. 2020). SDG objectives 6.1 and 6.2 concern access to safe water and sanitation facilities (Beard et al. 2022). Despite significant progress under the MDGs banner, sub-Saharan Africa still had water and sanitation problems. Similarly, meeting the SDGs' objectives for universal water access and appropriate sanitation, agreed upon by the international community by 2016, was impossible (Estache 2017). Specifically looking at sanitation, Schrecongost et al. (2020) were concerned that urban sanitation programmes were focused on the gradual extension of centralised sewer infrastructure, with little consideration given to reaching the poor, long-term service supply, financial viability, or the public system functions necessary to accomplish such results.

The COVID 19 pandemic highlighted the importance of water and sanitation services, given the growing inequalities and disparities between high-income and low- and middle-income countries (Pereira et al. 2021). SDGs 6.2 (sanitation and hygiene) and 6.3 (halving the proportion of untreated wastewater) aim to provide clean sanitation to everyone by 2030. However, the present pace of sanitation growth in some developing nations like Colombia needs to be more active and would need to triple to meet the targets by 2030 (Saker et al. 2022). In a study in Algeria, the analysis revealed that the drop in real investment since 2009, coupled with a budget deficit that has grown from 201.49% in 2015 to 385.56% in 2018, raises doubts about the achievement of SDG objectives 6.2 and 6.3 relating to sanitation (Kherbache et al. 2020). As a result, meeting the amount of investment envisaged for 2030 would take a lot of work. It appears that the SDGs will only be easily accomplished if changes aimed at the long-term recovery of sanitation service costs are implemented (Kherbache et al. 2020).

A report from “the Water Research Commission” of 2021 it was pointed out that since ratifying the SDGs, South Africa has made great strides towards seizing opportunities and facilitating efficient implementation of the SDGs (Libala et al. 2021). Nonetheless, the reporting period for 2019 showed that further effort is required to fulfil the 2030 Agenda. More knowledge is needed on how many goals are related to one another, which might reveal chances for advancement and sacrifices. This knowledge gap is particularly noticeable in SDG 6, which is water and sanitation-related (Libala et al. 2021).

Consider SDG 6.2, which calls for universal access to adequate and equitable sanitation and hygiene, as well as the abolition of open defecation (UN Water 2021; Shehu et al. 2022), claim that to achieve SDG 6.2 by 2030, the present pace of advancement must be quadrupled. Presently, no SDG area is on track to be achieved by 2030. Even basic sanitary facilities are still unavailable to 2 billion people worldwide. Seven out of ten of these people reside in rural regions, while three out of ten live in Least Developed Countries (UN Water 2021). 673 million people still defecate in the open, and 61 nations have open defecation rates of more than 5% (UN Water 2021). On the other side looking at SDG 6.3 which aims to achieve water quality and reduce pollution by 2030 (Hoekstra et al. 2017), according to Bouma et al. (2019) this was to be accomplished by eliminating dumping and reducing the discharge of hazardous chemicals and materials, lowering the amount of untreated wastewater, and significantly boosting recycling and safe re-use internationally. When it comes to Europe, the EU Nitrate and Water Guidelines demand monitoring of groundwater and surface water quality throughout Europe (Target 6.3). Threshold values enable the separation of locations with high water quality from those with poor water quality (Bouma et al. 2019). However, in other parts of the world, untreated sewage is dumped straight into the environment. On-site wastewater treatment systems, on the other hand, treat and then release effluent through the soil, allowing for appropriate purification (Hettiarachchi et al. 2016).

Sustainability and equity are two desirable but ambiguous concepts often used to describe goals for sanitation services internationally and in South Africa (Pan et al. 2015). As with sustainability, numerous factors must be examined, such as barriers to accessing sanitary facilities, with important issues about gender, people with disabilities, the elderly, and children.

Regional differences in sanitation coverage exist, for example, between rural and urban areas (Freeman et al., 2011) or across different income classes within the same city. Furthermore, a vital objective of the Sustainable Development Goals (SDGs) is to attain equal access to water and sanitation services (Bayu et al. 2020). As result of societal and legal structures do not ensure that women have equal access to fundamental human rights, gender gaps continue to exist (Banerjee 2011). It is highlighted that women bear a disproportionate burden when water supply solutions are weak or absent since they are primarily responsible for domestic water management (Geere et al. 2020; Silva et al. 2020). According to Wiltgen Georgi et al. (2021), empowering women to participate in sanitation delivery is the solution. This empowerment will allow them to demonstrate and express their rights and engage in meaningful interactions with the State. Providing sanitation services in informal settlements requires a more in-depth investigation of equality (Pan et al. 2015). In addition, the spread and impacts of COVID-19 have revealed multiple and cascading vulnerabilities, which particularly affect urban informal settlements (Parikh et al. 2020).

Another point by Giné-Garriga et al. (2017) is that facilities and services for sanitation must be culturally acceptable. Personal sanitation is a sensitive subject across geographies and cultures, and varied viewpoints on whether sanitation solutions are acceptable must be considered when designing, situating, and using sanitation facilities (Giné-Garriga et al. 2017). Furthermore, in addition to SDG 6, SDG 11, aims to ensure inclusive, safe, resilient, and sustainable urban and human settlements by reducing urban sprawl, increasing urban governance involvement, improving cultural asset protection, and addressing urban resilience and climate change issues (Küfeoğlu 2022). According to (Saroj et al. 2020), cities are anticipated to have superior services, especially water, due to their economic importance. However, by 2050, over 66% of the world's urban population will have insufficient access to water and sanitation facilities, in addition to poverty, pollution, and traffic congestion (Saroj et al. 2020). It is has been pointed that there is a huge disparity in water and sanitation across and within cities (Montgomery et al. 2005; Bayu et al. 2020; Nolan 2015). For example, despite various laws and programmatic initiatives, WASH levels in urban India continue to be an issue for creating a sustainable city and an equitable society. A complete research of WASH inequality, including its levels and trends, is required to establish effective policy solutions (Saroj et al. 2020).

2.3. Towards sustainable urban sanitation

Most of the used water is converted into wastewater in urban contexts, which can be divided into two categories: greywater and blackwater. Greywater is untreated wastewater that has not been exposed to toilet waste; its name comes from its foggy look and its position between freshwater (known as white water) and sewage water (known as blackwater). This study is particularly interested in the type of wastewater known as greywater. In general, according to (Amoatey et al. 2011), wastewater is water that has had its physical, chemical, or biological qualities altered as a result of the introduction of certain contaminants, rendering it unsuitable for particular uses, such as drinking. Sanitation has long been recognised as an essential component of disease prevention and primary health care programmes, broadly defined as a hygienic means of promoting health through the prevention of human contact with the hazards of waste, particularly human waste. In the context of this research, sanitation refers to mechanical or biological systems that clean wastewaters to reduce or prevent contamination and the spread of disease or contaminants. For this study, the wastewater of focus is greywater. However, many recent impact evaluation studies on sanitation interventions in low-income countries have yet to find any health improvements (Augsburg et al., 2018). Sanitation, according to Otterpohl (2001) may be viewed as a manufacturing unit capable of producing high-quality reuse water, safe fertilisers, and soil-improving products (including processed biowaste when suitable). Sanitation encompasses not only the collection, storage, treatment, disposal, reuse, or recycling of human excreta (faeces and urine) but also the drainage, disposal, recycling, and reuse of wastewater and stormwater (sullage), as well as the disposal, recycling, and reuse of household, industrial, and hazardous solid waste (Clasen et al. 2010).

Around the world, a quarter of the world's urban population lives in informal settlements and a rising number of those people lack access to sanitation because of the inadequacy or unwillingness of policymakers to make provision for sufficient services (Andersson et al. 2016). The concern is that despite low-cost, on-site sanitation being the reality for a number of the urban populations in developing countries, policy-makers are still concentrating on network and piped sewerage systems and centralised methods of sewage treatment which are designed and implemented without the participation of stakeholders and beneficiaries (Lüthi et al. 2010). Among the challenges associated with trying to make sure that sustainability and equity plans are included in the sanitation services are the vague criteria conditions within policy and more

emphasis on financial concerns and political point-scoring (Pan et al. 2015). Advancement of the status of sanitation in informal settlements in developing countries has proven to be difficult as a result of a lack of support towards the environment's institutions, lack of ownership, and the prevention of the development of new and fresh management schemes (Reymond et al. 2016).

Urbanisation is having an impact on Global South countries' chances of achieving SDGs, whereby developmental plans have fallen behind, leading to an escalation of haphazard implementations (Öberg et al. 2020). Cities are not homogeneous, especially in developing countries (Pan et al. 2018; Bourdon 2019). The suggestion is that success in achieving these SDGs requires new approaches (Meinzinger et al. 2009). Whether this means experimenting or diversifying or creating something entirely new could depend on how existing interests are shaping (Lawhon et al. 2018). It is becoming more accepted that conventional sewer-based sanitation cannot be the only suitable solution for developing urban areas. Virgolim (2017), also adds that the limiting factors to conventional sewerage systems might be because of physical and technical limitation issues. The reality is that there is growing recognition of the limited possibilities for achieving universal, uniform, networked access to services or modern infrastructure (Lawhon et al. 2018).

2.4. Characteristics of greywater in an urban environment

According to Emmerson (1998), domestic wastewater is sewage generated within residential settings. This wastewater can be classified into two distinct categories: blackwater and greywater. Blackwater primarily originates from toilets and kitchens and is characterised by gross faecal coliform contamination and high organic matter levels. On the other hand, greywater is generated from sources such as bathrooms and laundries and represents the most significant volume of wastewater produced. The World Health Organization (2006) make this important point that greywater is domestic wastewater that has not been contaminated by toilet waste or undergone any treatment. The water is derived from bathtubs, showers, hand basins, laundry tubs, floor wastes, and washing machines. Greywater excludes waste from kitchen sinks, garbage disposal systems, or dishwashers (Nolde 2000).

Greywater, mainly generated from household laundry activities, frequently demonstrates elevated pH levels due to the alkaline substances typically found in detergents. Moreover, most greywater streams often generate effluents that exhibit elevated levels of dissolved pollutants while displaying modest turbidity and suspended particles (Ghaly et al., 2021). Greywater is a residual liquid that arises from various cleaning or washing processes, and it mainly consists of surfactants as its main chemical components (Oteng-Peprah et al. 2018). The term greywater is derived from its characteristic cloudiness and grey appearance that commonly occurs when it is held for brief durations (Emmerson 1998). The sources of greywater exhibit variation across different countries and organisations (World Health Organization 2006). Greywater might be described in terms of several physical characteristics: temperature, colour, turbidity, suspended solids, and total dissolved solids. The features mentioned above are contingent upon the origin of the greywater (Maya 2019). Specific physical attributes, such as temperature and colouration, exhibit variability contingent upon the prevailing ambient climate and conditions. For example, the temperature of wastewater in colder places typically falls within the range of 7 to 18 °C, whereas in warmer regions, it typically runs from 13 to 24 °C (Maya 2019).

The global availability of water resources is deteriorating, leading to an anticipated impact on approximately 2.7 billion individuals by 2025. Water scarcity is expected to contribute to adverse socio-economic conditions such as poverty and hunger. The utilisation of greywater presents a highly effective solution to address the issue of water scarcity (Ghaly et al. 2021). Shaikh et al. (2020) express a similar viewpoint, asserting that the scarcity of water and the loss of natural water resources have compelled several locations across the globe to contemplate alternative water sources (Spychała et al. 2019; Shi et al. 2018). On-site greywater treatment and reuse is therefore receiving growing global recognition, particularly in water-scarce locations like arid and semi-arid areas (Shaikh et al., 2020). Greywater is an essential alternative water resource that has the potential to undergo treatment and subsequent reuse within buildings. This practice can effectively mitigate the demand for freshwater in regions experiencing drought. Ensuring access to safe water and addressing the difficulties posed by climate change, urbanisation, and population increase are critical imperatives that necessitate implementing sustainable water management practices (Van de Walle et al. 2023). The use of greywater for reuse purposes can enhance the resilience and adaptability of local water systems,

decrease transportation expenses, and facilitate fit-for-purpose reuse (Van de Walle et al. 2023). To effectively execute this approach, it is imperative to prioritise the microbiological safety of treated greywater (Petousi et al. 2023). Waterborne pathogens in greywater may contribute to illness in households using greywater for non-potable domestic uses (O'Toole et al. 2012a). In their study, Tal et al. (2011) observed that the use of filtering techniques on untreated greywater and the administration of increased chlorination doses resulted in enhanced bacterial inactivation. Another significant concern about the safe reuse of greywater is the potential resurgence of harmful microorganisms during the storage of greywater (Petousi et al. 2023). In the case of India, Godfrey et al. (2007) points out that greywater reuse in ashram schools in the Dhar and Jhabua districts has made more water available to meet children's basic needs. Implementing a child-friendly safety plan has helped in operating and maintaining the greywater reuse system and ensuring the safe delivery use of greywater at minimal risk. However, re-using greywater requires systems that can safely collect, treat, store, and re-use the treated water. In many informal settlements, such as Silvertown, there are no systems for safely collecting or treating greywater.

2.5. Informal settlements

The heterogeneity of the infrastructure when dealing with an informal settlement could have a relation to the heterogeneity of informal settlements. In Satterthwaite et al. (2020) it is mentioned that the phrase "informal settlement" refers to urban settlements outside legal institutions developed to record land ownership and tenure and enforce adherence to planning rules, land use, constructed structures, and public health and safety. OECD (2018) uses the term "unauthorised housing" to define places where clusters of dwelling units have been built on property over which the residents have no legal title or occupy unlawfully and unplanned areas and locations where housing does not meet current planning and construction standards. Millions of poor urban dwellers in developing countries who cannot obtain suitable housing through formal legal channels find shelter in informal settlements (McFarlane 2008; Wekesa et al. 2011; Jones 2012). According to Wekesa et al. (2011), an informal settlement is fundamentally described as a constructed area that is a slum, whether under illegal or legal ownership. In most developing nations, such settlement typologies house most of the urban poor (marginalised communities).

The definition of Sanyal (2017) is that informal settlements are settlements that were established in an unplanned and unmanaged manner, which means they are generally unrecognized by municipalities or other people in a position of power. This speaks to the inequalities as a result of informal settlements not being recognised with the provision of services and infrastructural provision. Most governments do not collect statistics on informal settlements or their residents because of their legal status (Lilford et al. 2017). Censuses should be able to give comprehensive data on informal settlements. However, they must define informal settlements and provide a space on the household census form to show if the household lives in an informal settlement (Lilford et al. 2017). In most cases, informal settlements are physically off the map of the legal metropolis (Dovey 2013). Satterthwaite et al. (2020) stated that DESA (2018) reported that globally, the urban population is roughly 4.4 billion people. Around 3.4 billion people live in urban areas in what the United Nations (UN) calls “low-developed zones” (a term that would also include informal settlements). According to UN predictions, urban population growth in developing countries will surpass 2 billion people by the year 2050, with Asia and Africa accounting for about 90% of this rise (Satterthwaite et al. 2020). This means that an additional 2 billion urban residents will require housing, basic necessities, and resilience to the effects of climate change (DESA 2018).

2.6. The precarious conditions in the informal settlements

The conditions that the people in informal settlements live under are precarious, characterised by poverty, the uncertainty of tenure, informal housing, a lack of essential amenities, and overpopulation (Davis 2006; UN-Habitat 2014). People in informal settlements face the economic repercussions of a lack of energy for productive revenue-generating activities and meeting other necessities such as education and health care, demonstrating the positive relationship between income poverty and energy poverty (Yvonne Chivanga 2023). In eradicating such setbacks, Corburn et al. (2019) claim that a community-based strategy aimed at improving physical and social environments, as well as economic and social situations in informal settlements, can be an important way to improve the health of people living in informal settlements.

As Africa's informal settlements grow, international organisations, NGOs, and governments advocate for robust public-sector action to address the issues in these settlements and restrict their growth. On the other hand, government interference in African housing markets has contributed significantly to the expansion of informal settlements (Boudreaux 2008). For example, an urbanisation policy was pointed out as one of the fundamental reasons for the expansion of an informal settlement on the outskirts of a Zanzibar town. Land management and planning regulations, which have frequently been viewed as restrictive and unable to accommodate the impoverished majority's ever-increasing need for housing, have also been linked to the spread of informal settlements (Ali et al. 2006). Simiyu et al. (2019) say that in addition to urbanisation, its spread can be explained by colonisation, poor urban planning techniques, ineffective governance, and the government's inability to accommodate the demands of the rising urban population.

Informal settlements have formed an essential part of Johannesburg since its inception, to some extent shaping its growth, often being displaced by formal development but with informal settlements re-emerging elsewhere (Huchzermeyer et al. 2011). It has been stated that informal settlement elimination should occur indirectly due to prioritising the expansion of informal settlement settings and circumstances through in situ upgrading to minimise the disturbance to people's lives (Huchzermeyer 2010). Unfortunately, little is known about the long-term impact of informal settlement upgrading on residents' health patterns in developing countries (Weimann et al. 2019). The case of Silvertown in this research has shown how an informal settlement establishes itself and how it is challenging to change, since effective change could often require the forced removal of people. More on the establishment and growth of Silvertown will be provided in the methods and results chapters.

This research aimed to analyse the extent of human interaction with the infrastructure and sanitation, particularly the CWs that were installed to address the greywater sanitation need during the research period. The issue of sanitation is a problem that has many layers in the context of informal settlements in South Africa. There is little attention given to addressing the problem of greywater disposal. This untreated wastewater could have severe effects for the environment and the health of the communities living in and near disposal points. Poor hygiene

habits and a lack of access to better sanitation facilities have been identified as contributing causes to the high rates of sanitation- and hygiene-related mortality and morbidity (Muanda et al. 2020). Water pollution has been linked to viral, bacterial, and protozoan illnesses such as salmonellosis, shigellosis, cholera, giardiasis, amoebiasis, hepatitis A, viral enteritis, and other diarrheal disorders (Dickin et al. 2016). An illustrative example is the recent cholera epidemic that took place in 2023 in Hammanskraal, Gauteng province, which resulted in an initial death toll of 15 and has since increased significantly (now 32) owing to unsafe drinking water, inadequate sanitation, and insufficient disinfection measures (Herbig 2023). In the Western Cape province, it has been reported in Lee et al. (2023) that the primary issue with diarrhoeal illness is the anticipated rise in the number of days with temperatures over 35 °C, coupled with a drop in annual rainfall and an increase in the frequency and severity of droughts due to climate change. Access to uncontaminated and secure water is an essential entitlement of every individual, and a strong water infrastructure is crucial in averting the transmission of diseases carried by water (3SMedia 2023).

2.7. Infrastructure as the backbone of a community

The precise definition of the word “infrastructure” is challenging to find. When breaking the word into two, “infra”, according to the Oxford dictionary, means “below” and the second part, “structure”, talks about the organisation of the parts. Therefore, it could be said that infrastructure has to do with different foundations broken down into arrangements that produce a structure that eventually serves as a configuration rather than a system (Lawhon et al. 2018). According to Bourguignon et al. (2005) infrastructure is understood through economics; the word infrastructure is taken as a subset of capital. In the 1990s, infrastructure was described as a determined production component, looking at how it contributes to the economy. In the same vein, earlier work viewed the function of infrastructure as a collective stock of social and financial overheads (Aschauer 1990). Infrastructure can be referred to as a country’s basic physical systems, such as its roadways, public utilities, sewerage systems, and any other buildings and systems that provide its economy with the ability to produce goods (Torrissi 2009). Many low- and middle-income cities lack suitable basic infrastructure, including roads, sewerage systems, and drainage networks. They are plagued by traffic congestion, air pollution, a high crime rate, and improper waste management (Nam et al. 2011). According to Kookana et al. (2020), given the rapid population growth of cities, additional infrastructure is needed,

notably for wastewater treatment and water delivery. Some of these populations depend on groundwater or crude water providers who use mobile tankers to meet their daily demands (Kookana et al., 2020).

Infrastructure is the backbone of society, connecting different services and assuring their significance and simplicity of use (Akhmat et al. 2011). In Bourguignon et al. (2005) the frequent conflation of service and infrastructure reflects the reality that in many circumstances infrastructure is important in the production of services. Infrastructure helps economic development by boosting productivity and providing services that improve people's quality of life (Gaal et al. 2017) Several aspects of social life are influenced by infrastructure, including where we live and the types of locations we inhabit, how often and how far we travel, and the communication systems we employ (Castells 2011). This also includes what we consume and how we get it, how we produce and use electricity, whether or not we can tolerate extreme weather, and, of course, how much we contribute to or mitigate global warming (Klinenberg et al. 2020). The counter-argument from Roy (2009) is that people make the infrastructure function in the community. It is crucial to consider how elements other than physical technology influence and advance infrastructure. Technology co-evolves with institutions, social actors, and policies to construct socio-technical systems (Geels 2002; Von Tunzelmann 2003).

2.8. Global North vs. Global South development standards

According to (Rutherford et al. 2015), research on urban infrastructure has shown that the emergence of modern forms of relations in territories, organisations, and social practices on and across all spatial scales in countries in the Global North during the historical period roughly spanning the mid-nineteenth century to the early twenty-first century was simultaneously a driver, an instrument, and a consequence of the development of networked infrastructure systems. As a result, access to uniform services was made available on a social and spatial scale (Rutherford et al. 2015). Furthermore, the dominant research focus and policy address has been on using these infrastructures in more developed urban areas of the Global North (Chambers et al. 2020). Applying this normative approach would explain why the Global South countries' infrastructures have not met the standards of the Global North. There is a concern for a

different outlook because developing countries have tried to apply the Global North approaches for many years, but those approaches have not yielded many positive results (Benabdallah et al. 2017; Lawhon et al. 2018). Instead, the HIC approach has been developed to understand how the infrastructural configurations of developing countries in the Global South are already used. A good example, stated in De Coss-Corzo (2021) is that developmental approaches such as patchwork infrastructure only sometimes foreshadow new forms of producing infrastructure and resource flows, as other forms of incrementality might. Instead, it shows how these practices can also be deployed to ensure that existing infrastructures and flows are sustained through adaptive labour. Heterogeneous Infrastructure Configuration (HIC) scholars argue that the configurations of infrastructures are dynamic Sseviiri et al. (2020) and are part of a network of relations (Lawhon et al. 2018). The ties between the configurations of the interconnected infrastructures that people engage with also play a role in establishing the relationship between people and their social interactions and the materialism of everyday life. Therefore, the HIC approach introduces an outlook of heterogeneity as this resonates with urban work on infrastructural development in the Global South rather than the homogenous approach to development, which sees Global North infrastructures as dominating (Lawhon et al. 2018).

2.9. Global South infrastructural configurations

Cities in the Global South typically have heterogeneous infrastructure arrangements. The configurations of these cities are more adequately splintered, unsteady, and aggressive, with a shortage of critical infrastructure compared to cities in the Global North (McFarlane 2010; Akhmat et al. 2011; Arku et al. 2021). Infrastructure in many Global South cities and their related informal communities must be improved for people to access sanitation, education, and healthcare (Wekesa et al. 2011; Finn et al. 2020). The institutional and economic frameworks that frequently hinder private or public infrastructure investment make it challenging to improve sanitation conditions in Global South cities and informal settlements (O’Keefe et al. 2015). Sanitation is not an isolated function tied to the infrastructural arrangement in the Global South’s cities and informal settlements, despite what is evident when we look at the issue more broadly. Global South cities and informal settlements are examples of high population densities which tend to cause excessive adverse effects, such as overcrowding, congestion, and environmental risks (Visagie et al. 2020). However, O’Keefe et al. (2015) believe that issues like a need for top-level political leadership to enhance living conditions and access to essential

services are more significant than just high density, lack of formal tenure agreements, a transient population, and poor or contradictory governance systems that cause inertia within the prevailing provisioning systems. All these factors reduce the need for private investment in sanitary infrastructure.

According to Lemanski et al. (2022), there is growing scholarly recognition that state-led centralized mass-scale networked infrastructure is frequently inappropriate for the Global South and is also declining in prevalence within the neoliberal Global North despite being the dominant historical model for Global North cities and promoted as the ideal policy goal for the pre-networked Global South. This is the central argument of HIC scholars regarding infrastructural development in the Global South. In providing modern infrastructure for cities and informal settlements of the Global South has generally involved embracing technologies and infrastructure similar to that of the Global North (Lawhon et al. 2018).

2.10. Why has informal settlement infrastructure not developed

Too often, crucial infrastructure is non-existent in informal settlements (Schindler et al. 2019). Informal settlement residents may slowly build small-scale infrastructure solutions or covertly encroach on official infrastructure systems (Schindler et al. 2018). When looking at South Africa's informal settlements, it is highlighted in SERI (2018) that the country has a developed legal and policy framework which aims to redress the legacy of apartheid. However, although great strides have been made, systemic challenges continue to compromise the enjoyment of fundamental human rights. These challenges came not from the legal and policy framework but rather from how this legal framework had been implemented in practice (SERI 2018). Another problem is that many other African cities are caught between an idealistic desire for modern water and infrastructure and a realistic recognition of the impossibility of universal access (Lawhon et al. 2018).

According to Kithiia et al. (2020), colonialism (pre- and post-) has played a vital role in infrastructural development investment in the Global South. None of the occasional sectoral reforms of the 1970s, 1990s, and 2000s, nor raised budgetary allocations to the sector, have

been helpful to poor residents in informal settlements who still need access to large-scale piped water systems and sanitation services (Kithiia et al. 2020).

2.11. Neo liberalism's impact on the infrastructural inequalities

This research, using the lens of HIC, explores the inequalities of sanitation embedded in the infrastructural configuration of the network (Rusca et al. 2017). Angelo (2017) argues that accounts of the Global South city must still fight the assumption that poor people's infrastructure, education, sanitation, and food provisioning in places like Mumbai or Johannesburg are products of contemporary inequalities rather than leftovers from rural life or consequences of migration from the countryside. Urbanisation can create challenges for sustainable development if it produces unequal outcomes. Infrastructure is therefore vital to urbanisation, providing services to support diverse urban activities. However, it can lock in unequal outcomes due to its durable nature (Pandey et al. 2022).

There is the argument put forward by Smit (2021) as it relates to Lawhon et al. (2018), that neoliberal policies, ideology, and practices which became globally dominant in the 1980s (Theodore et al. 2011; Adama 2018; Fourie 2022) and have continued to be so. What is neoliberalism? According to Kotz (2002) neoliberal theory can be defined as a largely unregulated capitalist system (a free market economy) that reflects the ideal of free individual choice. It provides optimum economic performance regarding efficiency, economic development, technological advancement, and distributive justice. In (Peck 2010) it is believed that neoliberalism appears to be ubiquitous and includes everything.

The most difficult conceptual challenge is that neoliberal ideology uses the language of freedom and choice to advance policies that privatise basic needs (Gatwiri et al. 2020). As stipulated in Keil (2009), neoliberalism aims to reduce (welfare) state services and security systems and promote the call for personal responsibility and self-care. The wealthy can frequently afford these services and compete fairly in the free market, but the poor cannot and thus end up marginalised (Gatwiri et al. 2020). This neoliberal thinking is not far-fetched from its early form of neoliberalism in the late nineteenth century through what was termed the

revanchism of the city. The “revanchist anti-urbanism represents a reaction against the supposed “theft” of the city, a desperate defence of a challenged phalanx of privileges, cloaked in the populist language of civic morality, family values and neighbourhood security” (Smith 2005, 207). A lot of debate relating to revanchist cities has been empirically grounded in Global North including Germany (Belina et al. 2003) Scotland (Atkinson et al. 2001) Canada, and the United States of America (Slater 2004).

In many developing countries, neoliberal policies have interacted with the “traditional” pattern of poor housing delivery — self-built informal settlements — in contexts where the urban impact of industrial development drew migrants from rural areas to cities, creating a high demand for housing (Rolnik 2013). In looking at informal settlements, it is hard to overlook the continued inequalities generated by neoliberalism in African countries, especially regarding the urban resistance movement Afenah (2009) or what Lefebvre (1996) calls the “Right to the City”. According to Wilson (2004) this has been seen as producing an “underclass” who have been attracted to the city but who cannot afford the high cost of services that come with living in an urban context (Alfino 2017). The lack of urban and housing policies to meet this demand and a lack of urbanised land policies to welcome this new (primarily poor) urban population resulted in extremely precarious housing schemes characterised by a severe lack of infrastructure and essential services, as well as ambiguous tenure status (Rolnik 2013). Menon (2019) has refuted the claim that developing nations can only catch up to their developed colonial dictators through neoliberalism. Access to cutting-edge goods and technology allows developing economies with low productivity levels to increase productivity, output growth, and, as a result, revenues. This view ignores the role of Western governments in fostering government change and appointing the elites who would later suppress democratic rights (Menon 2019).

2.12. Right to the city

Changing the narrative about inequalities experienced in cities of the Global South may be a radical conception of the “right to the city” according to Castro Seixas (2021) as proposed by Lefebvre (1996), which could help shape the urbanisation process. Castro Seixas (2021) goes on to present that in Lefebvre (1996), as a higher form of rights, the right to the city includes

freedom, the right to individualisation in socialisation, the right to habitat and habitation, and the right to freedom. One of the first campaigns for the right to the city was launched in Brazil, where groups among the urban poor, particularly in the favelas of big cities, started to promote the idea (Purcell 2014). As (Marcuse 2010) explained, the right to the city is viewed as a communal right, essentially a scream from urban residents who have been denied fundamental human rights. However, it is also a demand from people wanting to unleash their creative potential in an urban setting. Lefebvre (1996) asserts that capitalist industry forces itself on the municipality by establishing the supremacy of exchange value. It seeks to reduce everything in the city, including the space itself, to an interchangeable good that can be sold (Purcell 2014). That is why, this research, through the inequalities of services such as greywater solutions, which can be traced back to laws of neoliberalism, aims to show how people interact with the few resources and rights they have been subjected to. With the introduction of greywater collection and treatment systems, this research will also try to see how inequalities can be reversed by embracing the heterogeneous nature of the informal settlement (Silvertown), services, and the equal importance of the infrastructure and community.

Nagle (2017) also highlights that the “right to the city” includes the freedom for citizens to be involved in a city’s “oeuvre”, which is a continual process of design, production, negotiation, and living in urban areas. As has already been indicated, most informal settlements lack sufficient space. However, certain essential services require space Simiyu et al. (2019) such as sewers, roads, pavements, and recreational services. Therefore, by assisting and highlighting the contribution of the production of their spaces, as pointed out in the “right-to-the-city”, the development trajectory can be enhanced. In line with Lawhon et al. (2018), HIC understands these past oppressions, and the impact of neoliberalism leads to the need to think differently about development to see desirable and achievable outcomes. The essential claim is that even though public funding from post-colonial governments was frequently secured through foreign loans and utilised to expand low-cost services through networked services, the pursuit of universal availability has remained elusive (Lawhon et al. 2018). Lawhon et al. (2018) point to the literature on urban infrastructure in the Global South, which has also drawn attention to fresh opportunities for social organisation, property ownership, and power dynamics both inside and outside of the State. Moreover, there is an agreement with academics who have

promoted a broader definition of infrastructure that considers “people as infrastructure” (Simone 2004).

2.13. People as infrastructure

In this study, the empirical research has considered the essential part humans play in the infrastructural configuration, in line with Simone’s (2004) notion of people as infrastructure. Lawhon et al. (2018) have pointed out that understanding infrastructure in the Global South countries as well-organized systems is problematic and is a Global North approach (Lawhon et al. 2018). This study adds to the understanding of infrastructure as a broader literature, highlighting the socio-material production and maintenance of all technical artefacts. This points to the connection of an invisible division between the social and the technological (Rutherford et al. 2015). The point is that the very idea of infrastructure is deeply embedded in social relations and acts as part of material conduits (Anand 2011a; Larkin 2013). Therefore, like McFarlane et al. (2017) this study views infrastructure as selecting the socio-material connections that sustain urban life.

Like Angelo and Angelo et al. (2015) this research wants to understand the extent of infrastructure in the previous work by critical geographers and political economists using the social analysis technique. Infrastructural networks were traced by Graham et al. (2002) to show patterns of uneven socio-spatial development and to display how infrastructure strengthens connections between some places while isolating others. The relation of informal places, like the study site for this research, was formed by an association with past revanchism and current neoliberalism (Carmody et al. 2016). Some scholars have demonstrated how infrastructure can be used as a tool of governance and reduction of an investment (Keil (2009) or as a tool of social control (Olesen 2020). As geography scholars do for the objective dimensions of infrastructure, this research examines these relationships by focusing on the forms of social understanding, associations, and space contestation using an everyday life setting.

2.14. Lefebvre: The Production of Space

The Lefebvre theory of production aligns with the HIC theory of Lawhon et al. (2018). According to Lefebvre, the perception of scientific understanding and its apparent effectiveness in unravelling natural world riddles has led to the scientific method being regarded as the fundamental methodology for forming insights into society (Watkins 2005). According to Lefebvre, space is a medium of production and, hence, a component of society's foundation, and space is both a condition and an outcome of social superstructures (Fuchs 2019). The space in the study site is assembled by the different power agencies (the residents, government, and NGOs) and by the basic infrastructure in housing, pathways, electricity, communal taps, skip bins and chemical toilets. These infrastructures provide the space for interaction with the residents. According to Lefebvre, the social production of urban space is essential to the reproduction of society (Gottdiener 1993; Molotch 1993). This is true because the urban infrastructure located on the site of this study, including housing, mobile toilets, skip bins, communal taps, and greywater intervention, influences people's behaviour towards the infrastructure. But it is also important to point out that the lived experiences of those who engage with space can also affect the social aspect of it.

Although urban space and its organisation undoubtedly influence lifestyles and representations (planning), Lefebvre contends that the potential of free creative expression is subordinated to the hegemonic power of representation (Zieleniec 2018). Material space influences practices and behaviour and acts crucially on social groups and systems (morphologies, sociability, identities). First and foremost, through representations, social groups and individuals create themselves based on their histories and social ties (Busquet et al. 2013). Okuyucu et al. (2021) point out that Lefebvre asserts that when space is produced, it is primarily regarded as a social good. Yet, this product is not just any ordinary product; it is a definition that considers the product, the production, and their intricate interactions - the idea of space ties together the mental, the cultural, the social, and the historical. Space and human interaction directly impact the dimension of human behavioural connections in space, dictating living circumstances and space utilisation practices. Therefore, the degree of urbanisation is revealed via the space-human interaction (Okuyucu et al. 2021).

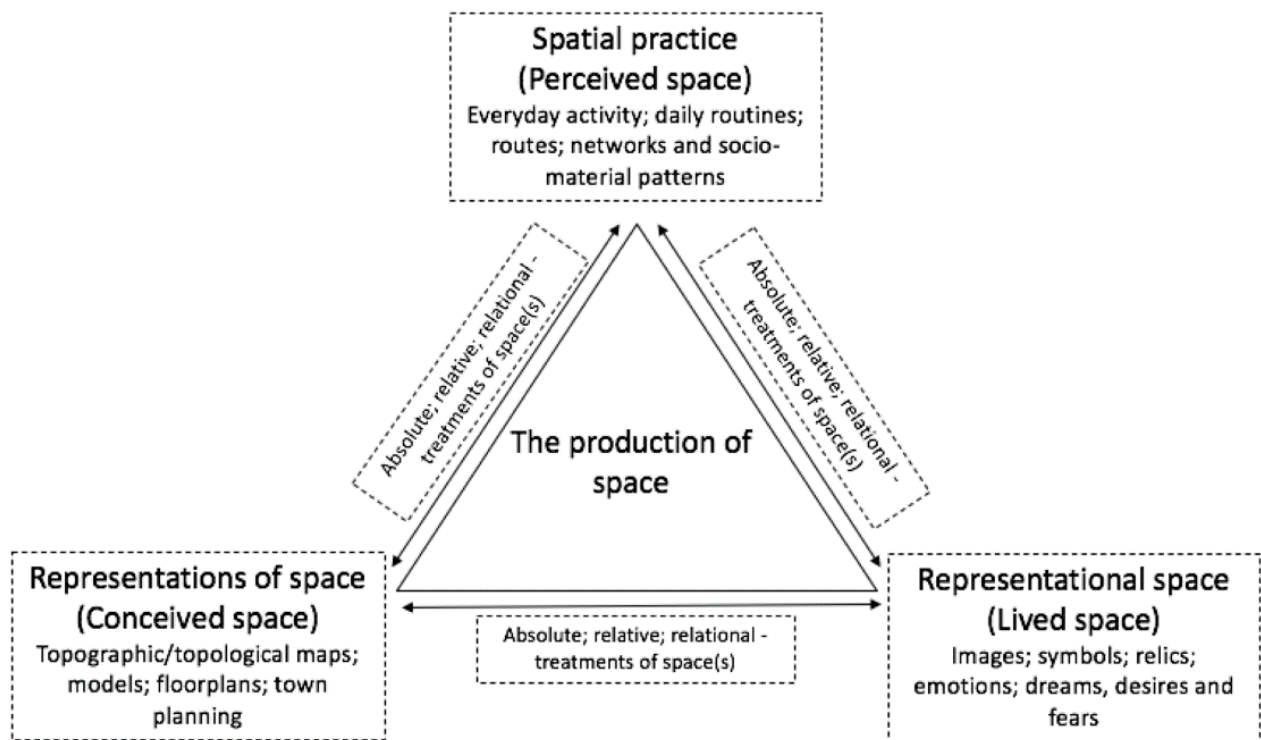


Figure 1: Henri Lefebvre Spatial Triad model.

(Holmes et al. 2021)

As depicted in the spatial triad diagrammed in Figure 1, Lefebvre argues that space consists of three elements: spatial practice (perceived space), representations of space (conceived space), and representational space (lived space) (Fuchs 2019). Spatial triads are offered as an introduction for an examination of everyday life (Rutanen 2014). Lefebvre argues that capitalism is based on the resistance between conceived, planned space organised as abstract space and the lived spaces of everyday life (Fuchs 2019). Conceived space is considered the dominant space under any mode of production (Leckie et al. 2010). On the other hand, Fuchs (2019) felt that conceived space only sometimes acquired dominating or dominant forms. In a socialist society, conceptualised space is claimed by human interest in such a manner that this knowledge helps all persons who live in a place, not just the ruling class. There is also the option of participatory design and planning, which involves residents in creating the environments in which they live (Fuchs 2019). This is the space of scientists, planners, urbanists, technocratic sub-dividers, and social engineers (Ng et al. 2010).

In a similar way, (Ilako et al. 2020; Leckie et al. 2010) think that representations of space are rationally accepted ideas of space for property development reasons. They are separate places conceived by architects, planners, engineers, and artists who construct such spaces based on what the residents experience and live in (Leckie et al. 2010). Capitalism, with the idea of conceived space, idealises design and built spaces but forgets how the interactions occur. There is a difference between everyday practice, experience, activities, and written guidelines and rules (Tresfon et al. 2022).

Lefebvre refers to the representations of space (conceived space) as the dominant space of any society (or mode of production). According to Lefebvre (1996) conceived space is the primary space that impacts all other spaces. Here, space is controlled to meet specific needs and provisions; this space is primarily developed based on the technical team's assumptions, with the overall suitable purpose usability and the physical feel of space intended for specific users (Ilako et al. 2020). The argument that is put forward is that the conceived space is the dominant and powerful space; "Conceived space would erase the decades-old lived spaces that had been appropriated" (Ng et al. 2010, p. 423) and replace it with the meaning that they idealise. This refers to the major players driving urban change (Setiadi 2021). However, urban designs were most likely created years before, and by the time they were built, what was deemed appropriate (at that time) would no longer applicable to the present users. Consequently, examining the many space concepts as conceptualised provides a foundation for determining the overall purpose and usefulness of various areas (Ilako et al. 2020). Relating to the urban setup of the modern city in developing countries, it could be argued that the conceived space idealised by governments has cemented the idea of "informal", as in an "informal settlement."

We have learned from Lefebvre that the spatial field concept implies that space is fundamentally a matter of politics. This is because space inherently has political implications, thereby giving rise to the politics of space (Heinickel et al. 2019). Politics is influential in several situations. Politicians in elected positions have the power to make authoritative statements about policies and priorities, create laws and ensure their implementation, determine national budgets, increase taxes and determine their rates and distribution, distribute benefits, provide funding to businesses and charitable organisations, oversee and direct bureaucratic

staff, establish regulatory agencies and various other organisations (Rose et al. 1992). (Peluso (2009) identifies a paradox in human-environment interactions, which researchers in Political Ecology further explore. These scholars demonstrate that this paradox has symbolic, material, and ecological implications. The exertion of authority could be more precise, resulting in several conflicting consequences (Ahlborg et al. 2018). Political issues exert a significant effect on the process of economic growth in a country. The pursuit of economic progress often entails substantial environmental degradation (Akon et al. 2023).

2.15. Political Ecology

Political ecology is a discipline that consists of encompasses various several theoretical and methodological frameworks that examine socioecological relationships. These frameworks collectively focus on the political aspects of managing natural resources, accessing and controlling them, understanding the environment, and comprehending how these elements interact with livelihoods and the dynamics of ecological change (Bassett et al. 2015). According to Radonic et al. (2015), political ecology is an academic tradition that aims to deconstruct mainstream representations of environmental concerns, arguing that these depictions are frequently favourable to unjust socio-environmental change. Basset et al. (2015) noted that political ecology emerged in the 1970s and early 1980s because of political economic criticisms of cultural ecology and systems ecology. The critique maintained that to understand environmental deterioration, for example, soil erosion, resource management practises, generally of smallholders in the developing world, needed to be contextualised within the larger political economy (Watts 2008; Blaikie 1985). Greenberg (1994) argues that political ecology creates a common ground where multiple fields interact. Political Ecology encourages case studies from agriculture, land tenure, health, development, international law, history specialists, and both the physical and social sciences. Each of these fields has previously made significant contributions to the study of political ecology (Greenberg 1994). On the other hand, looking at the other disciplines, empirical political ecologies of health (and illness) have examined how political economic processes interact with ecosystem change and related health effects and how various institutions, practitioners, and impacted individuals and groups interpret and judge such interactions (Brisbois et al. 2018). Major theoretical frameworks for analysing human-environmental interactions include feminist political ecology and the political ecology of health (Nunbogu et al. 2021).

Looking at the issue of water in Swyngedouw (2009), we are made aware that for far too long, water research has focused on the physical or managerial aspects of the water problem, often avoiding the puzzling question of how political-economic power relations merge the material and the administrative in specific and invariably socially unequal ways. On the other hand, political ecology, like the Marxist-inspired workers movement, is founded on a critique of the existing order of things (Lipietz 2000). Initially, political ecology was best recognised for examining the methods and effects of sizable resource development initiatives in communities focused on subsistence in the Global South. Political ecology has broadened its scope over time to include socioecological degradation in urban, industrialised contexts, and assessments of environmental politics (Roberts 2020). According to Brisbois et al. (2018), political ecological approaches typically situate present-day environmental conditions in an historical context and mainly seek to understand how particular places and populations are affected by forces operating at multiple scales, taking into account complex webs of relationships connecting social and ecological actors (Roberts 2020). In essence, disciplines of political economy, cultural ecology, social ecology, green socialism, environmental sociology, development ecology, anthropology, biology, geography, environmental ethics, agriculture, political theory, political science, and issues relating to governance, government, policy, and law are some of the components that make up and are relevant to political ecology.

Concerning HIC (Simone 2004; Lawhon et al. 2018), urban political ecology is an increasingly prominent paradigm in human-environment studies for analysing the power asymmetries entrenched in complex human-environment linkages in cities, and hence for comprehending the histories of their urbanisation (Radonic et al. 2015). The conception of the city as a continual and disputed socioecological change may be tackled by analysing the dialectical interactions between people and the non-human environment that surrounds them at its centre (Kaika 2004). In addition, political ecology in Forsyth (2002) emphasises the significance of studying the connections between social and physical systems and the role that time plays in forming human knowledge and its interactions with the physical environment. Studies in urban political ecology have mainly focused on objects to study the material fluxes that unevenly influence the urbanisation process in the context of capitalist power relations. These are primarily significant infrastructure networks, notably water infrastructure (Swyngedouw et al.

2004; Loftus 2012). Focusing on the ways that various actors interact with one another inequitably is necessary to comprehend the environment as a terrain crisscrossed with different power relations (Angel et al. 2019).

Inequalities in power include differences in decision-making participation, work division, resource availability and control, and knowledge and skills. Political ecology may enhance our understanding of power disparities and their origins and, therefore, show how it might be helpful in social-ecological resilience management (Quandt 2016). However, the ideas of participatory governance should be less generic and more placed within the boundaries of place-based institutional and environmental histories (Bixler et al. 2015).

2.16. Participatory approach

Parfitt (2004) noted that UN (1973) defined participation as a voluntary contribution made by individuals towards public programmes to foster national development. However, it is essential to note that this perspective does not encompass active involvement in programme design or the ability to critique its contents. Participation may also make it possible to include local expertise, resources, and knowledge in the design of interventions; it can guarantee that a project or programme is responsive to users' demands; it can also advance the objective of sustainability; and it can help eliminate the dependence mindset (Mubita et al. 2017). Sinwell (2023) highlighted that the theory for participation, or participatory development, is often cited in the academic literature as having its “roots in Freirean philosophy”. Freire (1998) raised a fundamental question in the context of participatory action research. Is it impossible to make a strong connection between the knowledge considered indispensable and the expertise acquired from the lived experiences of the students involved (Orlowski 2019). The participatory approach often promotes local people to be involved in decision-making that affects their personal and communal lives Riswan (2021). Participation refers to actions demonstrating forms of involvement performed by parties within evolving discussion structures (Goodwin et al. 2004). For Dinbabo (2003) participation evokes community involvement in the decision-making process of implementation of development projects. To facilitate the effective involvement of citizens and users in urban development projects, it is essential to possess information on the accessibility and suitability of various tools. Different approaches are

required at different phases of a design or planning process (Stelzle et al. 2017). However, according to Sinwell (2023), there is a risk in over-emphasising local knowledge since it obscures the larger politics at the regional or national level.

Participation includes local expertise, resources, and knowledge in designing interventions and guarantees that a project or programme is responsive to users' demands, advances the objective of sustainability, and can help eliminate the dependence mindset (Mubita et al. 2017). However, critics also claim participation does not result in local empowerment because participatory approaches must alter and challenge the bureaucratic, centralised, and administrative systems that govern decision-making and resource distribution (Mubita et al. 2017). Additionally, as explained by Babajanian (2015), participation does not guarantee that citizens will have the capacity to exert influence or control over the delivery of services. The effectiveness of addressing people's grievances and comments and ensuring fair and efficient grievance resolution also depends on the desire of service providers and government organisations to take action (Babajanian 2015). It is crucial to bear in mind that a significant relationship exists between a participatory approach and good governance, as they both pertain to the optimal direction of the state and the effective functioning of government (Zondo 2022).

The primary criticisms of participation can be categorised into two main perspectives: one that emphasises practice, particularly Participatory Action Research (PAR), and another that challenges the analytical foundations of participation (Parfitt 2004). Individual participation is not novel and lacks a singular origin (Mubita et al. 2017). Most of the criticisms of PAR involve the inappropriate application of methods, such as inadequate training of researchers, insufficient time in the field, weak research relationships and weak participation (De Oliveira 2023). Masschelein et al. (2006) point out that as an alternative to top-down methodologies, participation can enhance individuals' empowerment, acknowledge and cultivate their expertise and local knowledge, and demonstrate responsiveness to their diverse needs and interests. One of the critiques against top-down models is their limited applicability in scenarios characterised by the absence of a predominant policy or agency. Instead, such situations involve a plethora of governmental directives and players, none of which hold a position of pre-eminence (Pissourios 2014). A paradigm shift resulted from the failure of "top-down" or

growth models of development, which did not live up to their expectations, and from the realisation that approaches to development had to be adapted to local conditions that are shaped by different, socio-cultural, economic and political realities that favour more individual and social control over project and programme interventions (Brett 2003). In this illustration, implementing a bottom-up, participatory strategy prioritises the communities and individuals directly affected Semeraro et al. (2020) using a hybrid method that integrates both bottom-up and top-down participation strategies particularly when examining urban contexts, has been criticised due to its perceived tendency to exacerbate conflicts among various stakeholders.

Environmental Impact Assessments (EIAs) often take a participatory approach. The high participatory ideals of EIAs often need to improve in practice (Sandham et al. 2019). The deep-seated problems in the practice of public participation in EIAs in recent years, such as the lack of validity and authenticity of public participation, have presented new challenges for legislation on public participation in EIAs (Wang 2017). According to Sinwell (2023), we are made aware that participatory approaches are used in the belief that community services are homogenous. According to Lawhon et al. (2018), the HIC has brought to our attention that individuals living in poverty at the local level reside in a diverse environment characterised by various infrastructures. According to Sinwell (2023), there is an argument that involvement often idealises the community and fails to address the existing inequities within it adequately. In this illustration, implementing a bottom-up, participatory strategy prioritises including communities and individuals directly affected (Lundy et al. 2008). Petts (2003) argues that a fundamental problem is that many citizens do not participate. In addition, the literature on barriers to public participation in EIAs tends to adopt a top-down perspective. Citizens participate in EIAs, they develop attitudes towards the project and the broader policy, but public acceptance does not guarantee that the project (of which the EIA may be a part) is accepted (Cuppen et al. 2012).

In fostering participation, a point is made in Mwalyosi (1999) that the effectiveness of public engagement in a planning process is enhanced when it is directed explicitly towards stakeholders, particularly groups or individuals who possess a vested interest in the issues that are anticipated to occur throughout the decision-making process. The efficacy of participatory

methodologies is contingent upon both the structural and institutional circumstances in place and the individuals involved. This underscores the need to possess particular skills and competencies related to participation (Disterheft et al. 2015). Researchers have utilised comparative evaluations to determine the attributes of successful involvement, which have subsequently been employed in developing best practice guidelines (Webler et al. 2002). Nevertheless, these methodologies must provide environmental flow administrators with the necessary means to evaluate their participation programmes on time (Mussehl et al. 2023). In Rowe et al. (2004), it is thought that the evaluation's effectiveness is contingent upon several factors, including financial considerations, practical considerations, ethical/moral considerations, and research/theoretical considerations. Financially, evaluation is crucial to allocate appropriate public or institutional funds. Practically, evaluation allows for learning from past mistakes and improving future exercises. Ethically and morally, evaluation establishes fair representation and prevents deception regarding the impact of individuals' contributions. Lastly, evaluation contributes to advancing our understanding of human behaviour from a research and theoretical perspective (Rowe et al. 2004).

This research uses the theoretical framework of HIC to understand and examine the establishment of the CWs in Silvertown. The history of South Africa is based on the poor being deprived of service delivery, and in democratic South Africa, the trend continues. Neo-liberal policies and plans have aimed to rectify this inequality, but still, infrastructural development fails in the Global South as the world evolves. Therefore, according to Lawhon et al. (2018), HIC, as a framework derived from urban geography, aims to present novel perspectives on development, offering an alternative approach to conceptualising and researching infrastructure.

2.17. Constructed Wetlands

This research looks at the informal settlement of Silvertown, looking at greywater as the focal service. During this project, a nature-based solution using CWs was introduced to the community of Silvertown by an outside project team in the form of the URBWAT project. According to Kushwaha et al. (2023), CWs are artificial shallow reservoirs comprising plants, soil, microorganisms, water, and a substrate to promote the absorption and removal of nutrients

and pollutants. Nature-based solutions use ecosystems and their associated services to tackle pressing societal issues, including climate change, food security, and natural catastrophes (Cohen-Shacham et al., 2016). The relation between the two is what Agaton et al. (2023) point out, that CWs are nature-based solutions that employ natural plants, soils, and bacteria to purify home wastewater, in the case of this study, and industrial effluents in other contexts. According to Vymazal (2010), the systems are engineered to utilise mechanisms similar to those seen in natural wetlands but in a controlled setting. It is also added that these treatment systems are designed to replicate the activities of natural wetlands to gather rainwater, decrease nitrogen levels, and provide varied animal habitats (Agaton et al. 2023). Effectively managing and using these CW systems continues to be a problem, and there are fewer studies on the sustainable operation and successful application of these systems in real-world contexts (Gorgoglione et al. 2018). CW technology offers several advantages according to Reddy et al. (2014), but certain restrictions might affect its proper operation and maintenance. Clogging is the most often encountered operating issue in built wetlands. Gorgoglione et al. (2018), again adds that plant species and substrate material are critical influencing factors to the pollutant removal ability of CWs.

2.18. Heterogeneous infrastructure configurations (HIC)

According to Lawhon et al. (2018) HIC has unique features and operates differently from traditional methods. The term “heterogeneous” pertains to several characteristics of the variation found in infrastructure and is specifically used to highlight and contrast with the uniformity of the contemporary Global North infrastructure ideal (Lawhon et al. 2018). Does uniformity characterise infrastructure? Well In Buhr (2003) study, the term “infrastructure” is defined according to Jochimsen (1966) definition. Infrastructure refers to the combined physical, institutional, and personal resources and information accessible to economic actors. These resources play a role in achieving fair compensation for similar inputs when resources are allocated appropriately, resulting in complete integration and the highest level of economic activity.

Lawhon et al. (2018) aimed to better comprehend unique objects and their connections to specific socio-political urban geographies by establishing the HIC concept. Therefore,

considering HIC enables a more precise analysis of infrastructural artefacts as components of geographically dispersed socio-technological configurations (i.e., groups or collections of artefacts and objects) rather than individual objects. These configurations involve various technologies, relations, capacities, and operations, as well as different risks and power dynamics. The word heterogeneous alludes to several facets of infrastructure variation and is meant to contrast overtly with the homogeneity of the contemporary Global North infrastructure ideal. The term heterogeneous describes a situation in which two (or more) types of infrastructure are combined, but it is not immediately obvious which types are being combined. HIC refrains from using the word “alternative” because the infrastructure is often viewed as a coherent whole within its context, rather than being an “alternative” to the “ideal”. Through the formation of various socio-technical linkages, the configurations are often distributed spatially. Heterogeneity is present because it is a reaction to precarious settings, whereas, centralised infrastructures were usually designed to show strong internal and external dependencies (Lawhon et al. 2018).

The concept of HIC aims to provide more than a new ideal infrastructure. Instead, it provides a framework for making wiser, more rigid, and more politically contextual choices. It is also stated that in many informal settlements, such as a case study in Kampala, sanitation supply encompasses a multitude of ownerships, users, technical artefacts, usages, and temporalities. (Lawhon et al. 2018). The lack of central authority Sseviiri et al. (2020) over varied infrastructure configurations in post-colonial contexts means that they are characterised mainly by being situated and decentralised power relations (Lawhon et al 2018). In essence, Lawhon et al (2018) emphasise that a single, interconnected system is brittle. If it breaks down, everything connected to it also breaks down unless someone fixes it. In an HIC context in the Global South, the heterogeneity allows for continued operation, even if it is not as optimally functional as in the Global North. This is the central learning from HIC.

Water flowing, energy supplied, and garbage collected are examples of urban infrastructures and environments that are becoming renowned for their enormous variety and the presence of various overlapping systems, configurations, and actor networks that keep a city running (Truelove et al. 2021). According to Lawhon et al. (2018), the notion of HIC complements the

work of urban scholars on how we should imagine and describe urban infrastructure, especially in the Global South, with the consideration of dynamism, which needs to be acknowledged. In the same way, HIC adds to the argument of moving away from the “idealised smart city” as these configurations offer an alternative “new infrastructure ideal” that provides all-encompassing coverage that is geographically ubiquitous, managed centrally, and homogenous (Guma et al. 2022). Even the modernist idea has proven to have worked in the Global North, with the provision of homogenous delivery, which has been shown to be challenging in ensuring human development in the Global South. According to Essex et al. (2019) for instance, difficulties like fast urban and population growth - often onto private land on the outskirts of cities - have brought to light the technical, economic, and legal limitations of an energy system based on a networked grid. According to Nepal et al. (2023), many towns in the Global South need proper drainage and waste management infrastructure. It might be difficult for municipalities, often in charge of handling garbage in cities, to provide a cost-effective solution for the local inhabitants. However, the current systems in the Global South do not collect all the created waste due to a lack of waste infrastructure (Karagiannidis, et al. 2011). Such a networked distribution or collection system is frequently characterised by unfair, erratic, and rationed services for many (Munro 2020).

Like other critical urban studies approaches, HIC aims to provide a holistic approach to infrastructural development. HIC is a theoretical framework developed by urban infrastructure scholars concerned with modern developmental approaches in the Global South (Nilsson 2016; Lawhon et al. 2018). Their argument for Global South countries is that understanding infrastructure configurations as well-organised systems is a Global North approach (Lawhon et al. 2018). Lawhon et al. (2018) put forth the idea of urban infrastructure as hybrid and heterogeneous regarding the current issues that must be faced (Lawhon et al. 2018; Cirolia 2020). Instead, infrastructures are post-networked and off-grid (Rutherford et al. 2015; Koepke et al. 2021; Caprotti et al. 2022), incremental (Lawhon et al. 2018; Kundu et al. 2021; Peng et al. 2021), and human, incorporating lived experiences McFarlane et al. (2014). Recognising infrastructure as non-static, “lively” temporality is essential to these discussions (Amin 2014) and is a dynamic process that is constantly re-made, re-assembled, co-opted, and corrected by public and private individuals and institutions (Caldeira 2017; Baptista 2019; Lemanski 2020; Ramakrishnan et al. 2021).

Abbott (2013) notes that infrastructure is a fluid set of overlaying systems sustained by urban dwellers. Together, these narratives suggest that understanding urban residents' role in negotiating infrastructure through various movements and connectivity is essential to understanding heterogeneous infrastructures (Munro 2020). Urban studies have revealed that infrastructure is not exclusively technical or apolitical but is a physical-material representation of socio-political processes (Lemanski et al. 2022). Simone (2004) takes this further by pointing out that African cities are known for their citizens' continued mobility, flexibility, and dependence on transient arrangements. These residents need to understand how the city should be used and occupied. Thus, the urban poor construct infrastructure from the materials at hand and are ingenious and inventive users of whatever is available to meet their demands for a living (De Koning et al. 2012). Together, social aspects and technology are imagined as combinations of human and non-human connections, with infrastructure thought to be a sociotechnical accumulation, and urban social life is never reducible to purely the human/s alone (Amin 2014).

The conceptual symmetry afforded to human and material agency is significant (Odendaal 2021). One way "situatedness" can be probed in sociotechnical relations is through understanding the everyday practices of urbanites as they interface with infrastructure (Odendaal 2021). Like other existing work, the critique is that there needs to be an in-depth examination of the "network city". To move beyond the network to the articulation of the socio elements since scholars like (Anand 2011b; McFarlane et al. 2014; Graham et al. 2002) have studied how the materiality of contingent infrastructural configurations shapes our everyday social lives. According to Klinenberg et al. (2020) physical infrastructure is the sole determinant of social infrastructure.

2.19. Previous HIC studies

The Global South has provided most of the HIC studies presented by scholars e.g., (Nilsson 2016; Lawhon et al. 2018; Sseviiri et al. 2020). Truelove et al. (2021) highlight that the urban environments and infrastructures, albeit not just in the Global South, are characterised by

substantial heterogeneity and several overlapping systems, configurations, and actor networks. These networks ensure the city functions well by ensuring water flows, energy is supplied, and garbage is collected (Truelove et al. 2021). Simone (2004) states that African cities are marked by perpetually fluid, movable, and provisional intersections of inhabitants that function without clearly understanding how the city will be inhabited and used (Simone 2004). These cities' construction and infrastructure usage are characterised by various disruptions to centralised networks, complicated governance/management structures, and dynamism (Smith 2023). Using the example of electricity, Koepke et al. (2023) add that diverse socio-technical configurations distinguish sub-Saharan African cities. Examples include electricity, solid waste, water, M-pesa (a mechanism for sending money), and internet- and phone-related services (Smith 2023).

African countries, especially in East Africa, provide concrete instances of HIC investigations. The case studies (Sseviiri et al. 2020; Ernstson et al. 2022) looking at East Africa place a lot of emphasis on the various waste management practises that individuals use in addition to the services provided by the State and the commercial sector. HIC is not viewed as crossing the public-private divide but rather as originating from vital social activity in a particular setting and time (Ernstson et al. 2022). The study by Nakyagaba et al. (2021) shows how solid waste management is infused with blackwater sanitation, which exemplifies how previous studies have merged solid waste into other services. A few issues mentioned throughout the investigation by Nakyagaba et al. (2021) claimed that they dumped their waste in pit latrines. This is because more functional solid waste infrastructure was required, and a new municipal law mandated that residents pay for garbage collection services (Nakyagaba et al. 2021). There is generally an awareness that in Global South cities, broader (universal) access to services may be provided by a diverse array of technologies (Lawhon et al. 2018; Koepke et al. 2023).

Some studies have investigated the factors that have led to the abundance of alternatives for providing electricity, water, trash, and sanitation services. Mguni et al. (2020) utilised water, energy, and food (WEF) in Uganda's Bwaise and Kanyogoga informal settlements to show how HIC works. The observation is that the modalities of supplying water, energy, and food in informal settlements are intrinsically diverse (Mguni et al. 2020). The HIC of the WEF nexus

and their linkages, which political ecology inspires, are also highlighted by (Bruns et al. 2022). The distribution networks of infrastructure and services have a variety of flaws in the Global South, which is why the studies on HIC have provided several examples. Even Schindler et al. (2019) discussed how households secured access to water and decreased exposure to solid waste daily without official and informal designated services by referencing the fragmented water network and hybrid dependable waste management services.

When examining water access, Tetteh et al. (2022) pointed out that despite household access to better water and sanitation in resource-poor settings, notably in Sub-Saharan African cities, there were still significant regional disparities in access to safe, dependable, and inexpensive water. The fact is that the region's urban drinking water configuration is predominantly diverse. Political ecology may be used to explain heterogeneity because it shows how social, historical, political, and ecological processes interact to produce unequal and unjust landscapes and waterscapes (Smiley 2020). The colonial strategy of segregation and uneven service supply in Dar es Salaam has pushed the informal and outlying populace to rely on diverse water-providing systems (Smiley 2020). Schindler et al. (2019) point to the Tanzanian city of Bagamoyo's fractured water network as an example of top-down planning gone wrong and an example of HIC. (Alba et al. 2022, 722), articulated a genuine truth that there should be an inquiry into the potential circumstances for incremental change and go beyond "debates over state, community, or private ownerships, as well as formal or informal infrastructures". To fully understand the uneven and diverse methods by which water is allocated within the framework of Accra's growing urbanisation, it is essential to provide further consideration to the small-scale geographical patterns of water distribution in interconnected settlements (Alba et al. 2022).

Sanitation is another area where HIC thinking is highlighted. According to Lawhon et al. (2023), infrastructure in general, including toilets, is emblematic of modernity's problems since, despite best efforts, contemporary flush toilets seldom live up to their promise in actual use in Global South contexts (Morgan 2002). However, the truth is that Global South cities have always had various infrastructures, or as Lawhon et al. (2018) put it, the infrastructures are heterogeneous configurations comprised of social, technical, political, and economic

differences. This diversity extends beyond sewerage configurations, but the infrastructure for contemporary sanitation still needs to be effective (Kooy et al. 2008; Fischer et al. 2021). Lawhon et al. (2018) also examined the projects and particular artefacts concerning other locally accessible possibilities. The heterogeneity of sanitation infrastructure associated with daily practises and power-laden relationships (Lawhon et al. 2018) have come to light in studies of household experiences and practises of infrastructure in Global South cities (McFarlane et al. 2014; Muanda et al. 2020). A family's decision to have access to sanitation may be influenced by factors at home, as suggested by the diversity of sanitation access in an Indian rural hamlet, according to research by (Kumar et al. 2013). A new paradigm for urban sanitation might be developed by implementing various sanitation systems adapted to each urban environment and integrated under one institutional roof (Reymond et al. 2016). This would symbolise the diversity characteristic of emerging cities in the Global South.

Sseviiri et al. (2020) explain how the HIC initiatives have pressured the state to reassess the advantages of the modern infrastructure ideal as a paradigm for what (good) infrastructure is and should be, using the case study of Kampala. In the case of waste materials, there were documented patterns of recycling activities in both the traditional and informal sectors, including different players and methods with no state monitoring (Sseviiri et al. 2020). Looking at the informal practices, people found value in the waste sector by being incentivised to earning money by recycling the waste since according to Sseviiri et al. (2020) some of the waste contains value. The money was obtained from management charges or the potential re-use value of the resources themselves (Demaria et al. 2016).

Kundu et al. (2021), looked at where the State had not met uniform water access. The State administration had promoted the idea of a networked and treated surface water supply. However, because of several pre-existing socio-spatial disparities in the town and more significant systemic issues, the reach, effectiveness, sufficiency, and quality of water delivered through this piped network have been inconsistent (Kundu et al. 2021). Infrastructure is, however, perceived differently in real life (Kundu et al. 2021). Infrastructure is geographically and materially dispersed, inconsistent, with archipelago-like access points (Bakker 2003, 2003). Part of the various forms of water provision, such as localised piped networks to draw

groundwater, were only allowed in densely populated areas home to powerful landed elites and the commercial class. This was one of the many kinds of water access that emerged due to supply-side inequality. This led the poorer locals depending on informal private water vendors selling packaged drinking water (at a much higher personal cost). It is also clear that local actors, institutions, and their practices reconfigure, modify, and adapt these socio-technical systems - extending and adapting weak, fragmented public water delivery systems (Kundu et al. 2021).

A review of different articles focused on urban studies on HIC with a specific focus on the Global South, revealed that most of the applications addressing infrastructure were related to water and sanitation, electricity, and solid waste. Numerous studies have provided a valuable indication of the diversity of infrastructure in the Global South, modes of access to sanitation (McFarlane et al. 2014), water access through understanding the “water mafias” (Ranganathan 2014) and facilitating the capturing of more recyclables from waste streams (Rutkowski et al. 2017). It is crucial to understand that the absence of an active State plays a significant part in developing HICs. While not a HIC study, according to Ranganathan (2014), informal networks (i.e., mafias) are stepping in to provide services where the government has failed. The State’s absence has also been well-documented by Kundu et al. (2021), Lawhon et al. (2018), and Ernstson et al. (2022). Ranganathan (2014) revealed how the mafias exercise everyday power and how neo-liberalism creates tensions between groups by demonstrating their capacity to create and dissolve discursive and material barriers between the formal and informal, public and private, and the State and society (Ranganathan 2014). Also in the case of a small village, GaManoke, in South Africa, Bruns et al. (2022) has highlighted the inequalities caused by vandalism in municipalities and communities, which calls for heterogeneous configurations as the material for water and energy is not substitutable and is somehow uncooperative.

Finally, it is important to answer questions such as the “risks, redundancies, and strategies of users participating in such configurations” (Lawhon et al. 2018, p. 729). The limitations of HIC which have been pointed out by Lawhon et al. (2018) are that there HIC still lacks empirical work that needs to be done to validate the theoretical arguments put forward by HIC scholars. According to Lawhon et al. (2018, p. 730), there is a “call for empirical research on the

conditions under which particular socio-technical artefacts work, for whom they work, and what it means for infrastructure to work”. This research helps in understanding how the configurations of the greywater solutions work together in interaction with residents.

2.20. Informal settlements as an example of heterogeneous infrastructure configurations

The study site has been identified as an informal settlement, although it is important to note that some community members, the original inhabitants of Silvertown, were moved there by the local government and therefore represent some form of legal occupation and not just informal, illegal squatters. An informal settlement is a residential neighbourhood with low, under-served, and overcrowded accommodations, resulting in unhealthy, hazardous, and socially undesirable living conditions (Kitchin et al. 2009). On the other hand, informal settlements are usually illegal settlements because they are constructed on illegally occupied property, and their land-use patterns and structures do not comply with official local government norms and rules (Satterthwaite 2012). This research concerns how a greywater collection and treatment system forms part of the heterogeneity of infrastructure, relating to the previously used manners of disposal and existing infrastructure. As noted by HIC scholars, the urban poor are generally deprived of access to well-structured piped sewerage systems, forcing them to use alternative, informal, and modest facilities (Nilsson 2016). Using the lens of HIC, this research explores how the inequalities of sanitation are embedded in the infrastructural configuration of the network (Rusca et al. 2017). There needs to be an investigation into how infrastructures can be suitably constructed for various social purposes with different arrangements fitting different situations (Swyngedouw 2004; Nilsson 2016).

It could be hypothesised that some embedded inequalities result from the power dynamics. When specifically looking at power, Swyngedouw (2004) points out that power carries material flows and breakdowns and determines how resources are distributed. Looking at the greywater treatment solutions, it is essential to realise that incorporating other, new infrastructure is not easily defined, as pointed out by Lawhon et al. (2018). Different underlying components could be at play in understanding how the system might work. Factors such as politics, power, and social relations could affect material engagement. A significant highlight is also brought by Simone (2004) that the local government and other governmental institutions have shown a

lack of political and economic capacity to confine city activities (purchasing, selling, dwelling, etc.) to determined deployment locations, articulation codes, or the purview of designated actors. As Lawhon et al. (2018) pointed out, it is vital to understand the social codes that control the usability of open space.

These are essential questions to help understand the integration of greywater collection and treatment solutions. One of the questions to be analysed is how informal settlement HIC solutions encourage local actors to establish themselves as co-researchers (Kareem et al. 2022). Importantly, scientific knowledge is essential in transitioning to sustainable cities but doing so effectively requires academics not to exclude policymakers and residents. This is because it has been pointed out that researchers have only sometimes studied topics of relevance to local communities (Smith et al. 2014).

2.21. The Silvertown research - a different heterogeneous infrastructure configuration

What is most glaring is that even though blackwater sanitation heterogeneity is among the other service and infrastructural examples used to highlight or explain HIC, little has been written about the heterogeneity amongst the other different types of wastewater (sanitation) systems? The research site in the case study for this thesis highlights a greywater solution with CWs as part of HIC which is assessed longitudinally so that the new solution can be compared to the previous methods of greywater disposal. The implementation of the CWs is aimed to redress the inequalities that the people of this informal settlement have previously felt by implementing a nature-based solution for a service that has not previously been considered. This adds an extra dimension to the body of general work on sanitation and HIC.

This research aims to evaluate the HIC of greywater disposal using CWs in an informal settlement. This research examines how people's actions and perceptions concerning the constructed wetland produce and are made by society (Furlong et al. 2019). This, in essence, is what Simone (2004) refers to as "People as Infrastructure", which will be elaborated on by studying the people at the research site and how they have been disposing of greywater as a basis for understanding the value of the CWs. As Lawhon et al. (2018) have indicated, there is

a need for more empirical research on HIC. Firstly, what is valuable about the some of the HIC contexts that have been studied is that, just like this research site, they use examples of underserviced informal settlements. Also, what is evident in the other examples is that while “systems” are not explicitly present (the term “configurations” is preferred), diverse infrastructure components are nonetheless connected (Sseviiri et al. 2022). The research site example in this study gives an example of how the socio-technical objects engaged with the constructed wetland in an informal settlement. An attempt is made to address what it means for infrastructure to operate as Lawhon et al. (2018) suggests. Lawhon et al. (2018) draw mainly from African cases in their discussions, their research in the developed world has informed a few studies such as Furlong (2011). On the other hand, the contexts that have been covered in HIC by Lawhon et al. (2018) have been more at the macro level (i.e., at the level of cities or whole settlements) and less on the micro (individual) or meso (community) level where this research is focused.

At the macro level, HIC captures the variety of configurations and the multiple actors involved. This research study deals with a case where the service provided does not constitute the provision of a service that depends on a financial exchange. Rather the service is expected to be provided for free by the local government as part of a constitutional requirement to free basic sanitation. This study examines the extent of human interaction with infrastructure and sanitation, particularly the CWs, to see if there could be sustained continuity if the people oversee their own development. A few case studies in (Lawhon et al. 2018; Kundu et al. 2021; Sseviiri et al. 2020) look to analyse the everyday social relations at a town and national level (or both). The work of Sseviiri et al. (2020) is congruent with HIC, people as infrastructure (Simone, 2004), and viewing technology as precarious and hybrid (Furlong 2014). There has also been a focus on the deficiencies of Global South cities and the State’s need to act and provide services (Bakker et al. 2008; Nilsson 2016). Informal greywater disposal methods are an everyday practice that the people of the research site must engage.

The research site for this study stands out as there are no formal networked service options for greywater disposal, and the CWs were built in conjunction with the previously self-built disposal drains. The case study of this research site emphasises the socio-dynamics involved

in greywater disposal and, eventually, the installation of CWs to add value to the existing infrastructure to mitigate environmental consequences. There is a broader political-economic context that shapes the material configuration of what could have been large-scale networked infrastructure such as in Kundu et al. (2021) and the same is true for greywater disposal in this study. Additionally, there are social interaction factors (Simone 2004). Even when actors do different things within different places, each carries traces of past behaviours and an implicit drive to interact with one another in ways that draw on the existing social positions.

In this study, the research aims to analyse the dynamics of the HICs that shape the implementation of a greywater disposal and treatment system at a meso-level in a similar manner to Schindler et al. (2019) who looked at solid waste management services. The greywater disposal system in this study is a service that was not offered by any specific entity, unlike the services investigated in other HIC case studies. At a micro level, residents have made the effort to improve the greywater disposal service, but there is no formal service offered by local government in this context. It has been noted by (O'Toole et al. (2012b) that the presence of pathogenic *E. coli* in home greywater can cause significant human infections. Therefore, a greywater disposal solution is a critical service.

An example of the dire situation at the research site for this study is found by contrasting the available infrastructures with those found in (Munro 2020). It was also found in the study by Munro's (2020) that the HIC of electricity supply in the Uganda town of Gulu comes from a range of sources: the grid, solar (photovoltaic) modules, dry-cell batteries, and diesel generators. However, in this study, residents are the ones creating options with a limited range of available materials. Compared to other examined services like in Schindler et al. (2019), which had multiple service providers, this study site has no one providing greywater disposal services. In the study by Schindler et al. (2019), water provision is said to be the responsibility of the Dar es Salaam Water and Sewerage Corporation after the failure of private ownership. The lack of fulfilment of services in these case studies happened after the established provision bodies failed to keep pace with the demand for service provision (i.e., water provision and solid waste management). Different sectors (informal, formal, private and government) provide services such as wastewater management water provision in these others HIC case studies.

Various alternative channels are working concurrently in the case of Schindler et al. (2019) as the service demand is high. The high level of analysis examined in these cases brings about different network systems from various stakeholders, especially the State, highlighting how residents effortlessly switch from one model to another to reduce the risk or disruptions (Schindler et al. 2019).

However, the informality of the case study for this research has made actions such as water disposal less of a priority to be considered by either the municipality or residents and other services (especially blackwater sanitation, water, electricity, stormwater protection, and fire protection for housing) have gained higher priority. Therefore, putting greywater disposal as a possible solution into the spotlight as a service of interest has made this research a study of how different dynamics emerge in establishing a greywater collection and treatment system in the study site. This research wanted to see if CWs formed part of the web of relations such as those presented by (Schindler et al. 2019; Kundu et al. 2021) or (Sseviiri et al. 2020). The ideas of HIC, the web of relations formed when people build gullies to ensure that their greywater is kept away from their dwellings also plays a role in establishing the greywater collection and treatment system. As water access does not reach everyone, as illustrated in the (Schindler et al. 2019; Kundu et al. 2021) case studies, other related webs of technologies might take over at this research site. This case study looks to analyse a small informal community which inserted a greywater disposal and treatment system into an existing set of infrastructures, but which does not include any paid services like potable water access (Kundu et al. 2021) or solid waste management (Schindler et al. 2019; Sseviiri et al. 2020).

Some of the configurations that are used as HIC case studies are broad and multi-faceted, and they already have established systems of operation. In the case of Kampala (Sseviiri et al. 2020), recycling was a diverse sector when looking at its social and material aspects. It comprised entrepreneurs, public-private partnerships, and Non-Governmental Organisations (NGOs) (Sseviiri et al. 2020). The case study in this research context examines CW configurations that have recently been established. CWs provide a different way of looking at HIC regarding their diversity and explanatory power. This study documents how people engage with the HIC in their establishment and the integration of the CWs into the community to better

understand the presence of the CWs. This could enable the documentation of the impact of the HIC on the CWs, or vice versa, at the individual, household, and neighbourhood levels.

The concept of the HIC approach might encourage authorities to re-conceptualise how they should think about infrastructure. The normative ideal of homogeneity continues to shape how residents, planners, authorities, and academics imagine how infrastructure should be implemented (Lawhon et al. 2018). In HIC, it is still being determined what implementation challenges there could be if there is no equal commitment from all the stakeholders about service delivery development. Lawhon et al. (2018) pointed out that more work was still needed to understand the multiple associated risks and the approaches of users participating in the configurations of those infrastructures. In trying to understand engagement, this research documents the context of residents' approaches to configurations of a less established system, a greywater collection and treatment system.

Therefore, this research adds to the literature that argues that starting from heterogeneity is to think about infrastructure as dynamic and that the dynamism depends on the existing options (Lawhon et al. 2018). Therefore, it is important to understand the previous and current configurations and the opportunities when linking a new greywater collection and treatment system into such existing structures. Integrating a new greywater collection and treatment system into the research context could depend on the residents' ability to act freely on their commitment to the new greywater collection and treatment system and their beliefs about the efficacy and purpose of the new greywater collection and treatment system. Therefore, there is a possibility that there could be a lack of participation by the residents in exploring this infrastructural development. What should be considered is that other specific services take precedence, which could discourage the residents' efforts and commitment to considering a more heterogeneous approach to their already heterogeneous way of living, especially considering that the disposal of greywater was less of a priority. Importantly, Thwala (2009) reminds us that in participation work, the community should take more responsibility than other related stakeholders, such as the government or NGOs, to encourage people to adopt a new initiative. This is why the research project ensured that the community and other members

involved in the design of the greywater collection and treatment system and the broader community were given regular feedback on how the project had evolved.

2.22. Conclusion

The Silvertown study covers a variety of disciplines related to urban geography. From the broad perspective the review covers issues related to the inequality associated with greywater sanitation infrastructure. This has been supported by looking at the topics of influence to the lack of greywater infrastructure. The chapter started by explaining and looking at both MDGs and SDGs with the aim of understanding what has been done and what needs to be done to achieve equality and equity. That shed some light onto the need to get different contributions, especially from the Global South about infrastructure and the conditions under which people in informal settlements live. In having an overview of such conditions, the chapter tried to analyse why conditions in the informal settlements have not been optimum through reviewing Lefebvre's arguments on capitalism philosophy about space within and around communities. This encouraged additional literature into political ecology, which studies the relationship between political, economic, and social issues and environmental difficulties. All this served as a background for looking at HIC as the framework for this study. This chapter concludes by covering different HIC cases to produce a broader understanding and background to the contribution of the Silvertown case study.

Chapter 3: Methodology

3.1. Introduction

This chapter gives the road map of my research methods, outlining the detailed plans of how the research was conducted. Since the researcher was part of the research team, this chapter starts by disclosing the researcher's positionality in relation to the research. This section is written in the first person to emphasise the positionality. The chapter then proceeds to set the scene where the research was conducted, i.e. Alexandra Township, Setswetla, and Silvertown. The chapter then moves into the research methods, contextualising the designs taken to conduct the study. In this regard, the chapter explains why specific methodologies were chosen, hence the reason for qualitative research methods, case study research and the context of using probability and non-probability sampling methods. Moving from the data collection methods, the chapter elaborates on the data collected and how it was analysed. The chapter also elaborates on how ethics was considered and followed. The chapter concludes by detailing some limitations that made specific procedures impossible to happen in that way and how the researcher adjusted accommodate those limits.

3.2.Positionality

I come from a region of Hammanskraal, north of Pretoria, which has some sections that are not dissimilar to the situation in Setswetla. While I do not live in those informal settlement areas, I can empathise with them and understand some of their struggles in relation to access to adequate sanitation, water, reliable electricity, regular refuse removal, and housing. For my master's degree I collected data from another informal settlement, Carousel View which was very similar to Setswetla and so I felt that I had a good background understanding of the issues. In my previous degree, I dealt with water access and less sanitation. I realised that water and sanitation were more closely related than I initially thought. Silvertown presented a different case study about sanitation in an urban setup. In my master's project, greywater was not an issue because the yards of the participants were more significant to accommodate greywater disposal better. Therefore, my interest in the project was to gain practical knowledge through research about water-related sanitation. In doing this, my documentation of the greywater sanitation in Silvertown's aim was to give an empirical insight into the past, present, and future of greywater disposal in the informal settlement when heterogeneous manners are used. In Silvertown, greywater disposal is practised in a small space, which gave rise to interest. I was

part of the research team (funded by a European Commission grant through the Water Joint Programme Initiative) that built the CWs based on the agreement between the research team and the residents. My role in the project team was community engagement and to investigate how the residents related to the CWs. One of the common languages in Setswetla is Sepedi which is similar to my home language of Setswana and could therefore converse with people in their home language. As part of the team, I did not have a direct involvement in influencing how people viewed the CWs, but I helped explain how they were supposed to be used once they were built and spoke to them extensively about how they felt about the CWs. Indirectly, this may have influenced their perceptions about the CWs. One of the questions from this research aims was to understand the power relations and norms that affect how residents use the CWs. At this point, the residents could express their feelings on whether the research team had influenced how they viewed the CWs. This would put me in an interesting position in relation to the residents and the research team, not being a resident, but perhaps being perceived as representative of the project team, conveying their feelings and impressions directly to the people in charge of the research project.

3.3. Study Area

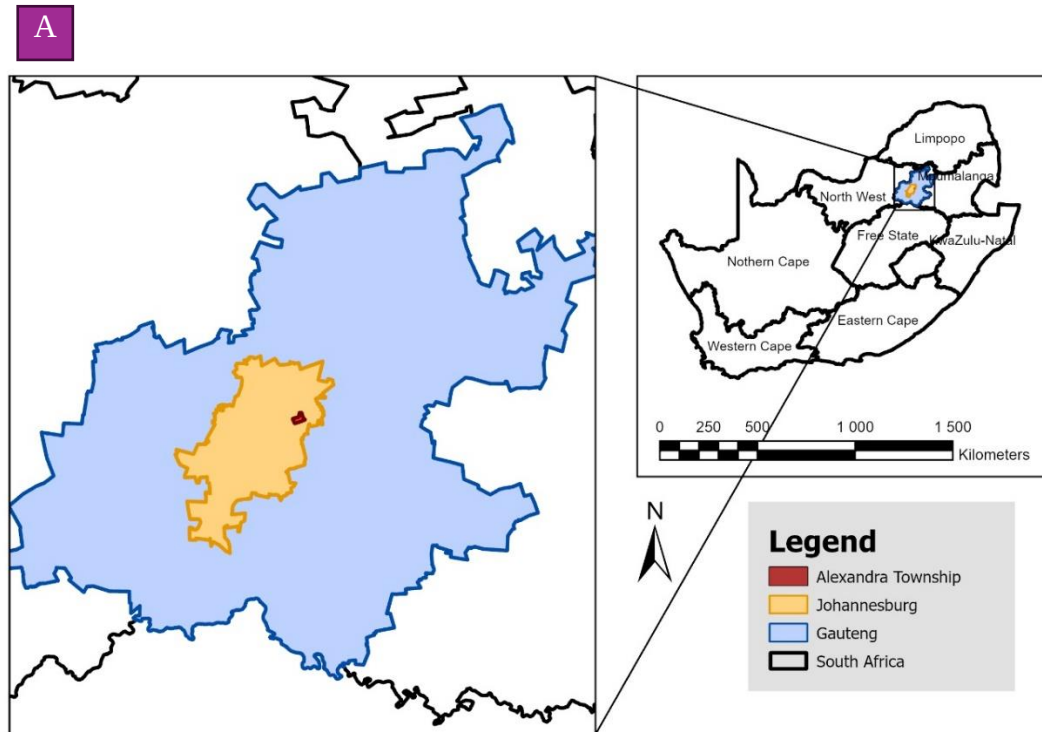


Figure 2 (A): Map showing Alexandra township in relation to Johannesburg city, Gauteng province and South Africa

Map: Kamogelo Mohuli, Lusizo Nqasha & Motshwaedi Sepeng (cartographers)



Figure 2 (B): Map outlining Silvertown, Setswetla informal and greater Alexandra township.

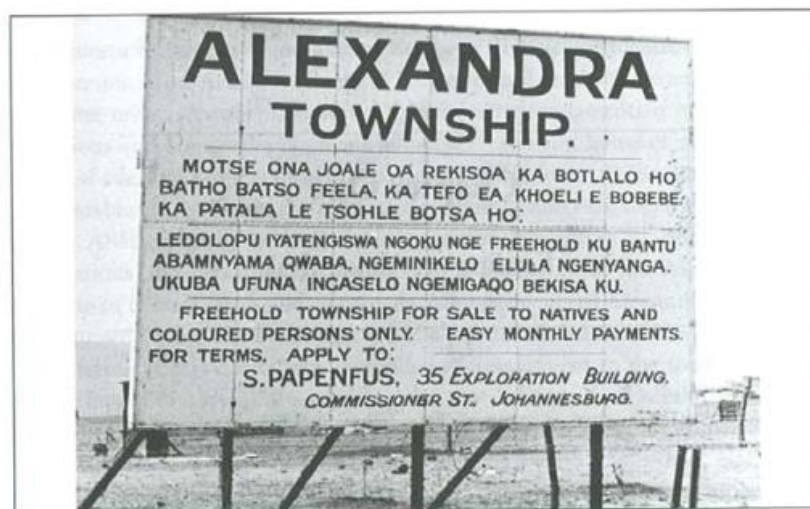
Map: Kamogelo Mohuli, Lusizo Nqasha & Motshwaedi Sepeng (cartographers)

Figure 2 (A) illustrated that Alexandra, or “Alex”, is a township in the City of Johannesburg (CoJ) in the Gauteng province of South Africa. The research was conducted in the Silvertown section within the Setswetla informal settlement, which forms part of Alexandra Township as seen in Figure 2 (B). The informal settlement is situated along the Western bank of the Jukskei River, running in a north-south direction.

3.3.1. The context of Alexandra township

Alexandra Township was established in 1912, where black people could acquire ownership (Hooghiemstra et al. 2017, 201). It is the oldest township in the Gauteng Province and also one

of the poorest areas in Johannesburg (Kiggundu et al. 2009). Alexandra township covers more than 800 ha (8 km²) and has a population of about 350 000 residents (Nyaloko et al. 2020). There are many contradictory sources with regards to the population and size of Alexandra township, ranging from 100 000 to 750 000 people and for the 8 km² to 6.91 km² region (Ngubeni et al. 2022). The reasons for these discrepancies could be related to the difficulty in counting the number of residents living in backyard shacks and the transient nature of residency. Alexandra township is distinctive in that it is the only township in Johannesburg close to industry and a variety of luxuries often found in cities such as shopping malls, cinema complexes, and a range of other retail outlets and services. This differs from the other urban townships in South Africa, often outside the urban centres (Roefs et al. 2015). Historically, Alexandra has suffered from a lack of infrastructure, overpopulation, and high crime rates (Richards et al. 2007).



Establishment of Alexandra as a freehold township (Source: Museum Africa).

Figure 3: The formation of Alexandra Township as a freehold zone.
(Bonner et al. 2008).

Alexandra, or Alex, as it is widely known, is a freehold township (Figure 3) on the edge of Johannesburg City Centre. It was established in 1912 to house Africans and Coloureds working on nearby farms (Makhubu 2016; Bonner et al. 2008). The farm on which the township was established “belonged” to a farmer and attorney Herbert B Papenfus (Makhubu 2016). (Makhubu 2016). Papenfus had planned to start a White suburb where he would sell the stands

to White buyers in 1904 (Wilson 2014). Unfortunately, the response was underwhelming due to the relative distance from the Johannesburg city centre at the time, and thus, was then sold to Africans and Coloureds (Makhubu 2016). According to Phillip Manana (cited in Bonner et al. 2008), Alexandra, at the time, was a swamp with a lot of clay. This was one of the reasons why white people did not want to stay there as this was believed to be the source of disease that killed a lot of people at the time. The other reason that is put forward for the white people's lack of interest is that Alexandra was far from Johannesburg, and the lack of transport systems would have made it hard to easily travel to and from the city centre for work (Bonner et al. 2008).

As Papenfus struggled to sell his property to the white people, he then redrew the plans for the estate. In 1911, he was approved to sell properties to other races and the set of people to buy were coloured people, with a few Africans also included. (Bonner et al. 2008). Important to consider is that this happened before the 1913 Native Land Act was passed, which prevented Black people from owning land in the metropolitan areas of South Africa. As a result, Alexandra township provided a unique opportunity for Black people to live within the city boundaries with status unless they had a temporary residence (Wilson 2014). The following year, as a result of the "1913 Native Land Act", no land could be proclaimed by Black people who migrated to Johannesburg for job opportunities (Wilson 2014). Following the Native Land Act, the Johannesburg City Council refused to be involved in Alexandra township because it was considered to be an established Black area. As a result of years of neglect and absence of investment, the township's living state deteriorated (Wilson 2014). During the 1976 student uprising, Alexandra township was one of the first area to start protests following the initial protests in Soweto.

3.3.2. Alexandra today

Alexandra is also one of the country's poorest urban areas. With hard edges (a highway to the east and major roads to the north, south, and west with established domestic or industrial development on the opposite sides of these edges) that prevent any further development or expansion of the township (Makhubu 2016). These edges include the motorways (M1 to the west and N3 to the east) and industrial buffer zones. Therefore, it is difficult for the Alexandra

township to gain access to further potential economic development through the emerging financial hub west of the township, Sandton. Thus, there are two polarised areas which exist less than 5 kilometres apart, as seen in the Figure 4 below.

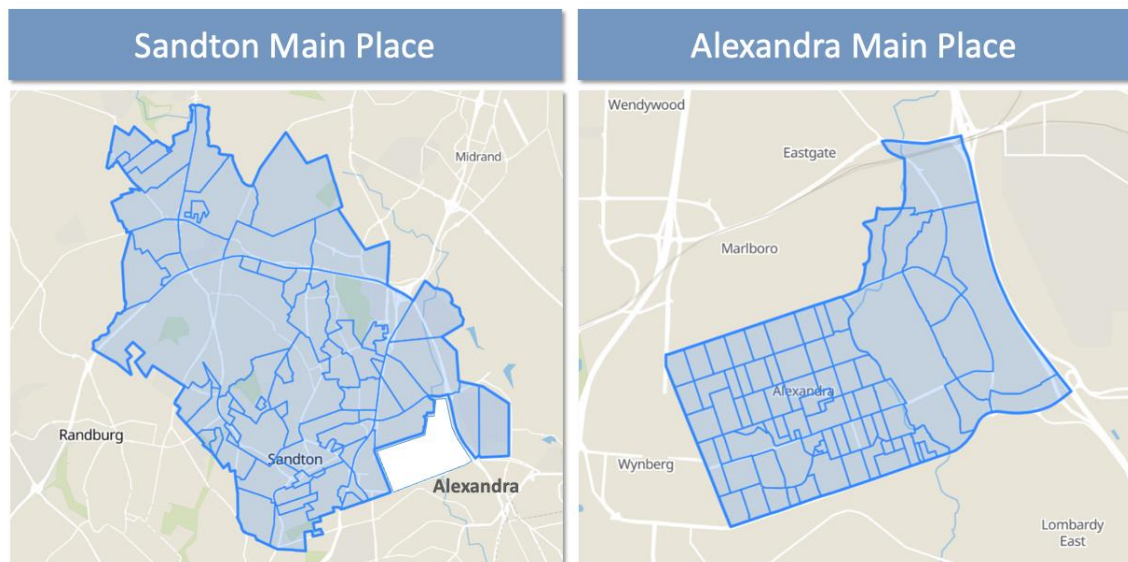


Figure 4: A photo showing the layout of Sandton (left) and Alexandra (right)
(Eighty20 data portal 2022)

The space in Alexandra township is very congested, with the population density being shown in Table 1. Alexandra township has high rates of poverty, unemployment, hunger, crime, economic inequality, illiteracy, and a large number of unskilled people (Allie-Nieftagodien 2013). Furthermore, inadequate housing remains a problem, as over 20 000 informal dwellings are estimated to exist within the boundaries of Alexandra township. Over 7000 families live in illegal backyard dwellings throughout the area (Agupusi 2007). Alexandra township suffers from severe overcrowding, inadequate infrastructure, and rising poverty and unemployment. The Alexandra Renewal Project (ARP), a state-sponsored area-based urban renewal initiative launched in 2001, sought to improve the overall living environment, among other things, through infrastructure upgrades and housing construction. In addition to Reconstruction and Development Programme (RDP) housing delivery, the ARP has supported a limited number of rental housing pilot projects. (Shapurjee et al. 2013).

Table 1: Demographic statistics of Alexandra Township

(Stats SA, n d).

Characteristics	Statistics	
Population characteristics	Total population	179 624
	Population density	25979 persons/km2
	Number of households	63 737
	Average household size	2.7
	Formal dwellings	74.30%
	Housing owned/paying off	44.50%
	Female headed households	33.90%
Service delivery	Flush toilet connected to sewerage	85.10%
	Weekly refuse removal	88.60%
	Piped water inside dwelling	39.20%
	Electricity for lighting	93.20%
Occupation ratio	Young (0-14)	23.80%
	Working Age (15-64)	73.90%
	Elderly (65+)	2.30%
Level of education	No schooling aged 20+	4.20%
	Higher education aged 20+	6.20%
	Matric aged 20+	38.50%

3.3.3. The context of Setswetla

Setswetla falls under Alexandra township, but the statistics of piped water inside dwellings of 39.20% and flush toilets connected to sewerage of 85.10% found in Alexandra township are not representative of the situation in Setswetla. Setswetla is just 5 km from Sandton, the economic hub of Gauteng province and South Africa. Setswetla is an informal settlement which is north-east of the Alexandra Township (Bonner et al. 2008). This informal settlement falls under the CoJ Municipality, Ward 109, as shown in Figure 5. Setswetla's origin dates from the 1980s and was established as a transit base to accommodate the excess population from the main Alexandra township (Bonner et al. 2008). Around the 1980s, Alexandra township encountered the problem of an influx of people who erected shacks in their backyards to accommodate the influx of people. One of the residents of Setswetla at the time recalled how the conditions of Setswetla were dire and basic when he moved there in 1986. Matome Rasetelo (cited in Bonner et al. 2008) explains how their access to water minimal and dignified sanitation did not exist as they had to rely on open defecation by digging their own pits. Rasetelo notes that as time went by, things improved, and the bucket system was introduced. Currently, most areas in Setswetla are serviced by chemical toilets. This will be explained in greater detailed in the results chapter.

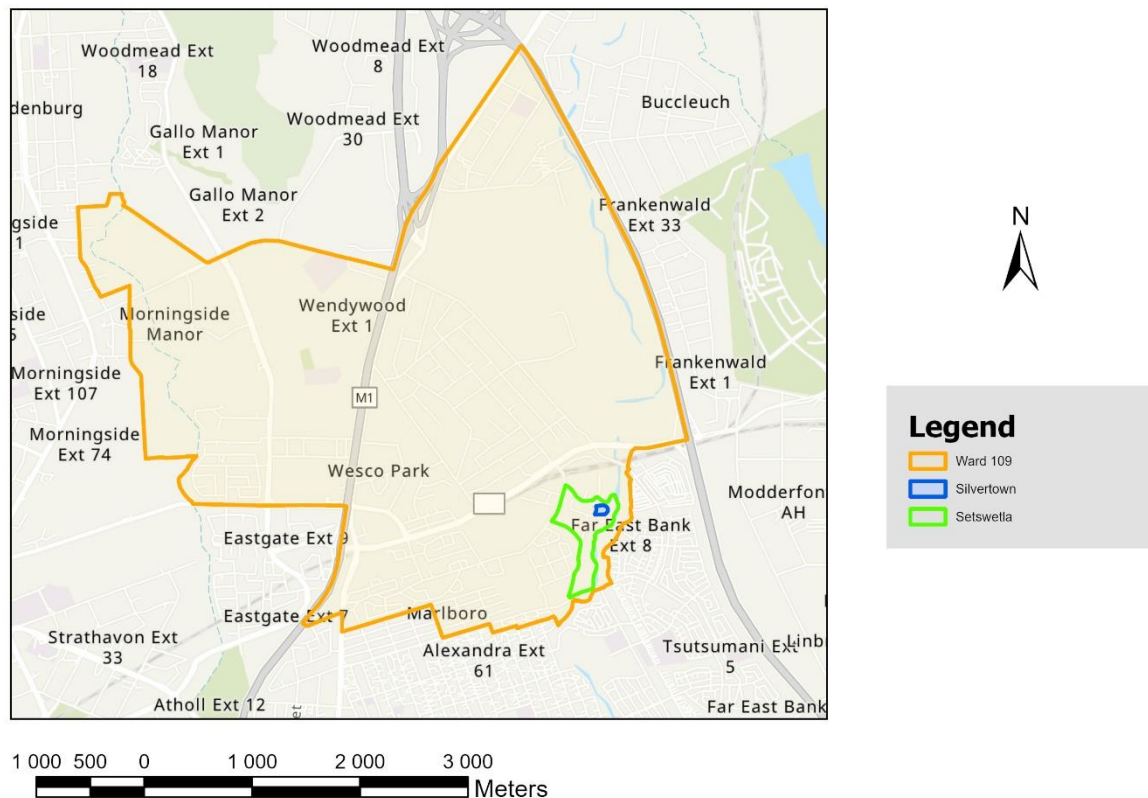


Figure 5: Map outlining Ward 109, Setswetla and Silvertown.

Map: Kamogelo Mohuli, Lusizo Nqasha & Motshwaedi Sepeng (cartographers)

As of today, the informal settlement remains neglected regarding service delivery, but things have improved regarding water access as communal taps are seen on the different streets of Setswetla as compared to when the Rasetelo's arrived in the 1980s. There are visible connections to electricity even though the growth of "illegal" land occupation undermines this with many ad hoc connections to electricity. The rapid illegal occupation of land is a problem in Setswetla, as those who erect shacks close to the river are in danger, considering that there are regular flooding events. Those people staying close to the Jukskei River do not have basic services such as water or sanitation unless they have made their own ad hoc connections (to water, electricity, or stormwater drains).

3.3.4. The context of Silvertown

Silvertown is one of the sections of Setswetla. Silvertown is situated between Gousblom Crescent Road on the west and the start of the Violet Crescent Road on the north. Small tributaries of the Jukskei River border Silvertown to the south and north, and the

Jukskei River creates a natural boundary to the east. The Marlboro Station of the wealthy Gautrain is about 2 kilometres to the north-east of Silvertown. Originally, Silvertown was made up of families that arrived in Silvertown on 3 November 2006 after being removed by the CoJ from the occupation of abandoned warehouses in the Wynberg area to the West of Alexandra township. Some of the people were relocated from industrial areas in Wynberg while others came from the residential areas within Wynberg. This arrangement was replicated in Silvertown by subdividing Silvertown into the four ERFs (ERF 62, ERF 49-50, ERF 51, and ERF 397) from Wynberg from where people were relocated. Erven (ERF) refers to a designated area of land, typically found in metropolitan areas, that is specifically set aside for building construction (Collins English Dictionary n.d.). The CoJ devised a plan to remove the Wynberg occupiers without making specific arrangements to move them to another place. Some of the current community members in Silvertown fought in court for the right to land to be accommodated. A court judgement afforded a place to be moved to temporarily while the government looked for a place for them to be placed permanently. Three of the original sections of Wynberg ERFs 49-50, 51, and 62 were moved onto the Setswetla site which is now locally known as Silvertown (because of the proliferation of corrugated iron sheets which were used to build their shacks). The other section of Wynberg, ERF 397, was placed in what is known as Verzonja, which is on the opposite side of the cemetery from Setswetla. Since 2006 many other people have moved into Silvertown, through the extension of existing dwellings and by occupying the land on the banks of the Jukskei River. There is a small nucleus of the original residents of Silvertown, but a large proportion of the people who now live in Silvertown have started living there since 2006.

3.4. Research Methods

3.4.1. Qualitative research methods

The study used qualitative research methods to collect data, primarily through formal and unstructured interviews and ethnographic observations. Flick (2018) explains qualitative research as analysing actual cases in their sequential and local particularity and beginning from people's expressions and actions in their local settings.

3.4.2. Case study research

The research might also be described as a case study. A case study is a study method that yields a detailed, multifaceted account of a complicated problem or phenomenon of interest in their natural, real-life setting (Crowe et al. 2011; Wheeldon et al. 2019). Starman (2013) feels that case studies are advantageous because of their great conceptual validity and effective strategies for developing fresh ideas. They are also useful in thoroughly evaluating the hypothesised role of causative processes in the context of specific situations and capacity for addressing causal complexity. On the other hand, despite the advantages of case studies, Zainal (2007) argues that case studies have been critiqued for needing to be more detailed and providing no basis for scientific generalisation if only a few subjects were involved. Another critique about case studies is that they can be too long or difficult to conduct, and may generate massive volumes of material that are difficult to synthesise and analyse (Zainal 2007). An in-depth understanding of Silvertown case study in the Setswetla informal settlement was generated to describe how the greywater situation was before the intervention and how the CW intervention was configured physically and socially. Initially, the study focused on different areas where the CWs would be built. Data were going to be collected from different sections within Setswetla. In phase 1, because of the iterative process of designing and building that took time and because the COVID-19 pandemic prevented data gathering for approximately six months, the Silvertown informal settlement became the only focus of the case study. The case study approach examined the life context of Silvertown and how it related to the CWs. Therefore, the same units of analysis or phenomena were studied considering the same research questions (Mills et al. 2009). The case study might also be described as longitudinal, collecting data before, during, and after each CW iteration from November 2019 to December 2022.

3.4.3. Sampling methods

I approached the residents of Silvertown, who were both engaging and not engaging with the CWs. Observations before coming to the potential participants aided me in identifying who was likely to be interacting with the CWs. Both men and women were interviewed, all above the age of 18, and the research was not restricted only to South African residents as foreign nationals are also staying in the area. In Tansey (2007), non-probability sampling is explained as a technique that involves the researcher selecting samples from a population without using

random selection. Babbie (2013) describes purposive sampling as nonprobability sampling, whereby the researcher selects the units based on the people's judgment.

3.4.3.1. Non-probability sampling

During the data collection process, the study used non-probability sampling approaches to select the participants for the structured interviews. The goal of non-probability sampling is not to provide a representative sample (Lawrence Neuman 2014). The study was initially going to use a non-probability sampling of participants in Setswetla as the project was potentially going to build CWs in other parts of Setswetla, depending on the progress of the building at Silvertown. Initially, while conducting the interviews, I aimed to select the members from different portions of Setswetla where the CWs were built, starting with Silvertown. The URBWAT project changed because the iterative process (design, build, and use) forced the building and modification at the Silvertown building site only over three years. This meant that data collection had to happen at Silvertown only, not the whole of Setswetla.

3.4.3.2. Purposive sampling

Purposive sampling was used to select people from Silvertown who met the specified requirements during the interviews in phases 1 and 2. (Tongco (2007) states that in purposive sampling, the researcher decides the purpose they want the informants to serve in the research, and they approach appropriate respondents to fulfil that plan. This is explained below regarding structured interviews for participants in Silvertown.

In phase 1, during the structured interviews, purposive sampling was used to select the participants in Silvertown. As a result of delayed data collection because of the COVID-19 lockdowns, the researcher specifically wanted to talk to the people in Silvertown who were using the CWs. However, some of the people who used the CWs were not at home during the day on weekdays when interviews were being conducted. Some of the interviews were therefore also conducted on weekends when these people were more likely to be available. The important point to note was that because of proximity of the CWs to the taps, meant that people in neighbouring sections, who were not living in the Silvertown section, were sometimes also

using the taps next to the CWs. So, while attempts were made to standardise who was interviewed, this was not always possible due to the dynamics of the informal settlement.

Regarding structured interviews, in phase 2, non-random sampling was used as in phase 1, as again purposive selection was employed to interview people who interacted with the CWs. If the people either used or were affected by the CWs, then they were considered for an interview. Just like in phase 1, purposive sampling was used to select the participants in Silvertown (and Maponyane which was an adjacent section with people who sometimes used the taps at the CWs) during the structured interviews. Most of the people interviewed were from Silvertown, but there were other people who were not from Silvertown. The people from the Maponyane section were also interacting with the taps next to the CWs, especially as they passed by the tap as they walked toward the Silvertown entrance where there was also a convenience store. Also, if the people living in the Maponyane section had a water pressure problem, then some of those people would come to Silvertown or when they passed by the tap, they would wash their hands. Therefore, data collection for the structured interviews was made with the explicit intention of interviewing whoever was at Silvertown. The researcher also went into the Maponyane section to interview there, but most of them were not keen to be interviewed by someone who was perceived to be from the Silvertown section (i.e., they were concerned that they would be interrogated for using a tap in another section). The purposive sampling method was also used to select the people who attended the design workshops. The participants were selected based on staying in the areas in Setswetla, which had the potential for the CWs project to take place.

3.4.3.3. Snowball sampling

Snowball sampling was also used as some participants suggested other people in the community using (or not using) the CWs. In snowball sampling, one person gives the researcher the name of another person, who provides the name of the next person, and so forth (Atkinson and Flint 2001). This happened at times when the structured interviews were conducted. For example, a participant also suggested the researcher should interview a family member because the family member spent more time at home engaging with the greywater disposal than they do.

3.4.3.4. Random sampling for unstructured interviews

During the structured interviews in phase 1, it was clear that the information received was not providing all the information. In some cases, some people did not want to be formally interviewed, but they were happy to inform the researcher about the happenings in Silvertown. It was, therefore, important to also adopt unstructured interviews to supplement data collection methods. The record for the unstructured interviews is attached in appendix 8.1. Unlike in the structured interviews when purposive sampling was used, simple random sampling was applied where whoever was present during the site visit would be approached and invited to have an informal conversation. It was not easy to structure the informal discussions as they were dependent on who was around and who was available to have a conversation related to the questions. According to Etikan et al (2017), random sampling is a technique that enables every single object to have an equal chance of presence in the sample. The type of random sampling that was used for the unstructured interviews was simple random sampling, which Bhardwaj (2019) explains as the type of sampling where the participants are chosen at random and solely by chance. As a result, the sample's quality is unaffected because each participant has an equal opportunity to be selected (Bhardwaj 2019). Of course, the chances of being a potential unstructured interview participant would have depended on the day the researcher visited, the time they visited, and other aspects such as the weather. Since the researcher visited on different days and at different times, this somewhat randomised the chances of being included in the unstructured interviewing sample.

3.5. Data collection methods

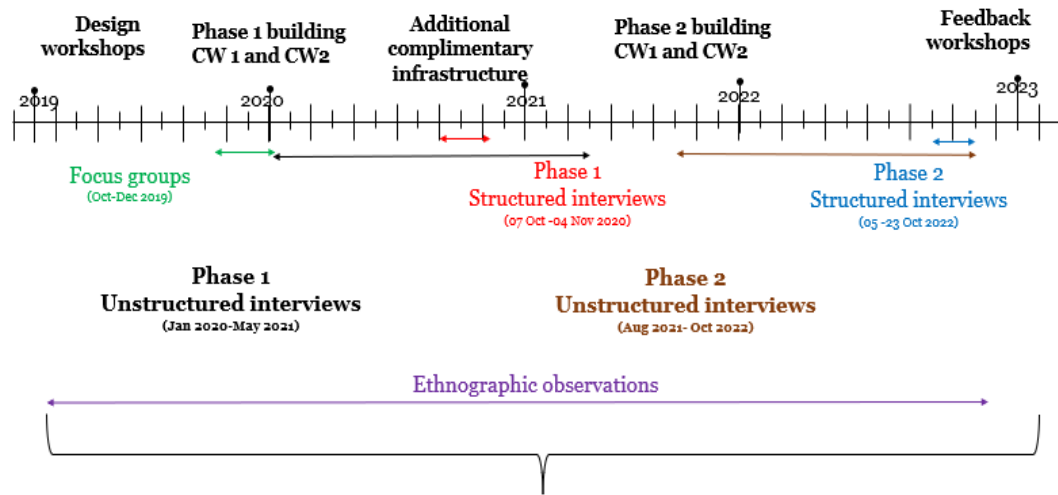


Figure 6: Timeline of data collection

3.5.1. Ethnographic observation

Research observation such as ethnographic observation is distinguished from other research techniques by having less influence over the subject matter (Ciesielska et al. 2018). The researcher generally encounters unexpected events due to adapting to the context and interactions, trying not to alter the outcome of possibilities, and having little influence on the surroundings (Ciesielska et al. 2018). In the social sciences, ethnographic observation gathers data regarding people, processes, and cultures (Kawulich 2012). In this study, ethnographic observation was employed as a strategy for gathering data to get a sense of behavioural occurrences in Silvertown included interactions with the CWs and the surrounding infrastructure. Further, ethnographic observation can produce accurate data that cannot be obtained from interviews (Arora 2011). In other words, ethnographic observation gave the researcher complementary information to the conducted formal and unstructured interviews. Different types of observations were used for this research. In the beginning, naturalistic observation was used to familiarise the researcher with the environment where the study was taking place, but, most importantly, to spontaneously study the setting. The researcher was able to observe and record the behaviour of the people. The ethnographic observation technique

known as “naturalistic observation” involves the researcher observing events in their unaltered, natural surroundings (Rydenfält et al. 2015).

Participant observation was also applied. The strength of participant observation is letting the researcher frequently integrate data collection (Cargan 2007). In some cases, the researcher conducted the observation, but did not make it obvious to the people that they were formally observing what was taking place. There were several different types of observation that took place in Silvertown during the study period. There were observations that randomly took place before the CWs were built in 2020. These participant observations were also used after the CWs were built and during the interviews. This was to see if what was reported by the participants correlated to what was observed. After the CWs were refurbished, in the second phase of interviewing people in Silvertown, the same process of participant observation happened.

The researcher was able to observe the spontaneous behaviour of participants in their naturalistic surroundings and the reciprocal nature of the interchanges, developments, and failures of the infrastructure in Silvertown. This was very important as it set the foundation for developing behavioural patterns which helped in setting up structured observations to deeply understand the behaviour and the extent of the infrastructure.

In phase 1, there were regular, unstructured observations of how people engaged with the CWs, and surrounding infrastructure related to the CWs. The structured observations were applied from before the CWs were built in 2020 until March of the same year when South African lockdown laws prohibited people’s movements. The unstructured observations resumed on August 21, 2020. The structured observations usually took place before the unstructured interviews. The unstructured observations concluded at the end of the data collection that wrapped up in when the last round of structured observation ended in September 2022. The researcher would normally go to Silvertown twice weekly to see how the CWs were doing and how people reacted to them since they were new to the settlement.

Structured observation is a technique for collecting and analysing data that uses observation schedules and predetermined behavioural classifications (Treanor 2010). For six months from April to September 2022, the activities around CW1 and its infrastructures were also observed in a structured manner. The observations would last for a week on seven consecutive days once per month, ensuring that different parts of the month were included. The observation of the activities around CW1 were carefully recorded where people's movements were recorded for one hour at time. The observations took place at three different intervals: one in the morning, one around midday, and one in the afternoon. This was to see if the different times of day affected how people interacted with the infrastructure. Observations did not take place in the evenings or the early mornings because ethically it was deemed unsafe for the researcher (who did not live in Silvertown) to be present during these times. It is possible that interactions with the CW might have happened at these times which were not captured (e.g., the emptying and cleaning of chamber pots, open defecation, etc.).

3.5.2. Photo Ethnography

The ethnographic observations were complemented with photographs. The photographs were used to document the activities around the CWs, with other related infrastructures, and the manner of engagement with the CWs. Photographs can assist researchers in understanding how societies are culturally and socially constructed, critically revealing the meaning people place on detailed activities, residences, items, and practices and recording and examining meaningful social events and issues (Cleland et al. 2021). Importantly, photographs can be used as documented records of the ethnographic observations. During the data collection 1 403 photographs were collected. These photographs were collected in different phases of the research project. The photographs were divided into different categories that included, service delivery infrastructure, the Silvertown environment, water collection and washing behaviours, and observations of everyday life. The photographs were also taken during the design workshops, during the prebuilding phases, different building phases, and the different assessment phases. Table 2 is a tabulation of the different categories photographs.

Table 2: Categories of the photos

Category	Items of photos taken				
Service delivery infrastructure	>Chemical toilets	>Shelters: (shacks and bricks houses)	>Human-made infrastructure: trenches and gullies in the settlements over time >Wall	>Electricity: Electricity cables, municipality connections and illegally connections	>Taps: photos of broken taps, leaking taps, plastic taps, metal taps, vandalised taps.
Environment	>Gullies filled with litter	>Litter around the settlement	>Burst pipes and burst sewers	>River, pollution >Flooding	
Behaviour	Littering	Children playing	Interactions with the CWs	Washing, cleaning, water collection, and water disposal behaviours	
Everyday life	>Waste collection	>People cleaning toilets >Sanitation company removing sludge from chemical toilets	>Pathways people use	Gatherings, meetings, playing games	

3.5.3. Focus groups

Focus groups were used for data collection in the design workshops. I was part of the research team, so during the workshop, I was one of the people who helped facilitate it. As the language was an issue in some cases, I also helped explain it to the people who attended the workshop to ensure understanding. The main facilitators were the URBWAT team leaders. The data received from the workshop was key in getting to know the community better, understanding the greywater problem, and comparing solutions from both the research team and the community. Focus groups were used for data collection in the design workshops. The Setswetla design workshops took place from October 2019 to December 2019 as seen in Figure 6. The number of people that attended workshops were as follows: Silvertown (11), Masinwini (14), Bridge (9), Old Setswetla (12), New Stand (7), Giyani (12), and Xitshoba (10). The people who attended the workshops were recruited by both the leaders in the community and the research team. Initially, the research team needed to become more familiar with the different areas of Setswetla to identify possible sites for the intervention. For focus groups such as Old Setswetla, Silvertown, and Giyani, the community members who attended were recruited by the community leaders because there were already community leaders who were staying there. Once the research team was familiar with the people, they recruited people from the various sections of Setswetla through word of mouth with the help of the community leaders. After each workshop the focus group attendees took the research team on a site visit of their respective sections to show their water disposal situation. Since the site visits involved walking through various sections of Setswetla the site visits were also used to recruit further participants for later workshops. Each workshop was held in a community room at the Greenhouse (the Greenhouse was built by the Non-Governmental Organisation, Gift of the Givers, to house people who had lost their dwellings in one of the frequent floods that impacted Setswetla) in a room which was also used as a gym. The focus groups were facilitated by the researcher team and the researcher acted as an observer, taking notes of the issues raised by the participants. Before the focus group started, the purpose of the study was explained and the right to withdraw was raised. The focus groups were not audio-recorded because of the noise in the venue and because of the interactive nature of the focus group where participants were divided into smaller groups to facilitate discussions around developing alternative designs.

As the format of the workshops was based on a focus group setup. The URBWAT project team would introduce themselves in the workshops. Once the introductions were made, one member

of the URBWAT project team would explain the overall purpose of the workshop as well as ethical issues such as the voluntary nature of the workshop, the issues of confidentiality and anonymity, and how feedback would be given. After the URBWAT project team had briefed the workshop participants, they were asked to break into groups of 3 to 4 people. In the groups, they were asked to discuss and draw their current living conditions with regards to water access and greywater disposal. Next, the groups were asked to discuss and draw how they want the water and greywater disposal to change. Participants were asked to be realistic, given their situation. For example, they were not asked to describe their ideal, but rather what they thought was feasible. The groups were given 30 minutes for this task. While the groups were busy with this task, they were also asked to select a member to present their group's discussion/drawings. Once the groups had finished the discussion, their representative would present to everyone that they had depicted in their sketches. After all the groups have presented, a member of the URBWAT project team would then respond to the suggestions from the groups. The URBWAT project team then presented the general URBWAT project solution and asked for their general feelings and then specific suggestions. Once this was completed, the workshop participants were given refreshments and then were asked if they would take the research team on a tour of their section to explain in person what they had depicted in their drawings and to show why the research team's suggestion could/could not work. Some community members were shy about expressing themselves even though they were encouraged to demonstrate the water disposal in the language they felt comfortable with. Other community members acted as translators and would also clarify any vernacular language issues. Some people spoke English, and there were cases where people would use their home language, like isiZulu, Tsonga, Sepedi, and TshiVenda. This last section of the workshop took about one hour with each workshop lasting about three hours in total.

3.5.4. Structured interviews

Structured interviews were used as a method to collect data from the residents of Silvertown. The structured interviews used with the residents of Silvertown ended up being informal in setup. On the other hand, the structured interviews that I did with the community leaders were formal. As described by Ruslin et al. (2022), structured interviews have formalised, limited sets of questions. There is an advantage to using structured interviews as they encourage standardisation, reducing mistakes caused by question variances (Rashidi et al. 2014). Given

the nature of the situation it was not always possible to audio-record the interviews (i.e., they took place outdoors, often with a great deal of ambient noise, in a high-theft area where electronical equipment would often be viewed as a target). Instead, notes were collected using a pen and a notepad during the interviews. The interviews took roughly 30 minutes each. Where it was possible to digitally record the participants' responses, this was done by using a phone. Before the interview, the participant information sheet was shared with the interviewee and permission was obtained to conduct the interview (and permission to record was obtained if the interview could be recorded). The recordings were transcribed onto a computer in Word. In phase 1, questions were aimed at understanding if people were using the CWs and what people thought of them. In Phase 2 questions were centred around how CWs integrated into existing structures and what influenced their use of CWs. Data collection of interviews in Phase 1 occurred during the following days listed in table 3.

Table 3: Phase 1 Structured interview records

Days when data was collected	Number of people interviewed			Number of people who declined to be interviewed			Duration in the field
Wednesday, 07 October 2020	(5) F/F/F/F/F			(3) F/F/M			08:00-14:00
Saturday, 10 October 2020	(2) F/M			(4) M/M/F/M			16:00-18:00
Wednesday, 14 October 2020	(4) F/M/M/F			(2) M/M			12:00-15:00
Sunday, 18 October 2020	(3) F/M/M			(2) M/F			10:00-12:00
Wednesday, 21 October 2020	(4) F/F/F/M			(3) F/M/F			14:00-18:00
Thursday, 22 October 2020	(2) F/F			(3) M/M/M			08:00-12:00
Monday, 26 October 2020	0			(3) F/F/F			16:00-17:00
Thursday, 29 October 2020	(2) M/M			(2) F/ M			12:00-14:00
Wednesday, 04 November 2020	(1) F			(2) M/M			16:00-17:00
Total	23	F:15	M:8	24	F:10	M:14	

Key

F=Female

M=Male

In Phase 1 of data collection, the researcher went into Silvertown without planning how many people they would interview. The aim was to have Structured interviews with approximately 30 people. In Phase 1 23 Structured interviews were conducted because the same people were always present, and others people who were present declined to be formally interviewed. It was challenging to conduct Structured interviews with people as they were not keen on the idea of a Structured discussion. Data collection happened on nine different days, with only one day where nobody could be interviewed. The data collection started on 7 October 2020 and ended on 4 November 2020, within a five-week period. It was anticipated that data collection for Structured interviews could have been completed in two weeks but due to these challenges the time span for Structured interviews was extended. Data collection of interviews in Phase 2 occurred during the following days listed in table 4.

Table 4: Phase 2 Structured interview records

Days when data was collected	Number of people interviewed			Number of people who declined to be interviewed			Duration in the field
Tuesday, 05 October 2021	(1) F			(4) M/M/F/M			10:00-12:00
Thursday, 07 October 2021	(3) F/F/F			(3) F/F/M			12:00-16:00
Sunday, 10 October 2021	0			(4) M/F/M/M			15:00-18:00
Friday, 15 October 2021	(3) M/F/F			(2) F/F			10:00-14:00
Saturday, 09 October 2021	(4) F/F/F/M			(1) M			16:00-18:00
Monday, 18 October 2021	(3) M/M/F			(2) M/M			08:00-12:00
Wednesday, 20 October 2021	0			0			16:00-18:00
Saturday, 23 October 2021	(3) F/M/F			(2) F/M			12:00-14:00
Thursday, 04 November 2021	(2) M/M			(3) F/F/F			16:00-18:00
Saturday, 06 November 2021	(1) F			(2) F/M)			08:00-10:00
Total	20	F:13	M:7	23	F:11	M:12	

Key

F=Female

M=Male

The Structured interviews in Phase 2 started on 5 October 2021. When the interviews were conducted the building for Phase 2 had already finished. A total of 20 participants were interviewed during October and November 2021. The researcher visited Silvertown 11 times to do Structured interviews. Unlike in Phase 1, when the researcher visited the field randomly, in Phase 2, the structured interview visits were arranged to ensure that different days of the week were covered and that different hours of the day were captured. For each of the four weeks that the researcher was in Silvertown, he made sure that he interviewed on a weekday and a weekend (either Saturday or Sunday). All except one day that the researcher went to collect data, there was at least one participant who was willing to be interviewed. Thirteen females were interviewed, and seven males were interviewed. Twenty-three people also declined to be interviewed; twelve of them were male, while eleven of them were female.

As mentioned earlier there were other people from outside the Silvertown section who were involved in the use and interaction of the CWs. People from different parts of Setswetla were found in Silvertown, particularly the Maponyane section. The three people who were interviewed who were not from Silvertown had visited people in Silvertown; therefore, it was also easy to interview them indoors to maintain anonymity and confidentiality to some extent. Anonymity was difficult in most cases, even for people in Silvertown in their homes, as the space in their homes was small and it was common for other people to be present during the interview. The researcher tried as much as possible to make sure that people were interviewed indoors to make them feel comfortable, but again, there were cases of people who were interviewed outside as per their request.

3.5.5. Unstructured interviews

The data collection for the unstructured interviews in Phase 1 was conducted over nine months, from January 2020 to May 2021. The unstructured interviews that I did with the residents of Silvertown were informal in setup. As seen in Appendix A, a total of 227 participants were interviewed, of which 140 were males and 87 were females. In some instances, unstructured interviews were conducted when individuals were gathered. In the case of phase 2, data collection took ten months, from August 2021 to October 2022, and a total of 226 people were interviewed during that period. 111 women and 115 males were interviewed. The Setswetla

design workshops. Unstructured interviews were used to collect data from the Silvertown community. The main aim of these unstructured interviews was to make sure that people were questioned in a less controlled set-up. The researcher recognised that some people did not answer questions in the Structured interviews as they did not feel free to say things. The questions in the unstructured interviews were open-ended with general questions that encouraged the informants to begin speaking without directing the content of the discourse (Saks et al. 2007). The unstructured interviews were also conducted part of building rapport with the residents. Once residents felt comfortable, they were more willing to provide information to the questions. The questions posed to the residents in the unstructured interviews were related to how they were interacting with the CWs. The questions asked were generally similar to the questions in the structured interviews. However, some of the information in the unstructured interviews was directed by the informant rather than the researcher. Following an unstructured interview format, typically some informants would answer the questions posed to them by the researcher, and then they would randomly start giving additional information. For example, after the construction of Phase 2 at CW2, a resident spontaneously started a conversation indicating that they loved the extensions that were done to the CWs to make sure that there was enough capacity to accommodate the water. This informant went on to explain that CW2 was now creating a problem because stormwater from the road was being directed by the CW into their homes. Unstructured interviews were used throughout the research period. Similarly to the ethnographic observations, the unstructured interviews were used to collect get additional information and to validate information from other sources. Unstructured interviews were seldom recorded although interview notes were written down in a notebook or the researcher's personal journal. Data collection of unstructured interviews in Phase 1 and 2 is attached in the appendix.

3.5.6. Personal and reflexive journal

The researcher kept a personal reflexive journal to record daily activities while collecting data and to note any personal reflections on the data collection process. The reflexive journal unveils hidden contextual information, enhancing the prime ethical and methodological purpose of the research to understand the lived participants' experienced (Smith 1999). The reflexive journal was also used to record what was seen or heard from conversations with people in the different parts of Silvertown. This helped the researcher to remember the important details that were not

possible to record during the interview, especially the unstructured interviews which were happening randomly. The reflexive journal was an important piece of data of its own accord because it captures information such as the “mood” of the community and helped guide the analysis of the data by recording general trends that the researcher felt were emerging during the Structured and unstructured interviews and the observations.

3.6. Data analysis

Different methods were used to clean the raw data collected. The answers were recorded using an answer sheet during a Structured interview. In some cases, some of what was written down was clear and orderly, while in other instances, the responses needed to be re-arranged into a more orderly format. It was, therefore, necessary that the answers were recorded and transcribed after every day of data collection. In analysing raw data for Phases 1 and 2, the interviews were cleaned and represented in table format for each phase for both the structured and unstructured interviews. A table was created in Microsoft Excel to record the interview data for the structured interviews. The table was divided into the 13 questions which were asked in Phase 1 and the five questions in Phase 2. To ensure that the data could be easily incorporated into the central core categories and correspond to the later analysis stage (selected coding stage), it was essential to keep all the information linked to its respective questions (Payne et al. 2004). When it came to the unstructured interviews, data were related to the structured interview questions as far as possible. New columns were created for information that did not fit the existing question categories. Similarly, the data collected using a notepad were also transferred to the Excel spreadsheet. The spreadsheet was also populated with information related to the interview, such as their age group, gender, mode of water access, and purpose for visiting the tap/CW.

3.6.1. Narrative analysis

Narrative analysis was used to analyse this data. Narrative analysis can be explained as the exploration of a person’s own story as influenced by any personal, ethical, social or political issues that the research brings (Weatherhead 2011). In data analysis, themes that can adequately represent the narratives are included in the account of data sets (Dawadi 2021). The data from Phase 1 and Phase 2 of the research was interpreted through narrative analysis. Narrative

analysis is a collection of analytical techniques used to understand texts or visual data with a structured storytelling format. The focus is on the arrangement, substance, and purpose of written and spoken discourse narratives (Wright 2015). As the researcher wanted the participants to describe their experiences, they then used semi-structured interviews. In analysis, the data from phase 1 inductive coding was applied to make sense of the data. Inductive coding begins with close readings of the text and consideration of the multiple meanings inherent in the text (Thomas 2003). After the interpretation in Phase 1, the main questions were clear what to ask based on the participants' responses. Therefore, the themes developed from the phase 1 data collection also helped establish themes for phase 2. In the analysis, the researcher applied more of a deductive analysis because it built some of the themes from what developed. The deductive analysis is a method that seeks to evaluate pre-existing categories, concepts, models, theories, or hypotheses (Kyngäs et al. 2020). The researcher employed narrative theme analysis, wherein the primary emphasis is on the substance contained inside the text.

Hoshmand (2005) argues that some narrative analysis is a storied account of traditional forms of data (e.g. interviews). This storied account explains how the data were analysed in the context of this research. In the beginning, related answers, questions to ask in the next phase, and concluding accounts were grouped to produce a common direction for the different stories that the people told. These were then analysed by combining story components from the narratives of the individuals in Silvertown within a coherent storyline to identify relevant trends in the data. In other words, the various accounts that the people were talking about and the accounts of meaningful stories of the everyday life in Silvertown greywater, infrastructure and CWs were connected to create narrative networks. The purpose of these narrative networks was to study routines as narratives (Holstein et al. 2011). The idea was to understand the everyday life in Silvertown relating to greywater disposal and how people experienced the CWs. In analysing this data, the narratives became classified into histories (where people were coming from), politics (public affairs that shaped the community), and how life unfolded daily in Silvertown. All these aspects were then critically analysed. Critical analysis in narrative research entails scrutinising a narrative's political, social, and ideological consequences while questioning its underlying assumptions and values (Hassan 2024). Narratives were collected based on the common themes that were raised from the underlying characteristics which spoke

about the hierarchical structure that controls the way of living in Silvertown and were further linked to data on hierarchical rankings in the community and the political structure that controls the local structure. Initial data about the hierarchy in Silvertown from the workshops were applied to Phase 1 and then augmented with more detail from Phase 2. These narrative data were analysed and presented as the first part of the story before getting into the data about services and infrastructure. In producing the results, the emerging narratives were not assimilated into the theoretical framework. Instead, the organised data were formed into themes which allowed the researcher to tell the story about the history of Silvertown, the greywater problem, designing, building, and using of the CWs, and the interconnections of the other infrastructure. In the discussion, the collected data is then considered in light of the literature review.

In the first step of data analysis, labels were created through highlighting the data in an open coding manner. Open coding is a method where concepts are extracted from raw data and afterwards organised into conceptual categories. The objective is to create a primary, descriptive, multidimensional framework for analysis (Khandkar 2009). To break the codes into more meaningful data, the related codes were grouped to form meaningful data that would eventually become categories that could summarise the main ideas. The next step is axial coding which offers a framework or template to synthesise and arrange data into more logical categories. Also included were the subcategories that provided emergent notions of depth and complexity and potential connections to other components of the analysis framework (Scott et al. 2017).

To interpret data from the unstructured interviews mind mapping was used in extracting data from the notes and transcriptions. This was done to provide a mechanism to remove researcher bias and guarantee that data are analysed in ways that prioritize the informant experience. Mind maps are, therefore, helpful tools for qualitative researchers (Wheeldon et al. 2019). Most of the analysis of the unstructured interviews was about ideas or issues that did not fit neatly into the structured interview questions. The mind map helped in making sure that in the later stage of analysis, these codes would fit systematically into the selective coding scheme from the analysis of the structured interview data. Selective coding refers to the systematic coding of

only the core codes and those codes connected to them by the researcher (Alston et al. 2003). Once chosen, the core codes serve as a guide for additional theoretical sampling (Alston et al. 2003). What made the codes come together was that some of the open-ended and the close-end questions were related. This made it possible to see how the coding from the formal and unstructured interviews could fit together. For example, issues about whether people attended the workshop meetings, whether someone explained how the CWs work, and how best to inform the residents about the CWs could be linked to structured interview questions about similar issues. Where answers did not match any of the formal questions, the researcher created new codes.

3.6.2. Ethical consideration

Vizzuso (2015) points out that a researcher is responsible for ethical conduct when conducting research. Before data were collected, ethical clearance was received from the Human Research Ethics (non-medical) Committee at the University of Witwatersrand. In the information sheet, it was explained to the participants of Silvertown that they would be taking part in the study voluntarily and that they had a chance to withdraw from the study anytime they wanted without being penalised. When people could not read, the researcher verbally explained the information to the participants. In the same way, if participants felt uncomfortable answering the questions, they were allowed to abstain from answering during the interview.

Before the structured interviews, the first data collection process was focus groups for the design workshops. The focus group sessions were recorded by the research team using note taking for better understanding of the discussions and design drawings which the participants made were also collected as data. The nature of session was explained to the focus group participants, and they were asked to agree to participate. It was not possible to guarantee anonymity in the focus groups, especially since the people who attended knew each other as they were coming from the same area in Setswetla. The only guaranteed was that the researchers would not record personal information and would not report personal information that would allow someone to identify an individual. While participants were asked to keep personal information raised in the focus group discussion it was not possible to guarantee the confidentiality of information shared in a group setting. The nature of the focus groups sessions

meant that the research team also wanted the participants to carry on discussing the topic with other community residents, even after the focus group session had ended.

With regards to the interviews, the researcher explained to the participants through the information sheet that the aim was to conduct research for his PhD degree. The researcher gave the participants his name and the name of his supervisor and indicated that he was a student from the University of Witwatersrand. The researcher then told the participants what the nature of the questions would be during the interview and the value the research would be adding to the service delivery and urban development field in their community. The researcher made it clear that their responses were not anonymous (because the researcher would know who they are) and other people (including family members in the same dwelling) might see that they are being interviewed. In fact, there were cases during the data collection where those being interviewed insisted on being interviewed with other people around them. It was explained that information would be analysed as a group and that every effort would be made to ensure that individual interviewees could not be personally identified in the report and thesis. Once the participants understood the information sheet, they were given an informed consent form for written consent (or in some cases verbal consent where they were not comfortable signed a form) and let the researcher know they had agreed to participate in the study. There were individuals who constantly provided information, whether through structured or unstructured interviews. As a result, I have given these individuals codes for better reference and understanding for the reader. The codes have guaranteed the individual's anonymity.

The researcher explained to the participants that they were part of the project implementation and involved in the production of the CWs through engagement with the residents on development plans. Therefore, they were informed that the researcher was influencing some of the processes involved in producing the CWs. The researcher did not collect identifying information about individuals, such as names, addresses, or identification numbers. It was important to assure the Silvertown participants that none of their gathered information was revealed to other people or could be directly traced back to them individually to ensure confidentiality. The nature of the physical spaces, with the rooms being small and people staying together, could have affected the anonymity.

The researcher's supervisor saw the collected data in its early stages without revealing the participants' names. The researcher also clarified to the participants that the final research would become a public document, a Ph.D. thesis, and possible publications. The participants were informed that the collected data would be stored on a password-protected external drive and later in a password-protected cloud service which no one would be allowed access without the password to guarantee the data protection. They were also informed that the data would not be deleted as it could be used for future studies or as part of a data verification process. It was ethical to ensure that the interviewees and other members involved in the design workshops were given feedback on how the project worked. The feedback with the community took place on Monday 24 October 2022, at the Greenhouse in Setswetla.

3.6.3. Limitations

Sometimes, it was a struggle to interview people without others seeing what was happening because people would walk in (and sometimes even start contributing) during the interview. Many of the indoor spaces were too small for interviewing in a private setup, which compromised anonymity. Therefore, the researcher was forced to make it clear in the information sheet that the anonymity of the participants could be compromised because of other people seeing them being interviewed, except in the case where the participants were interviewed alone indoors. There were participants who, during the course of the interview, indicated that time was a problem. In such cases, the order of the questions was changed to cover the critical questions before time ran out. There were cases where the main question and the follow-up question were asked simultaneously when time was the issue.

It also was not easy when people did not want to be audio recorded. In these instances, hand-written note-taking was used and later, after the interview, these were written into meaningful notes. Given the time difference it was possible that the researcher could have inserted his own thoughts, feelings, and ideas into the notes. Even after explaining the anonymity and confidentiality process, there were still some participants who wanted to avoid being interviewed as they thought the information would be published with their names. Silvertown, while crowded, occupies a relatively small space, and one could assume that the residents knew

the positionality of the researcher with regards to the research project. There may have been residents who thought that the researcher had political or legal motives beyond wanting to understand people in relation to the infrastructure given that these services were sensitive topic to many residents.

The COVID-19 pandemic made conducting direct interviews for six months during Phase 1 impossible because of the South African lockdown-level restrictions. The restrictions made it impossible to visit the research site to observe how people were using the CWs, to take photographs, and to meet with people formally and informally. At that stage in the research project, the researcher did not have many telephone numbers of residents and had not had sufficient time to build up rapport with the residents. This was a critical time in the data collection process as the CWs were handed over to the residents in Phase 1 on the Tuesday and on the Thursday the country went into a hard COVID-19 lockdown.

It was a problem to take photographs of activities when people were around as some people thought I was taking a photograph of them even though the researcher was taking a photograph of an object or relationships between objects. In those cases, extensive conversations had to take place and the photograph had to be shown to the person (or people) to reassure them. Where it was preferable to take a picture that included people, permission was asked first and every effort has been made to anonymise people in the pictures produced for reports or publications.

Since the researcher was not living in Silvertown, there were times when it was not possible to collect data due to the perceived risks. This was especially the case after dark, usually between 19h00 and 05h00 (although these times varied depending on the time of year and when the sun was setting). There were also times on the weekends during the day where it was perceived to be too dangerous on site due to community dynamics (e.g., residents fighting with one another, or drunk residents). The researcher had to be constantly aware of their surroundings and make judgment calls about his own safety and the risk of the situation. The researcher also had

informed his supervisor every time he went to the research site, his intended length of stay, and to send a message when he had safely left the research site.

3.6.4. Conclusion

This chapter contextualised the research site of Silvertown, not forgetting the area that Silvertown falls under, Setswetla and Alexandra Township as a whole. A qualitative research design was used in the collection and analysis of the data as this was a case study. In this regard, this chapter gave reasons why this case study was used, and explained the non- probability sampling, purposive, and snowball sampling methods that were used. This was followed by the discussion on the collection methods that were used, ethnographic observation, photo ethnography, focus groups, and the use of both structured and unstructured interviews. That was followed by detail of how the collected data were analysed through the use of narrative thematic analyses. The chapter then concluded by giving insight into the ethical considerations and limitations that bounded the study.

Chapter 4. Results

4.1. Introduction

The results chapter is divided into two interconnected sections. The chapter starts with a detailed outline of the structure of Setswetla and Silvertown in Ward 109. This structure plays a significant role in how the development of infrastructure plays out in this informal settlement. As an introduction to the second part of the results section, this chapter highlights the services that are provided as well as the services that are not provided in Silvertown. In the second part of this chapter, the design, building, and use of the CWs is described. This introduces the evaluation of greywater disposal and how the CWs fit with existing methods of greywater disposal. The design section evaluates how the design workshops worked and the role they played in the research team's decision to build the CWs in Silvertown. The building and the evaluation of the use of CWs is divided into Phases 1 and 2, following from the repetitive, iterative building process. In the evaluation of the two phases, a detailed evaluation is given of how the construction unfolded, how people used the CWs, and the physical state of the CWs in relation to existing infrastructure and services. This chapter concludes with an overall evaluation of the suitability of the CWs in Silvertown. The URBWAT project aimed to establish a greywater collection and treatment option using multi-disciplinary collaborative efforts between university academics from Sweden, South Africa, and Germany, together with the residents from a section of Setswetla (Alexandra). The research aims to understand how people relate to CWs through their engagements and how CWs relate to the previous methods of dealing with greywater disposal.

4.2. The geography of Alexandra and Setswetla in relation to work.

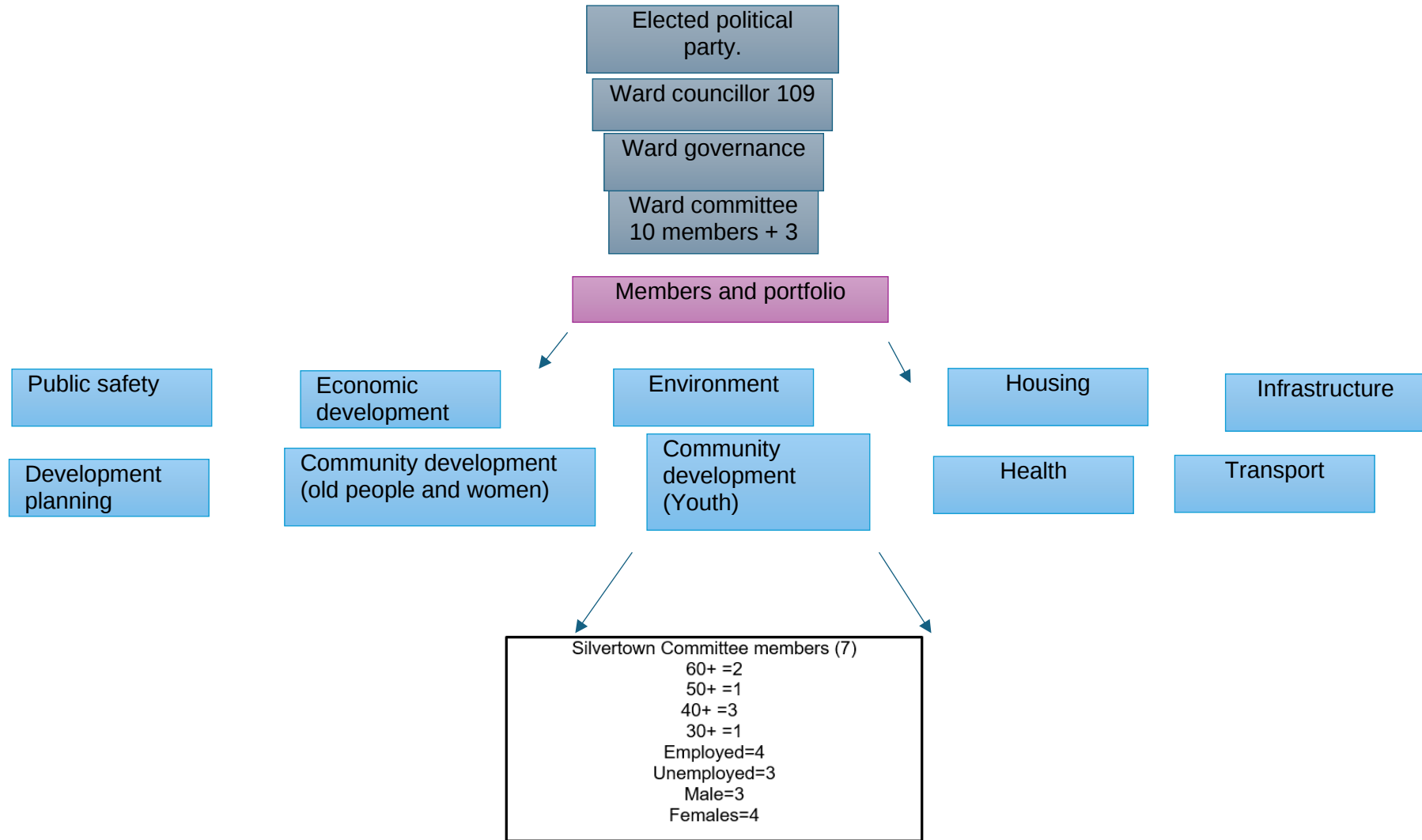
Alexandra township bordered on two sides by commercial enterprises. The logistics hub of Linbro Park suburb is located East of the N3 freeway. However, Webster (2020) argued that the N3 freeway cuts off many Alexandra township's poorer residents from employment opportunities due to the lack of easy transportation pathways between residences and work opportunities. To the West of Alexandra town there are a number of factories and warehouses, in the Wynberg suburb, but further west is the M1 freeway which makes it difficult for poorer residents to access work opportunities in the commercial hub of Sandton. To the north, Kelvin's warehouses are separated from Alexandra by the major dual carriage way of Marlboro Drive

and the warehouses of Kramer view are also difficult to access because of the M1 freeway. Further north are Midrand's warehouses but are also difficult to access because they involve crossing both the M1 and N3 freeways (Webster 2020). To the south of Alexandra township are the warehouses of the suburb of Kew. These are relatively accessible to the residents of Alexandra township who only need to cross the dual -carriage way of London Road, which is fairly easy to cross, but the entire sprawling township of Alexandra needs to be crossed by residents of Setswetla if they wish to try and access the warehouses of Kew in search of work. However, there are some residents of Setswetla who think that their informal settlement is perfectly positioned which would explain why this informal settlement attracts a lot of people. Some residents argue that they come to stay in Setswetla because it is surrounded by areas rich with job opportunities, even if those job opportunities have limited physical access from Setswetla. Some residents feel Setswetla is ideally placed because residents only need to spend a little money while looking for jobs. Setswetla is in close proximity to job hubs such as Linbro Park, Modderfontein, Longmead, Alexandra, and even Sandton.

Setswetla is near areas with job opportunities, so people are inclined to stay in this informal settlement even though the conditions could be better. Among the problems experienced in Setswetla are overpopulation related to illegal occupation, vandalism, and crime. Those who are poor are out in the look for cheap accommodation and Setswetla provides this. When I was in Silvertown, one of the people who rents a house there said the original people have built rooms in both Setswetla and Silvertown to provide rental accommodation for such circumstances. The individual went on to say that they have different prices for these rooms but were usually less than R1 000 for a room. It is even cheaper when you consider that the water is free, and some people do not even pay for electricity (with illegal connections in the area). In one case there is a story about a shack fire that impacted a lot of homes in Silvertown. Relating that to why some people stay in Silvertown, one person whose shacks were burned down told me that he comes from the Mpumalanga province, and he was staying in the shack because he was looking for a job. Even though the fire had burned most of his belongings, he told me that as soon as he realised that his shack was burning, he went to remove his belongings that were close to the door. One of those belongings he kept close to the exit was his job-seeking documents like his ID and references. In the context of the South African home affairs system, if he had lost his

ID document, it would have taken another month or two to get another one, which would have halted his progress in looking for a job.

4.3. The hierarchical structure of Setswetla and Silvertown



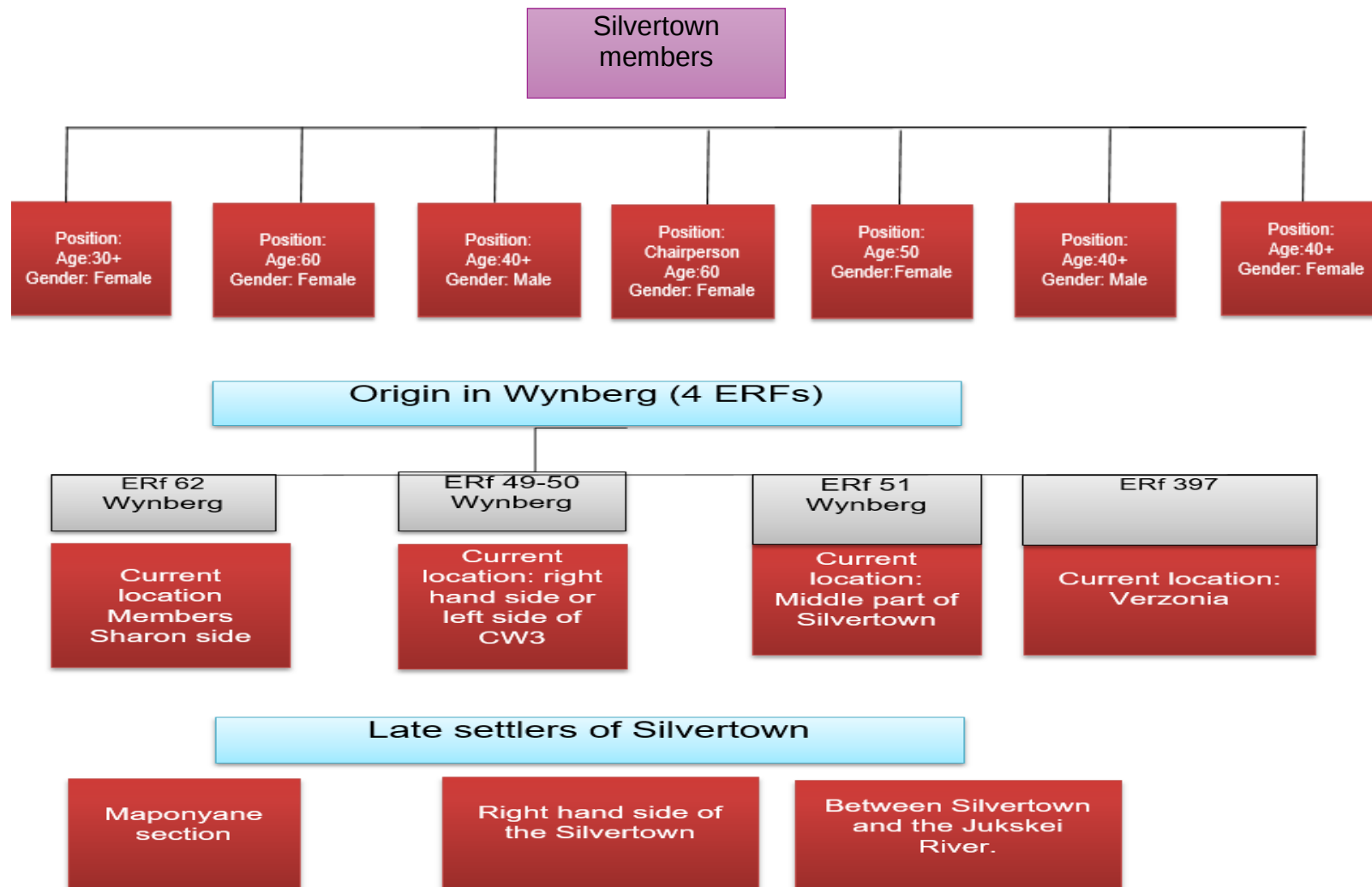


Figure 7: Hierarchical structure of Setswetla and Silvertown

Figure: Motshwaedi Sepeng (researcher)

Silvertown is part of a larger structural system that starts from the political hierarchy of national, provincial, and local governance and continues with a variety of community-organised structures. This hierarchical structure is represented in Figure 7. At the top of this structure is the Ward councillor. The Ward Councillors are elected members who are elected at the Ward level in municipal elections every five years. Setswetla falls under the CoJ and the Ward Councillor represents Ward 109. The sphere of Ward governance is a vital aspect that is intended to be independent of political affiliation, but more often, the Ward Councillor represents a larger political party. In the case of Setswetla during the study period there were two Ward Councillors representing the Democratic Alliance and one Ward Councillor representing the African National Congress (both political parties with representation in national parliament). Ward 109 predominantly consists of wealthier residents from suburbs such as Morningside, Wendywood, and Kelvin. The relatively wealthy suburb of Marlboro Gardens (wealthier in comparison to Setswetla), located on the boundary of Sandton and Alexandra (Pisanello, 2019). According to the Sandton Chronicle (2021), the other places that are included in Ward 109 are Eastgate, Kramerville, Gallo Manor, and Wynberg. Wynberg was the place from where many of the original residents of Silvertown were removed.

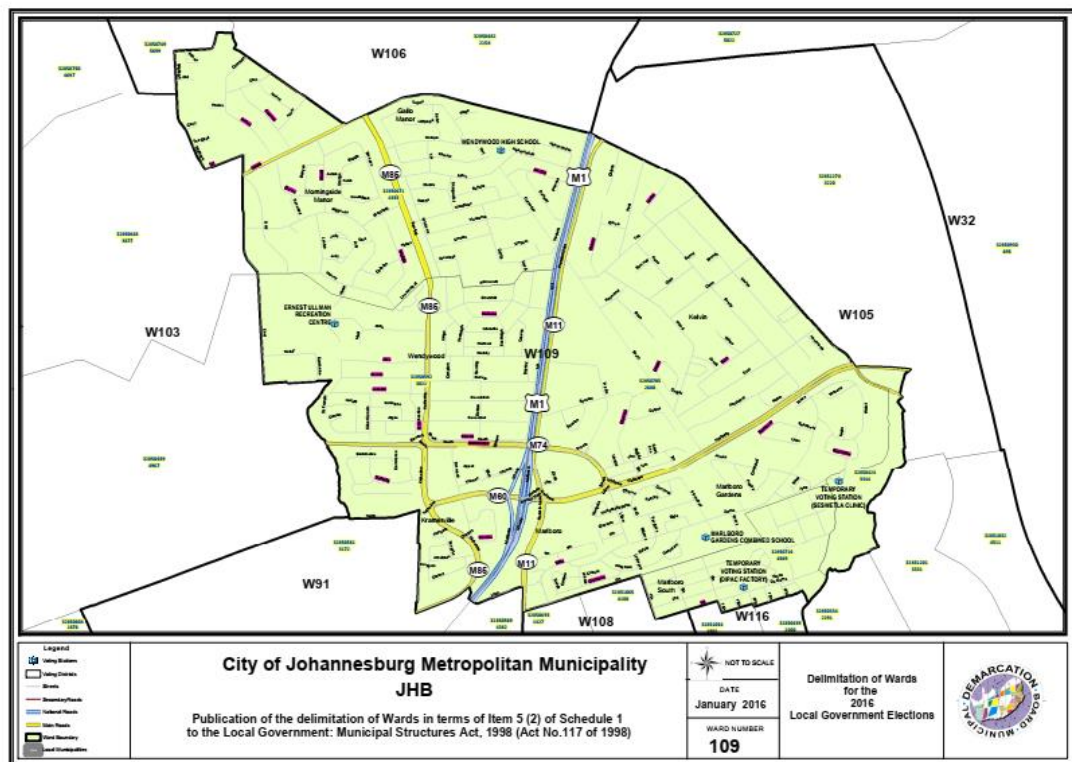


Figure 8: Map of ward 109.

(Wazimap n.d)

4.3.1. Transitional power of councillors in Ward 109 across the URBWAT project

Ward 109 presented in a 2016 map Figure 8, there were several changes regarding the councillors. When the URBWAT project CWs project started in Setswetla in 2019, the councillor at the helm was Werner Smit of the Democratic Alliance (DA). Smit was the councillor of Ward 109 from 2016 until 2019 when he resigned from his position before his time in office was up. Following the departure of Smit, Lori Coogan, also from the DA, took over in a caretaker role for a short period until the by-elections. On 24 July 2019, the CoJ held by-elections to elect the new councillor in Ward 109. Candidates of the African National Congress (ANC), the DA, and the Economic Freedom Fighters (EFF) took part in the Ward 109 by-elections (Pisanello, 2019). Liaquid Ebrahim, a candidate for the ANC, received 51.15% of the vote, just enough to win control of the ward. When the term of Liaquid Ebrahim

ended in 2021 when the regular municipal elections (local government elections) took place, Lori Coogan from the DA took back Ward 109 and continued to serve as a councillor for Ward 109 until the end of the research project (Dlamini 2019).

4.3.2. Ward Councillor

Ward Councillors are members recently elected by residents of a ward to represent various political parties, other organisations, or are independent. Ward Councillors attend Council meetings on behalf of their residents (SALGA 2006). The CoJ Council meetings, the Speaker acts as the chairperson and ensures that the Council Code of Conduct's rules and guidelines are followed. The speaker's job is to uphold the fundamental principles essential to all Council members. The speaker ensures that Council members adhere to the code of conduct and have enough support from other Council members to do their duties efficiently (SALGA 2006). There is also a responsibility to ensure that issues are not politicised and that the residents' problems are addressed despite their allegiance and support to a political party. However, in many cases, due to party politics, Ward Councillors are also likely to represent the policies of their political affiliation. In some cases, this can cause tension between the residents who have elected them and the political party who has provided the infrastructure to support the Ward Councillors campaign for election (e.g., posters, meetings, phone calls, physical visits, and other financial assistance). Regardless of these affiliations and tensions,

Ward Councillors are responsible for their ward as the chairperson of their Ward Committees. Secondly, Ward Councillors monitor the progress of service delivery in their wards. When projects come from the CoJ it is required that they must first go through the Ward Councillor, who then passes projects to the Ward Governor and from there, the projects are communicated to the Ward Committee responsible for overseeing the implementation of the project in the community. When there is a problem with the projects in the community, the Ward Councillor and Ward

Committee must verify if the people are residents of the Ward; then, the matter will be referred to the CoJ through the Ward governance body.

4.3.3. Ward Governor

The Ward Governor is the link between the Ward Councillor and the Ward Committees. The Ward Governors are employees of CoJ with skills in the required field. The Ward Governor is formally part of the local government but plays an administrator role rather than a law/by-law making role. The number of Ward Governors depends on the subregion. Region E (which includes Ward 109) has 16 Wards and each Ward Governor is responsible for three Wards. The Ward Governor forms part of the body that interacts with the Ward Committees and the Ward Councillor in Ward 109. The administrative jobs that the Ward Governor is involved in include:

- Organising meetings and setting agendas.
- Organising the communication processes with the community (i.e., not the actual content of the communications)
- Handing posters to the Ward Committee members to put up and taking minutes in the meetings.

For Ward 109, a monthly meeting is held between the Ward Governor, the Ward Councillor, and the Ward Committee in Marlboro. If a committee member fails to attend three consecutive meetings, the Ward Councillor will report the matter to the CoJ speaker. Matters happening in the community need to be reported to the Ward Governor. When projects are happening in Setswetla, the instructions will come from the Ward Councillor through the Ward Governor to the Ward Committee members responsible for Setswetla. Depending on their different portfolios, the Ward Committee members will then pass on the message and the service needed.

4.3.4. Ward Committees

The Ward Committee is the first sphere of governance that actively includes the residents of Setswetla and Silvertown. The Ward Committee is made up of members from the various communities in Setswetla who submit their names or register them to be considered for membership in the Ward Committee. For Ward 109 the Ward Committee is made up of ten members who have different portfolios. These members meet monthly to give feedback on their portfolios. One member represents Silvertown, while the others come from other parts of Setswetla and other parts of Ward 109. The portfolios include development planning, economic development, environment, housing, infrastructure, public safety, community development 1 (old people and disability), community development 2 (youth), health, and transport. These portfolios work hand in hand with their respective service entities such as Pikitup under the Department of Environmental Affairs. Sometimes, the Ward Committee has the authority to hire contractors to do the jobs for them.

How Ward Committees are set up allows for broad representation of all community interests (Reddy et al. 2014). According to one of the Ward Councillors from Ward 109 the Ward 109 Ward Committee is made up of different individuals from Ward 109 representing suburbs such as Kramerville, Kelvin, Eastgate, Gallo Mano, Marlboro Gardens, Morningside Manor, Wendywood, and Wynberg. Every five years after local government elections, ten Ward Committee members are elected by the community after they have submitted their application to the Ward Governor. The Ward Committee members are usually decided by the Ward Councillor. The Ward Committee members can be from a different political party than that of the Ward Councillor. One of the community leaders from Setswetla indicated that many of the people serving on the Ward Committee were primarily people from informal settlements like Setswetla and Verzonja. The Ward Committee works with

the council to help meet its service delivery objectives in the area and meets monthly to discuss plans of action and progress on previous plans of action.

4.3.5. Setswetla community leadership

Setswetla is made of two broader sections, the main sections of Setswetla in yellow outline and the Silvertown extension in red outline, as shown in Figure 9. The main sections of Setswetla consists of most of the southern parts of the Setswetla, from Gousblom Crescent Road including the (Bridge area), towards the Florence Mophosho Road. The Silvertown section is an extension north of the main section of Setswetla going north from Gousblom crescent along the Jukskei River towards Marlboro Drive. Silvertown is the smaller section of the two and is on the northern section of Setswetla. Silvertown starts from the right-hand side of the Gousblom Crescent until the start of the Violet Crescent Road. On the left-hand side of the Gousblom Crescent are a few community-driven commercial establishments like the car wash, a bricklaying site, hawkers selling food and everyday items, and the now soccer pitch. When the URBWAT project started in 2019, the area where there was a soccer pitch was vacant. Instead, it was just an empty field with some glass recycling. Both sections in Setswetla (the main Setswetla section and Silvertown section) have community leadership forums.



Figure 9: Map highlighting Silvertown and Setswetla
(Google Maps n.d.)

4.3.6. The Community Leadership Forum (CLF): Setswetla

The Community Leadership Forum (CLF) in Setswetla largely mirrors what happens at the Ward Committee. Indeed, some of the people who sit on the Ward Committee hold the same portfolio positions in the CLF. The CLF is made up of Setswetla residents who are nominated and elected by the community. The CLF has a chairperson (the equivalent to a Ward Councillor at the Ward level) and the same portfolios as the Ward Committee (i.e., development planning, economic development, environment, housing, infrastructure, public safety, community development for old people and people with a disability) community development for the youth, health, and transport. The purpose of the Setswetla CLF is to handle queries at the settlement level (e.g., the installation of additional transformers for electricity, the roll out of fire protection services for the elderly), to provide efficient communication with the CLFs of the different sections, and to escalate issues to the

Ward Committee where necessary. If severe issues in the community need to be communicated, then the CLF call a meeting with the community on the soccer pitch. The interesting thing about the soccer pitch is that when the URBWAT project started in 2019, the area with a pitch was just a space full of grass. Around 2020, during the COVID-19 lockdown, the space was cleared. The pitch is on top of a plateau topography; therefore, you have to walk up an incline to get there. When you are on the pitch, you can overlook the whole of Setswetla and some of the neighbouring areas like the Gautrain Marlboro station and East Bank. The pitch has been developed to a point where there is now a car wash on the ground of the plateau.

4.3.7. The Community Leadership Forum (CLF): Silvertown

Each section of Setswetla also has its own CLF with their own structure and portfolio depending on the needs of each section. The Silvertown community chooses the members of the Silvertown CLF. In Silvertown, the CLF is made up of four core positions: the Chairperson, Deputy Chairperson, Secretary, and Deputy Secretary as illustrated in Figure 10. According to a community leader TS from Silvertown the CLF consists of an additional three members, bringing the total CLF membership to seven members. Of the seven members in Silvertown, four are male, and three are female. Two of the members are over the age of 60, one is over the age of 50, three are over the age of 40, and one member is over the age of 30, shown in Figure 11. Four members are employed, and the other three on the forum are unemployed. Other sections in Setswetla may have additional CLF members depending on the needs and issues prevalent in that section. For example, a community leader PD from Setswetla indicated that the CLF structure in the section where they stayed was composed of ten members. Currently, the CLF members in Silvertown are made up entirely of the original members Silvertown.



Figure 10: Community leadership forum structure in Silvertown.

Figure: Motshwaedi Sepeng (researcher)

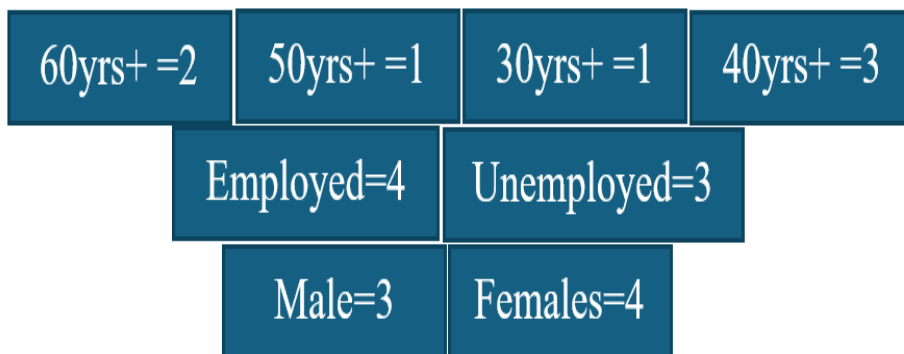


Figure 11: Silvertown Community leadership forum (7)

Figure: Motshwaedi Sepeng (researcher)

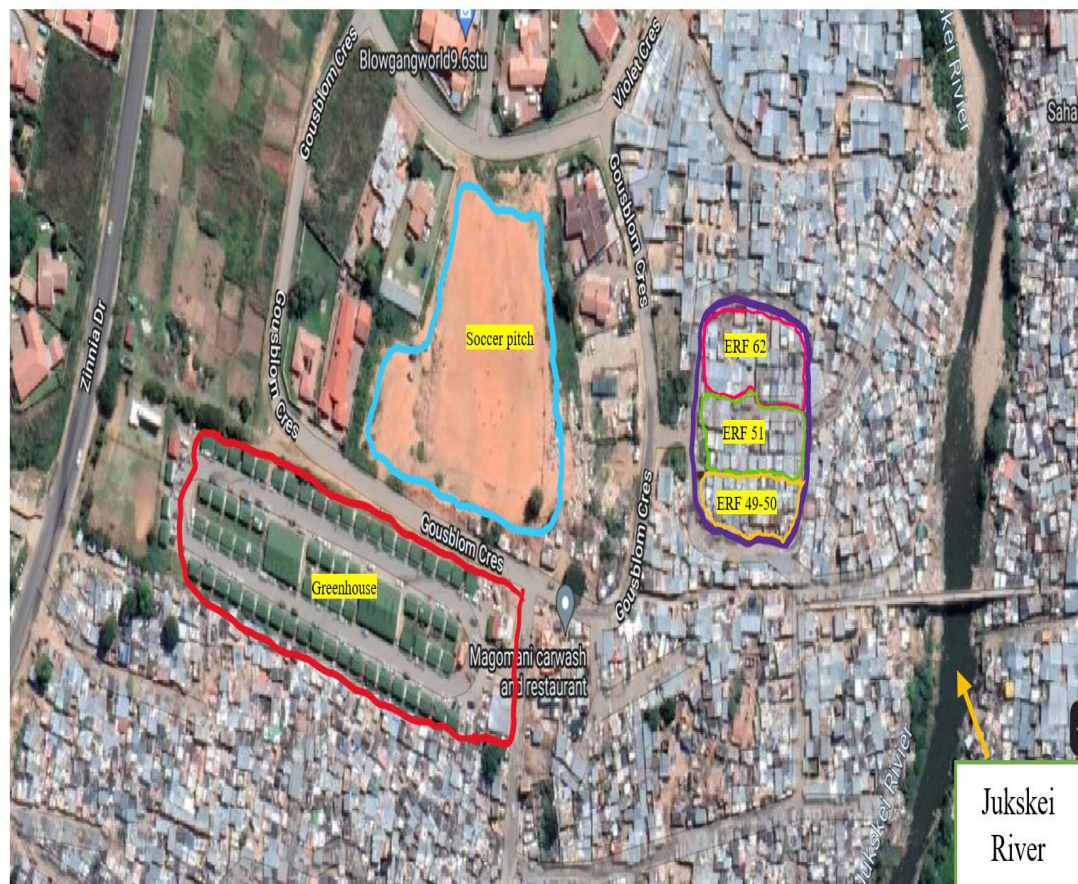
When residents have issues or problems, they report these to one of the CLF members. Depending on the nature of the matter, it is resolved by the CLF members, and if it cannot be resolved, it is reported either to the Setswetla CLF or to the Ward Committee members (depending on the nature of the issue/problem). When issues need to be discussed with community residents, a whistle is blown for community members to gather. These meetings are usually held at around 7 pm to accommodate those who are working and not available during the day. The place of gathering within Silvertown is in any available open space. In the context of Silvertown, some meetings were held to discuss updates from the lawyers about pending court matters and their existence as members of Silvertown. It must be remembered that Silvertown people were temporarily placed in Silvertown when they came from Wynberg. The original plan was to put them in a suitable place one day, which has yet to happen.

4.4. Silvertown past and current existence

The structure of Silvertown is made up of different layers that play roles in how everyday life occurs. Where the heart and soul of Silvertown come from has a relation to the various ranks within its community. As detailed already, the CLF within Silvertown is made up of the people who have direct ties to the original members of Silvertown. The settlement comprises the original members and the later “settlers”. Originally, Silvertown was made of families that arrived in Silvertown on 3 November 2006 after being removed from the occupation of abandoned warehouses in Wynberg. Community leader TS from Silvertown indicated that the composition of the living arrangement in Wynberg was such that some people came from the residential areas within Wynberg while others came from Wynberg warehouses. When the land they were occupying was needed for development, the municipality devised a plan to remove the Wynberg members without making specific arrangements to move them to another place. Some of the current community members in Silvertown went to court against the government to find land to be accommodated. According to community leader TS, they won a court

judgement to be afforded a place to be moved to temporarily while the government looked for a suitable home to be placed permanently. Three of the original sections of Wynberg ERFs 49-50, 51, and 62 were moved onto the Silvertown site. The other section of Wynberg, ERF 397, was placed in what is known as Verzonja, which is on the opposite side of the cemetery from Setswetla.

Silvertown, as part of Alexandra Township, falls under the ERF 35. There were about 100 original members who occupied the space in 2006. When people arrived in Silvertown, they were grouped based on the groups they were in when still in Wynberg. As presented in Figure 12, in Silvertown, the people from ERF 49-50 were placed on the right-hand side or left side of what is now CW3. The members from the ERF 51 were placed in the middle part of Silvertown, and the ERF 62 members were placed on the left-hand side or right side of what is now CW2.



Key (legend)

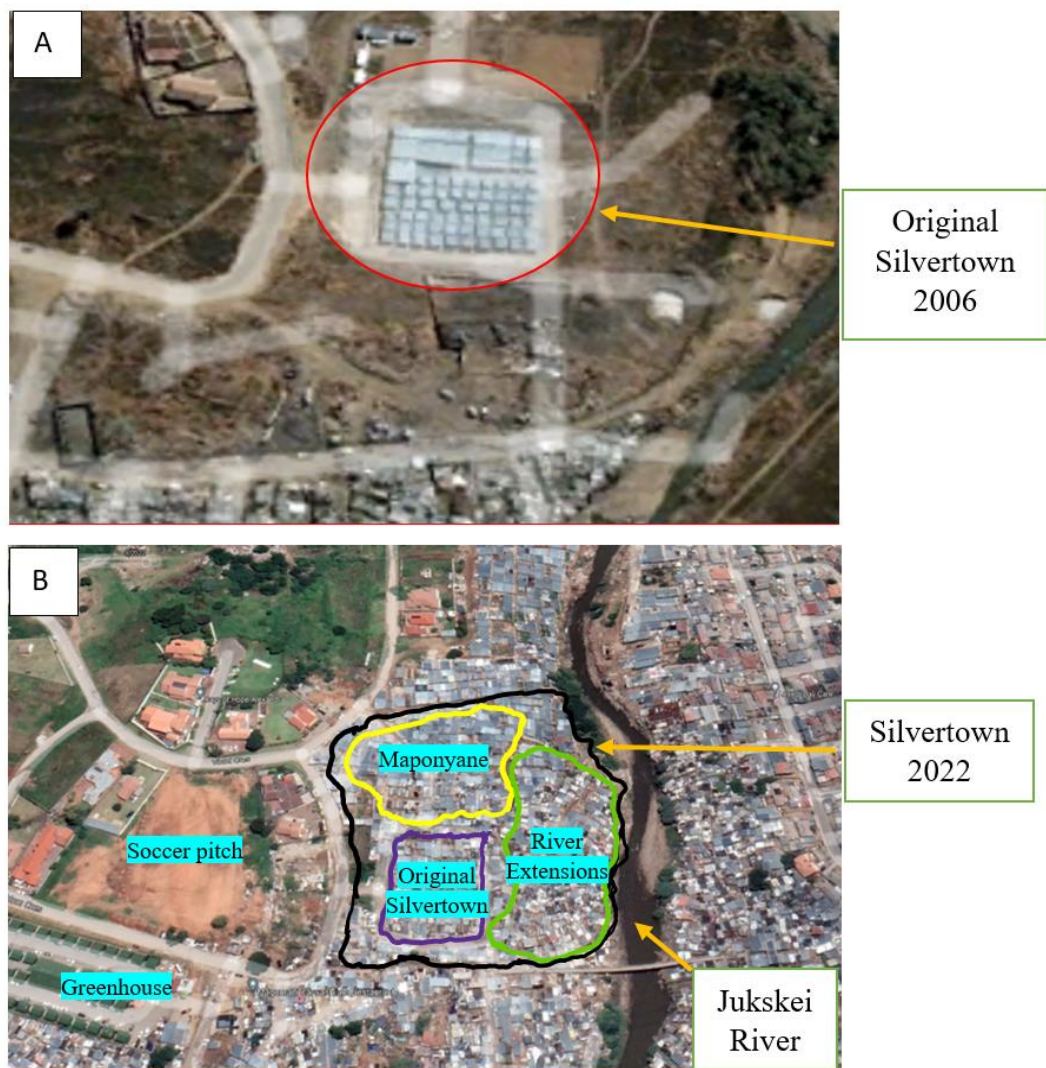
- Greenhouse
- Soccer pitch
- Silvertown area
- ERF 62
- ERF 51
- ERF 49-50
- Jukskei River

Figure 12: Image indicating the section in Silvertown and the extended infrastructures like the soccer pitch and the Greenhouse settlement.

(Google Maps n.d.)

Since 2006, the original members of Silvertown have yet to be taken out of Silvertown as promised. Over time this has led to the Silvertown settlement expanding, with an influx of people moving into Silvertown to find a place to stay. The arrival of these late settlers into Silvertown accelerated in 2017. The original members of Silvertown argue that they are the “legal” members of the place. The

Silvertown settlement originally expanded as some of the later settlers came to Silvertown because they were family members of the original members of Silvertown. These early settlers have, in turn, argued that some of the late settlers came to Silvertown illegally. The original members of Silvertown sold these informal settlers' accommodation stands. The boundaries of Silvertown were initially marked by the street poles at the edges of Silvertown, as seen in Figure 13 showing the Silvertown expansion over the years. Figure 13 (A) shows how Silvertown was less populated in 2006 compared to Figure 13 (B), which indicates the densely populated area of Silvertown in 2022. The poles are still there, but the influx and expansion have occurred well beyond these poles, with densification also happening within the area bounded by the poles. The expansion rate continued as the northern side of Silvertown (Maponyane) saw a land-grabbing occurrence that was claimed to have been politically influenced. Participant S said that a political party (the EFF) encouraged people on a national platform to take over unoccupied and build houses on it. In 2017, this northern side of Silvertown saw people starting to occupy the vacant land in what is now unofficially known as the Maponyane informal settlement, which is bounded in yellow in Figure 13 (B). When the URBWAT project started in 2019, the Maponyane section was far less dense than it is now. The other late Silvertown settlers have occupied space by renting from the original members of Silvertown. Silvertown is now an extensive section in Setswetla where all the expansions, like Maponyane and the River Extension, fall under it.



Key (legend)

- Original Silvertown 2006
- Silvertown 2022
- Maponyane
- River Extensions
- Original Silvertown
- Jukskei River

Figure 13: Silvertown expansion over the years: November 2006 (A) and September 2022 (B)

(Google Maps n.d.)

Similarly, an expansion has also occurred from the original Silvertown area towards the Jukskei River. This “illegal” expansion close to the river (across the whole of Setswetla and not just in Silvertown) has resulted in vulnerability during the flood seasons. As reported by Mvulane (2020), in November 2016, flash floods hit Setswetla and people’s houses were damaged, leaving many people living near the banks of the Jukskei River homeless. This led to the Gift of the Givers building a centre further up from the Silvertown intersection of Setswetla, known as the “Greenhouse” settlement. The Greenhouse settlement was a project between CoJ’s Department of Housing and the Gift of the Givers, which aimed to relocate people away from the Jukskei River banks (Mvulane, 2020). Compared with the type of houses in Setswetla, the accommodation at the Greenhouse settlement is considerably better. The setup of the Greenhouse settlement is that of a gated complex with a fence around it. The place is paved with houses adjacent to each other. The Greenhouse is divided into two streets that accommodate three rows of houses. The houses are made of corrugated iron and have cement floors. The Greenhouse also has a community hall used for various activities. For example, the URBWAT project team used the Greenhouse Hall to hold the design and feedback workshops. Even though the water access is through communal taps, the Greenhouse settlement has flushing communal toilets, unlike the other places around in Setswetla. Mvulane (2020) also reported that the execution of the Greenhouse settlement was allegedly corrupt. The claim was that the officials moved people to the Greenhouse settlement without complying with identifying that people were homeless from the flood disaster.

Despite everything, Silvertown still exists. The CoJ municipality has generally provided water and electricity. The same can be said for services like solid waste and blackwater (sewage) removal, which the municipality has organised to be collected during the week. The municipality does not provide housing; therefore, the people of Silvertown have had to build shacks from corrugated iron (in the beginning), although currently there is a good number of brick houses. Even though

housing is not provided, and people are expected to provide for themselves, this is perceived as achievable. The same cannot be said about the accessibility of sewerage services, particularly the situation concerning providing ways to dispose of greywater. Unfortunately, available space in the Silvertown settlement is congested and contested, with some residents asking for a space for children to play and others wanting the space to build (or extend) their homes. The fact that there is nowhere for residents to throw away their greywater, in Silvertown and other parts of Setswetla, it has been observed that children have been seen playing with dirty, disposed greywater which flows through the community. That is a concern for several reasons (but especially health reasons), which is why the URBWAT project was seen as vital.

4.5. Hierarchical system of how services are accessed

Just like many communities, there is a hierarchical system for access to services, even though the hierarchical system is not formal. The original members of Silvertown have more influence than the people who came into Silvertown later. This was clear from the beginning of the URBWAT project when the workshops took place. The community leaders from Silvertown accompanied the people and these community leaders were mainly the original members of the Silvertown section. Some original Silvertown members were present at the workshops and were more vocal in the sessions than the other members, who were a bit shy. Because these hierarchies were informal, they took a bit of time to be revealed. One of the Silvertown residents said that the original residents did not control everything. She mentioned that illegal electricity was one of those things that could not be controlled. However, regarding space to build, usually, newcomers must go through the original Silvertown residents to get permission to build. The exception to this was people who had chosen to build closer to the river. This is one of the reasons why these dwellings were “illegal” by other residents in Silvertown.

The hierarchical system also determines how a person gets access to services like water. In one example, a woman from the Maponyane section, which is just opposite Silvertown, wanted to access water from a tap in Silvertown. She had her washing basket, she greeted the people already washing at the tap, and politely asked who to speak to about accessing water. She was directed to one of the CLF members, who then told her she could not access water from that tap. The reason that she was given was that the people of Silvertown were the ones who had to spend money when taps were broken without help from anyone. The issue of “outside” people coming to use the taps has been a pressing one where several stories have circulated. Information gathered from unstructured interviews revealed that the issue was that some people from the Southern side of the stream in Silvertown (the original Silvertown area) did not want people from the Northern side (the “new” Maponyane section) using the tap and even went as far as placing locks on the taps to prevent unauthorised people from using the taps. A person from the Maponyane side of the stream said that the politics of the place meant that people who were the first settlers of Silvertown prevented latecomers from getting access to the water from the tap. To counter that opinion, someone from the Southern side of the stream in Silvertown (the original Silvertown settlement) said that when many people access the tap, some do not close it, and sometimes the tap gets broken. According to this Silvertown person, the taps were mainly cheap plastic and broke easily. As the people closest to the tap, were often the ones expected to fix the taps when they are broken. It was noted on multiple occasions when visiting Silvertown that these plastic taps would be broken, and this situation could go on for an extended period without being attended to.

Some community members have the power to see that access is provided in a particular way. Whether their power is directed at doing things correctly or not is a matter of some debate within the community. In some cases, the CLF is obviously wishing to bring order to the way things are done in Silvertown. In one of the unstructured interviews, it was stressed that in Silvertown people could usually do

as they wanted but this was possibly why there were concerns about lawlessness. Disposal and dumping are two cases where it is difficult to track people all the time. There was a case of a woman who, after she had finished cutting tree branches in Silvertown, wanted to dump them in the skip bin, but CLF member TS saw her doing that and told her to take branches out of the bin and dispose them on the ground on the other side of the road from Silvertown. The researcher spoke to CLF member TS to try and understand their logic. CLF member TS indicated that large rubbish materials were a problem because they filled the skip bin too quickly. Rubbish in the skip bins in Silvertown was only collected once a week on a Thursday. Given the high density of people, the skip bin can quickly become too full, leading to litter dropping onto the ground. The CLF members have all been in this area for quite some time, and therefore, they understand that this situation could attract rodents, flies, cockroaches, and other pests as well as spreading rubbish throughout the community if the wind blows.

A similar situation occurs with water disposal, as some community members feel they can dispose of water anywhere they feel. In other places around Silvertown, disposal is more sensibly managed. At the start of the study, the place where water disposal was most chaotic was at the entrance to Silvertown. Different materials had been seen disposed of or dumped at the entrance to Silvertown. After building CW1 in Phase 1, some people were disposing of their kitchen water directly into the CW through the inlet, and they washed off material from the dishes, like bits of food that became trapped in the inlet grid. Even before CW1 was built, when the builders were laying the foundations, one morning, the builders found faeces disposed in the construction site. The sense of wanting to keep things in order was also seen just after the completion of the building in Phase 1 when two community leaders said that they would make sure that the CWs were going to be taken care of. However, the data collection for the Phase 1 and Phase 2 construction (discussed later in this chapter) showed that more people felt comfortable using the CWs for disposal, but there was less action from the residents to keep the CWs clean.

There are difference forms that services get accessed in Silvertown as discussed above. The next two sections provide more information on the services that are provided and those that are not provided in Silvertown.

4.6. Services provided in Silvertown.

4.6.1. Water

Water is a service that is officially provided by the municipality, and just like any other service that is provided in an informal settlement, it is not received by everyone. The standard available water infrastructure in Silvertown is in the form of public communal taps. In the data collected through unstructured interviews, it has found a small number of taps were originally installed in Silvertown just after the arrival of the people. Over the years, with the unregulated acquisition of land, more tap connections have been made. The taps in Silvertown are situated in different spots across the settlement. The taps provided by the municipality are found close to the access roads.

However, community residents have also added many “illegal” connections to these communal taps. This has included adding additional community taps, connections directly into people’s dwellings, connections directly to appliances that use water (e.g., washing machines), and even connections to toilet systems to create “flush” toilets. Some of these connections have been sanctioned by the CLF members whereas other connections have been made despite the objections of CLF members. These connections are usually made by people who can afford to pay someone to make the connection, or by people who (believe they) have the requisite plumbing skills. Due to the large number of additional connections to service a very densely populated community, there are frequently times where water pressure decreases significantly or even stops altogether.

Most of the taps have plastic tap heads. The reason for the plastic heads mentioned by community residents was that there is a tendency for the copper tap heads to be stolen by people because they have a resale value. However, the problem with plastic taps is that they are not durable enough to last long and break easily and frequently. On several occasions, when visiting Silvertown there were broken taps with water gushing out or, conversely, taps with broken tap heads which meant that people could not get water out of the tap. This situation would often continue for a few days unless someone in the community found a way to fix the tap or successfully reported the incident to the municipality through a CLF member. In terms of reporting, just like any other service in Silvertown, the CLF members usually report the incidents to the relevant municipal authority.

Related to the issue of leaking pipes is that some people leave the taps running. There were numerous occasions where the researcher would find the tap left running and unattended. Sometimes this was because the tap had been opened when the water pressure was low (or non-existent), with water only trickling out. At some later point, the water pressure would return, but the community member would be absent, either because they had lost patience, or they had started to do another task. Since people in Silvertown do not pay for the water, they are using, they were also unlikely to responsible for the misuse of water resources in this way. Some arguments have been made that adequately pricing water and water-related services can encourage people to waste less, pollute less, or invest more in water-related infrastructure, and value watershed services more (Dhawan 2017). However, in this community there was a great deal of resistance towards paying for what most people considered to be a basic human right. This situation is complicated by the fact that national legislation determines that a certain minimum amount of water is provided free to all citizens. Since there are no water meters, no accurate measures of how many people or households are using the water, and no mechanisms for collecting fees for water use, people see water as a free resource when it is available.

Before the CWs' construction, taps were broken at the chosen sites for building of the CW1 and CW2, as seen in Figure 14. The poor quality of the plastic taps was seen first-hand at both CW1 and CW2, as the taps were either leaky because they were not able to close tightly or because the tap head had been removed. However, while building the CWs, the taps were fixed or replaced as part of additional site maintenance by the URBWAT project team. Even though the taps were fixed or replaced, community members still requested that copper taps should be fitted because they are durable. The copper taps are more expensive, and in communities like Silvertown, such configurations are unlikely to prove sustainable. Just like any community with public infrastructure, it is difficult to guard this infrastructure all the time, but especially at night when it could be hard to see acts of vandalism. It is possible that Silvertown could be slightly different, being a relatively contained space, with service infrastructure and houses being close to each other, and vandalism might be easily detected. Based on conversations with residents, it is important to note that these taps are viewed as public property, and a few people have attempted to safeguarded them by putting locks on them as seen in Figure 15 lock tap. Nevertheless, there is still a higher chance that a copper tap head will be stolen than a plastic tap because it has a re-sale value or because they could use it inside their own dwelling if they have made their own connection.



Figure 14: A broken tap at the site of CW1 before building.

Photo: Motshwaedi Sepeng (researcher)



Figure 15: A communal tap with a lock placed around the tap.

Photo: Motshwaedi Sepeng (researcher)

Deliberate vandalism also plays a role in the taps being broken. There have been cases where people have played a part in deliberately breaking the taps. Stories of people breaking the taps because they do not want them near their houses have circulated. A good example is that after the CWs were built in 2020, a person built a house close to CW1. Shortly after that, CW1 was vandalised, whereby cement was poured into the CW1 inlet, and the tap was broken. There have also been suggestions that it is children who have been involved in breaking the taps when they play with them.

There are frequent water shortages in Silvertown for a variety of reasons. One of the reasons is that water reaches Silvertown through a single pipe, and when people in lower lying areas use water, those in higher lying areas struggle with water pressure in their taps. The people in lower lying areas are the also those who did not have taps installed by CoJ. Of course, this is not the only problem, as the structured interviews in Phase 2 (2021) found that the additional household connections also contributed to the loss in water pressure. When the URBWAT project started in 2020, there were fewer noticeable problems with water pressure in the taps in Silvertown. This resulted in the URBWAT project team considering extending the CWs project by building CW3 in the southern part of Silvertown. However, after the CW3 structure was built, CW3 did not function because of poor water pressure.

The water pressure issue has always been an on-and-off problem in Silvertown. In Phase 1, the tap at CW2 was used because there was less water pressure at CW1. The researcher also observed people going to different sites or taps within Silvertown to access water when water pressure was low in one of the taps. According to the residents in Silvertown, the water pressure problem has been getting worse because more people are trying to connect water to their own

dwellings. This has reduced the supply to the communal taps in higher lying areas. This has also not been helped by people leaving the taps open while washing.

4.6.2. Electricity

Electricity is a service that the municipality has provides to the people in Silvertown through a variety of means including prepaid meter boxes. The municipality has put the necessary external infrastructure in place to facilitate provision through electrical poles, above-ground wires, and high voltage cables. At the entrance into Silvertown (locally called the “gate”), there is a vegetable garden to the right of the entrance where you can find the main Silvertown electricity transformer. Electricity is supposedly channelled to the people who stay in Silvertown. In the unstructured interviews problems with electricity provision are often attributed to the “backroom culture” implemented by the residents. A “backroom” is a bachelor or studio room attached to a main dwelling. These “backrooms” are then rented out by the “landlords” to people looking for cheap accommodation. This culture is associated with many townships (and not only informal settlements) in South Africa as there is an increased need for affordable housing close to workplaces in urban areas. A second reason for “backrooms” is that they can provide an income to people in the main dwelling. The “backroom culture” is highly prevalent in Silvertown.

From the unstructured interviews it was evident that in Silvertown it was quite common for these “backrooms” not to be supplied with electricity. In some cases, those offered space to erect their shacks or “backrooms” are willing to live without electricity. In Silvertown, it is usually the case that those people who provided the space to build also have electricity in their homes and it is likely that they would make an offer to connect the new members for certain fee. There are people within the Silvertown community who specialise in making these “illegal” connections, either connecting directly from the electricity poles or from connections made from the “landlords” dwelling.



Figure 16: Illegal electricity connections in Silvertown

Photo: Motshwaedi Sepeng (researcher)

During ethnographic observations it was evident that there were regular “illegal” electricity connections being made in the area, and these connections would often cross over the greywater infrastructure as shown in Figure 16. In Phase 1, a water pipe at the site where there CW2 was situated had to be fixed to stop a leak. Underneath CW2, “illegal” electrical cables were found buried in the ground. After building and extending CW2 in Phase 2, a number of electricity cables which crossed from Silvertown into the Maponyane section were found. These wires had

to be redirected to go over the newly built wall (which was built to prevent flooding adjacent to CW2) connected to CW2. The wall has, therefore, prevented the electricity cable from touching the water. In unstructured interviews, numerous residents claimed that these illegal connections contributed to power outages in Silvertown. During ethnographic observations there were numerous occasions when power cuts were experienced. In some instances, the power cuts were due to load-shedding, while on other occasions, it had resulted from people making “illegal” connections for their electricity. This happened either due to overloading of the transformers that have been installed or due to “tripping” the electricity system while the connections are being made.

Residents were asked during the unstructured interviews whether they paid for their electricity. Some people did indicate that they did pay for electricity, but for the majority of residents it was not clear whether they paid or not. Not having electricity services is perceived by most residents as problematic because it “forces” them into making illegal connections. Considering that the original residents of Silvertown were provided with electricity, and the late comers were not, this has resulted in a high degree of inequality in service provision. The areas in central Silvertown therefore have some legal connections while the area directly to the north of Silvertown (i.e., Maponyane) are all connected to electricity “illegally”. These areas do not have electricity services because the municipality had not anticipated that people would be staying there. In Silvertown, just like the other sections of Setswetla, the people who were not originally connected to the electricity grid have found ways of connecting straight from the poles and transformers.

In one of the ethnographic observations of Silvertown just after CW1 had been built, a power cut was observed because of the illegal connections in Silvertown. On this day, electricity cables were found on the ground. When enquiries were made as to what had happened, it was discovered that this situation had occurred because of an

illegal connection. People were visibly angry. One of the CLF members was also angry at the situation and said, “We cannot let a few people spoil the rest of us” (CLF member TS). The weekly refuse collection services and toilet draining services also get disrupted when cables hang too low. On the day of this observation, the waste removal truck could not enter Silvertown to remove waste from the skip bin because the cables were hanging too low for the waste removal truck to enter.

The electricity service interruptions are not exclusive to Silvertown. Loadshedding is a phenomenon that interrupts the electricity service in South Africa at regular intervals. Unlike other, wealthier, areas in the city, Silvertown residents rarely have access to generators or solar panels that would help them address electricity shortages during load shedding. The loadshedding schedule is well known and can also be tracked using a mobile phone application (one of the common applications is known as “EskomSePush”) or found online. This means that residents can easily distinguish between loadshedding and other types of electricity outages (such as damage to electricity infrastructure). In Silvertown, there are also electricity interruptions when the cables are stolen or the electricity trips because it is overloaded. When there are electricity service interruptions, the alternatives are gas, paraffin, and candles. This significantly increases the risk of fires if not carefully attended. When the power is cut for reasons other than loadshedding, people must report the incident to one of the CLF members for assistance to restore the power. When there is a power outage, one of the Silvertown CLF members reports the matter to one of the Setswetla CLF members who oversees infrastructure and then directly reports the incident to City Power who is the municipality organisation that oversees electricity provision in Setswetla. During unstructured interviews it was argued that City Power prefers when the requests are directed through one person, as they are likely to ignore calls from the informal settlement unless it comes from their contact person.

During the ethnographic observations it was evident that City Power usually takes quite a long time (several days to several weeks) to attend to electricity outage matters, irrespective of the cause. In one instance though, when it was clear that illegal connections had caused the power outage as the cables were hanging loose, the next day, the City Power workers were on site to attend to the matter and restore electricity. The act of illegal connections in places like Silvertown is perceived as so normal that people do not even attempt to hide the work when such actions happen. There was one occasion when City Power installed a new transformer in the wake of power cuts because of the additional electricity demand. Almost as soon as the new transformer was installed, people started to add “illegal” connections to the transformer.

4.6.3. Solid waste removal service

Skip bins are the only infrastructure provided to contain the solid waste that the people of Silvertown generate. Setswetla does not have a system where people have personal dustbins that are collected by the municipality outside their homes. Instead, a single big skip bin is placed at the entrance to Setswetla next to a set of portable toilets. The skip bins across Setswetla are collected on different days by hired companies. In Silvertown, solid waste is collected by Pikitup waste management. Pikitup hires contractors to do the collection. During unstructured interviews it was indicated that the skip bin in Silvertown was collected once a week on a Thursday. The skip bin is taken away for disposal at an external site and returned on the same day. Since Silvertown is made up of many families, more than one skip bin is needed if collection only takes place once per week because during ethnographic observations the skip bin was frequently found to be full or even overflowing.

All sorts of things get thrown into the skip bins. A skip bin is essentially a dumping site in terms of its usage, as it is where anybody throws their rubbish. CLF member

TS and other Silvertown community members confirmed the collection schedule. However, it was noted that the collection of the skip bins is often delayed, and in these instances, the skip bins are highly likely to overflow. One frequent incident that was pointed out is when there is a municipality strike, and the collection is not done. In such instances, the skip bin would start to smell because it is exposed to the sun. The Silvertown community have sometimes resorted to burning the rubbish in the bin to reduce the volume of waste in the skip bin and to reduce the smell.

When a skip bin gets collected, it is not replaced by another bin immediately. When the skip bin is taken away by the bin collectors to be emptied, people often must dispose of their solid waste on the ground. There have also been instances where people have resorted to burning solid waste materials when the skip bin is absent. During unstructured interviews it was discovered that the burning of waste also occurred to stop litter from flying everywhere when it is windy. The burning also helps in reducing the smell and stops the attraction of rodents and flies. There was an occasion when there was an argument between two women about their solid waste disposal. One woman dumped her plastic waste where the skip bin had originally been placed, but at that point it had been taken away for the waste to be emptied elsewhere. This made the other woman angry, and she argued that the other woman should wait for the skip bin to be returned instead of placing waste loosely on the ground. The counterargument for the woman who dumped the waste was that she was going somewhere and did not want to leave the rubbish in her house because it would smell bad. Dumping solid waste when the skip bin has been taken away creates a problem because when the skip bin is returned, there is waste on the ground that the bin collectors will not pick up. It is left to the community residents to put rubbish which is on the ground into the skip bins.

There are also waste collectors who come from outside Silvertown to collect waste material from the skip bin. These people physically go into the skip bin and extract

plastic, glass, and metal materials that may have some financial value. These people would generally be men between the age range of 18 and 40. There is no specific time frame when these people would come, although they are more likely to come close to the day of collection when the skip bin is full.



Figure 17: Skip bin collection.

Photo: Motshwaedi Sepeng (researcher)

Solid waste that residents dispose into the skip bin to be collected by truck, as seen in Figure 17, is aligned with the Western service delivery concept. The large numbers of individual households and the lack of available space in Silvertown makes it impossible to collect solid waste from small individual bins. Furthermore, the configuration of shacks built on one on top of another makes it difficult for separate bins to be placed outside each community member's dwelling. But more importantly, Silvertown residents do not pay municipal taxes, and therefore, it could be argued that there are insufficient financial resources to implement a door-to-door collection system. Silvertown has many households that depend on this single skip bin. During unstructured interviews it also became apparent that the dwellings surrounding Silvertown (e.g., Maponyane) were also using this single skip bin because they did not have a skip bin of their own. The main issue here, as seen in Figure 18, is that the bin gets full quite quickly.



Figure 18: Skip bin full to the brim in Silvertown

Photo: Motshwaedi Sepeng (researcher)

On the other hand, it is considered difficult for residents staying close to the Jukskei River to dump their waste into the skip bin at the entrance of Silvertown. These people live relatively far from the entrance and are more likely to throw their waste directly into the river or onto the banks of the river which is usually taken away with stormwater. During ethnographic observations this behaviour was frequently observed. All sorts of objects and materials get thrown into the river. There was even one instance where people were observed throwing a fridge into the river. Where solid waste accumulates on the ground it may eventually be taken away if a formal complaint (e.g., bad smells or unhygienic conditions) is made to the municipality. This was observed when a small truck loaded the refuse onto a truck to take away for disposal.

Concerning the CWs, the overburden on the solid waste system (i.e. this single skip bin), also has knock-on effects. CW1 is built adjacent to the skip bin and some of the litter from overflowing skip bins can pollute the CWs.

4.6.4. Blackwater sanitation services

Silvertown residents are provided with a limited number of chemical portable toilets as the blackwater sanitation infrastructure available to facilitate the disposal of human faeces and urine. These toilets are only available to some people, like other services such access water, solid waste removal, and electricity. This means that residents only have access to a specific toilet in Silvertown unless someone grants them access to another toilet. The community has divided the toilets amongst community members so that clusters will share a single toilet. Most of the toilets are locked after use for security and hygiene reasons. The number of people who share each toilet is highly variable. According to CLF member (BR), the toilets are allocated according to the number of people the municipality had recorded. Over the years, as people started coming into Silvertown this put additional pressure on these services. As a result, the limited number of chemical toilets has reached such

a pressure point that people have taken it upon themselves to organise sharing rights and locks. However, this is not practical, especially for women and children at night. According to one of the unstructured interviews, it is not considered safe to go to the chemical toilets in Silvertown at night. The informant said she could not even let her daughter go to the toilet by herself during the day because of safety concerns. Due to these safety and security concerns, it is quite common for people to have a bucket (called a “chimba” or “tshimba” which is possibly derived from a “chamber pot”) in their dwellings which people use for their toilet needs overnight. This bucket is then emptied into a chemical toilet during the day and washed at one of the taps. This washing and rinsing process provides an opportunity for faecal matter to enter the greywater disposal systems.

When the portable toilets are drained or cleaned, it is not possible for people to use the toilet at these times and there are few (if any) alternatives since other toilets have locks on the doors for safety and privacy. People are reluctant to let others use their toilets because they must clean them themselves. However, the draining of toilets generally does not take that long. After the toilet draining has finished, it often drips and leaves a mess on the toilet seats and floor. Therefore, the toilets need to be cleaned before they can be used again. After the draining of the chemical toilets, women would often be seen with buckets and mops trying to clean the toilets. On some occasions a hire company was present to do this cleaning. In unstructured interviews it was established that the cleaning company was part of the draining company. However, residents often found themselves cleaning the toilets as it was felt that the cleaning service did not clean to their satisfaction.



Figure 19: A sequence of toilets drained in Silvertown.

Photo: Motshwaedi Sepeng (researcher)

The chemical toilets get drained three times a week on Mondays, Wednesdays, and Fridays, as seen in Figure 19. Since the inception of Silvertown there have been two separate contractors that have been hired for the draining: Supreme Sanitation and Sunshine/Sanitech Toilet Hire (the current contractor). In September 2022, the Supreme Sanitation contract was terminated because of poor service delivery and a new company, Sunshine/Sanitech Toilet Hire, was hired to deliver the draining services. A community leader PD indicated that residents of Silvertown and

Setswetla had regularly complained about their poor service from, Supreme Sanitation which replaced Sunshine/Sanitech (see Figure 20 showing the placement of the chemical toilets in Silvertown).



Figure 20: Placement of the chemical toilets in Silvertown.

Photo: Motshwaedi Sepeng (researcher)

Unlike water access in individual residents' homes, blackwater sanitation is more complicated; therefore, there are very few people who have toilets in their homes in Silvertown compared to those who have water in their homes. There are some people, though, who do have toilets in their homes. Some people have hired their own portable toilets, while some have dug their own French drain system. There are indications in other parts of Setswetla that some people have made "illegal" connections to existing sewers and others have connected directly into stormwater

drains. The reality is that from the start of data collection to the present moment, only a few people have toilets in their homes in Silvertown. The people living close to the Jukskei River have no formal access to sanitation, leading them to use informal approaches such as building “out-houses” with drains that lead directly into the river, resorting to open defecation, or using a “flying toilet” (defecating into a plastic bag, tying a knot in the bag, and then throwing the plastic bag as far into the river as possible). There is a good chance that a great deal of this blackwater ends up in the river (either directly, or through groundwater).

4.7. Services not provided by the municipality for Silvertown.

Informal settlements often need additional infrastructure and essential services that are not provided by the municipality. According to (Habitat 2015) informal settlements are regions needing more secure land tenure and dwellings and adequate access to essential urban infrastructure. Undoubtedly, other services and infrastructure need to be provided depending on the region’s rules. Silvertown has the same problem. Based on observations, additional services are required, especially with regards to greywater sanitation.

4.7.1. Housing

The municipality does not provide housing in Silvertown, and residents are the ones who build this infrastructure. When the original residents moved to Silvertown, they had to erect their own shacks and dwellings to accommodate themselves. Currently, the buildings in Silvertown are a mix of shacks and concrete-brick houses. In the beginning, when the early settlers of Silvertown came to the area, their shelters were mainly corrugated iron shacks. Based on what one community leader TS said, the place therefore became known as Silvertown. Over the years, as people got settled and, in some cases, started to make money, some people started building their houses out of concrete bricks once their standard of living went up (Figure 21).

There has also been a great deal of development with the increases in population size in Silvertown.



Figure 21: Illustration of the combination of the erected shacks in Silvertown and the brick houses that have been built.

Photo: Motshwaedi Sepeng (researcher)

When people first came to the area and wanted immediate shelter, they tended to build shacks from “found” materials such as corrugated iron sheeting as they were more accessible and cheaper to construct. The longer that a person stays in Silvertown, the more likely it is that the construction materials will become more formalised. For example, in the river extension area of Silvertown materials used for when we first worked in the area in 2019 consisted of various “found” materials such as plastic sheeting, wooden boards, election posters, and even stones and mud.

As the research project has progressed, the materials for these dwellings have transitioned through various stages from corrugated iron sheeting to brick dwellings. Of course, this has not all happened at the same rate, so it is quite common to find dwellings in various states of transition in the same area.

In Silvertown, the situation is now different, where houses are mostly made of brick and mortar, especially near the entrance to the Silvertown settlement. It is quite typical in Silvertown for dwellings to pass between family members. If a dwelling owner leaves it is likely that the dwelling will be occupied by another family member. Similarly, if the family grows (e.g. a parent, child, or other family member) joins the family unit then the family may try to increase the size of the dwelling (e.g. by building an extra room). Similarly, it is common for residents to build an extra room to try and create an income stream. This type of rental space is highly transitory with “tenants” changing frequently as they try and look for work or seek temporary shelter between changes in family or relationship situations. With the early settlers of Silvertown, the living arrangements are usually far more stable. These residents tend to stay in the same dwelling, but usually engage in upgrades (e.g. changing the materials used to construct their dwelling from corrugated iron to bricks; adding a room to accommodate a family member, adding a window to a dwelling, or making a water connection) when money is available or as investment to try and generate rental income.

There is a strong culture of space being in high demand to build houses. When the CW1 was built, a builder said that he wished that the space for CW1 could have been used to build his house. He said that if he could talk to the research team, he could build a house next to CW1. A few of months after CW1 Phase 1 was built, a person erected a shack between CW1 and the next house. This confirmed that space for building houses was considered valuable. Similarly, when CW2 was being extended for Phase 2, extensive negotiations had to take place between the research

project team and a resident who claimed that the land was his and that he was planning on extending his dwelling. Even after dimensions and placement of the extensions had been agreed, the resident continued to build his dwelling extension on the location of the CW2 extension. This forced the CW building team to adjust CW placement and dimensions on an ad hoc basis. Since there are no formal written contracts in place to determine land ownership, these negotiations must take place on a person-to-person basis, and often involve several individuals who may have claims to the same land. It appears that the original settlers, if supported by the Silvertown CLF, usually have the final say, although that decision can often be contested if money has been exchanged.

4.7.2. Safety and security

Several safety threats are found in informal settlements, including crime, forced evictions, and natural and man-made disasters. There have been several people who have complained that Silvertown is not a safe place. When the research team was new to Silvertown, they were often warned and told that they needed to adopt a “buddy system” approach when walking around Silvertown or Setswetla as a whole. During ethnographic observations no criminal activity or physical harm was witnessed. However, there were often stories about cases of rape, especially at night, theft, physical battery, and assault. On one occasion, during observations the researcher witnessed an argument where a man had been accused of wanting to rape another person. The issue of rape was raised numerous times in unstructured interviews, especially by women worrying about themselves and their children.

Informal settlements are perceived as dangerous places with high rates of crime. It is even more dangerous for strangers since strangers might look different from the norm and, therefore, could create anxiety among the residents. In the beginning, when the researcher was new to Setswetla, he would sometimes try to walk around alone. The Silvertown CLF encouraged him to ask people to accompany him since

it was considered dangerous to walk alone of the residents do not know him. It can be intimidating as some of the things might not look normal. On one occasion the researcher witnessed one of the builders who went to the shop just outside Silvertown “gate” and bumped into someone who had always had a grudge against him. They started fighting, and people stood and watched without breaking the fight until one of the other builders was alerted. This other builder stopped what he was doing and went to separate the two people who were fighting. This kind of behaviour is common in Silvertown. That was not the only fighting incident that was witnessed during the ethnographic observations. There was another incident when two women from the same household were fighting. Apparently, it was normal for these two women to fight. A similar incident was witnessed when two young women from different households fought over old grudges. The residents left them to fight, and once they were finished, one of people who was fighting went to the police station to open a case. A friend of the other woman advised her to also go to the police station to open a case so that the two cases would cancel each other out.

Two other incidents bear mentioning. In the first incident which occurred during the formal observational evaluations of Phase 2, the observers noticed that a strange man (not a resident) was hanging out near CW2. The observers felt uncomfortable and spoke to the residents to see if they knew anything about this man. They were told that this man had been seen a few times over the preceding days exposing himself to residents. At this point, the observers stopped their observations and only returned when this man had been forcibly removed from Silvertown by residents. In the second incident, which happened after formal data collection had been completed, one of the key informants, who had also worked as a type of “project manager” for the Phase 2 construction, was murdered outside his dwelling at about 10 pm one evening. The other residents heard a single gunshot but were scared to come out of their dwellings for several minutes in reduce their chances of being

involved in the incident. Stories such as these were frequently recalled during both formal and unstructured interviews.

There are some security measures at some of the shops in the Silvertown area. There were cameras at the “Moosa spaza shop” located at the Silvertown entrance. The spaza shop is a well-known food store that offers residents necessities and is typical of townships in South Africa (Basardien et al. 2014). A resident of Silvertown indicated that the reason for the cameras was that there had been several break-ins at the spaza shop. The spaza shop is owned by a foreign national who has a good relationship with the community. In Silvertown there was no active policing or community night watches. However, some older people who form the physical nucleus of Silvertown have created their own “gated community” as seen in Figure 22. This has become common in Silvertown, with some people near the CW3 site replicating the fencing around their houses. As dwellings become more formalised it is common to find security gates on doors and burglar bars on windows. There is a thriving business in Silvertown that specialises in constructing security solutions for people’s dwellings.

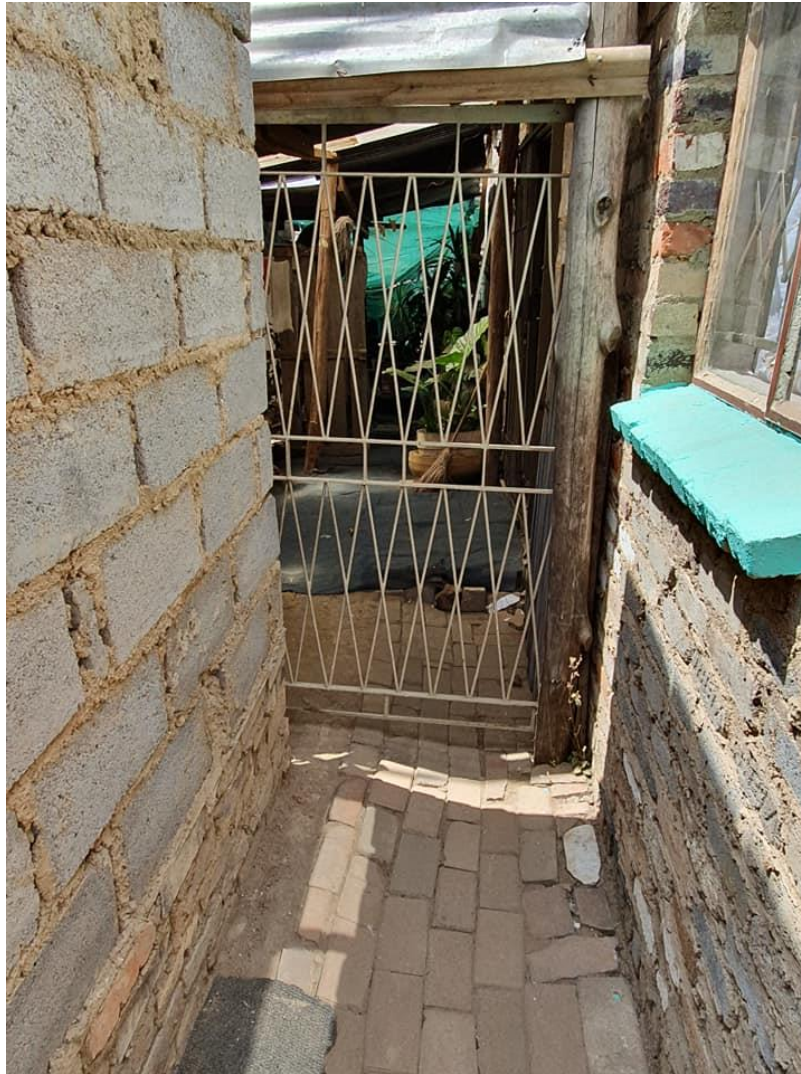


Figure 22: People putting gates around their homes in Silvertown.

Photo: Motshwaedi Sepeng (researcher)

4.7.3. Greywater services

The most important service for this PhD study that is not present in Silvertown is the greywater collection, transportation, and/or treatment services. The greywater services in Silvertown, just like in many informal settlements, are not orthodox. In some instances, the residents may be fortunate to have to access these services outside their homes. In the case of Silvertown there are no formal greywater services at all. While there are limited services provided for blackwater in the form

of chemical toilets, the greywater services are ad hoc and entirely developed by the community residents. The inadequacy of greywater collection and removal services also has an impact on the water quality of the adjacent Jukskei River, with the greywater regularly flowing into the river (Fitchett 2017).

The disposal setup in Silvertown was like the setup in other parts of Setswetla. The only difference was that in Silvertown, unlike in the other sections of Setswetla, there was some physical space around where the taps were situated. This was one of the reasons that the Silvertown section was chosen for building the CWs. Before the CWs were built, greywater disposal depended heavily on the situation around each tap. Different tap sites had different manners of disposal. The site where the current CW1 is situated had a low concrete platform installed by the municipality around the base of the tap with a small drain in the concrete platform for water disposal which flowed into a makeshift gully. The platform was a low square-shaped platforms less than 2m² in area. People would place their water containers on the platform and do their washing at this location. After they had finished washing, they would then empty the washing water either into the drain (if the container was heavy) or directly into the makeshift gully if the container was lighter or if the platform was being used by someone else. This gully was in a T-shape, with water coming from a stormwater drain forming a T where the greywater came from the tap running towards the Maponyane section. This gully was a trench excavated by Silvertown residents which, over time, got more larger as people disposed of their greywater there.

The site where CW2 is now built was like CW1, with one difference. The tap next to the CW2 site was less developed than the tap next to the CW1 site. There was only a tap, and a few bricks placed on a small, low piece of concrete that acted as a platform to elevate containers when people came to use the tap. This setup did not have a drain to support disposal like at the CW1 site. Therefore, this meant that

people had to dispose of the water into the same makeshift gully by lifting their containers before emptying them, regardless of the weight of the container. For this reason, people would often need assistance to lift heavy containers for emptying. This makeshift gully at the site of CW2 was the same gully that was formed at the CW1 site. At the CW1 site, when people were washing with larger containers, they could dispose of them into the drain as well as directly into the makeshift gully, and when people came with smaller buckets, they could dispose of these into the makeshift gully. In contrast, the makeshift gully next to the CW2 site was the primary point of disposal for all containers.

Before the CWs were built, most people came to the space where CW1 was built to dispose of their greywater into the makeshift gully. The space where CW2 was built was also used frequently but less frequently than the CW1 space. While there were other open spaces in different sections within Silvertown, some people disposed of their house-cleaning greywater directly outside their homes and, if needed, rinsed their buckets at their closest tap and disposed this water directly at this site. In such situations, they would choose this manner of disposal rather than going to the tap (where there were makeshift gullies for disposal). This was especially the case for those Silvertown residents who considered it long way to walk to the tap at the entrance to Silvertown CW1 or CW2 to dispose of their greywater.

4.7.3.1 Gullies

Water disposal outside people's homes was common, as seen in Figure 23. Regular disposal spots would sometimes develop into gullies with continual use as seen in (Figure 23 A). In other areas of Setswetla (but not in Silvertown), some of these gullies have been formalised by residents either by creating concrete/cement gullies or makeshift pipes, as illustrated in (Figure 24 A). Similar makeshift gullies were present in Silvertown but have yet to be formalised with cement/concrete.



Figure 23: Open spaces for greywater disposal

Photo: Motshwaedi Sepeng (researcher)

A good example is the big makeshift gully in (Figure 24 B). This makeshift gully was partly created by the runoff of wastewater and stormwater from the direction of Gousblom Crescent. The closest thing to having a well-built gully in Silvertown is the New Stand area adjacent to Silvertown. This area has an open access “road” from Gousblom Crescent heading to the pedestrian bridge, where a concrete gully was constructed feeding from the tap while the study period.



Figure 24: Developed and paved gully in Setswetla (A). A gully that has turned into a bigger stream overtime in Silvertown (B).

Photo: Motshwaedi Sepeng (researcher)

4.7.3.2. Drains

Ad hoc drains are more common than makeshift gullies for greywater disposal in some areas of Silvertown. These ad hoc drains are usually situated close to the communal taps as seen in Figure 25 circled in blue. Even though there were drains associated with the taps, there were instances whereby people were disposing of their water directly into the gullies. Positioning the taps and the drains is strategic for easy disposal after people have finished accessing water. It should be noted that the length of the drains was usually very short (i.e., usually no longer than one metre). The exception to this length was the drain adjacent to CW3. In this instance, the “drain” started at a tap about five metres before CW3 and ended about one metre after CW3. The drain used to extend approximately five metres after CW3 to another tap, but this tap was dismantled by the person living in a dwelling next to this tap because their dwelling was constantly inundated with wastewater disposed

at this site at this point the land flattened out at water accumulated around the site of this tap. These drains therefore cannot be considered as equivalent to a piped sewer system. Nevertheless, from unstructured interviews residents seemed to favour drains because they said that they would prefer a system that would make greywater disappear without being visible.



Figure 25: Drains adjacent to a communal tap.

Photo: Motshwaedi Sepeng (researcher)

4.7.3.3. Indoor greywater disposal facilities

A limited number of people already appeared to have a greywater disposal facility within their dwelling in Silvertown. Some people have installed a limited piped system in their houses. These piped systems are connected to piped water systems, and sometimes even to toilets, sinks, and basins in their houses. It is not always easy to establish where these piped indoor disposal facilities transported the greywater. In one unstructured interview it was possible to determine that a washing machine with a pipe running into the makeshift gully was one of the appliances that people

use to dispose of greywater from their houses. In some instances, the pipes appear to lead to French-drains that have also been installed with their indoor blackwater systems. A French drain is a drainage system that collects water runoff from road pavement. It functions by channelling the water into slotted pipes that are buried below. The collected water is then filtered via coarse aggregate and geotextile materials. (Nam et al. 2014). In other instances, the pipes appear to lead to the primary makeshift gully. When constructing CW3 several pipes were discovered leading to the drain which flowed under the CW3 site. Since some of these pipes may have been installed many years ago and residents may have changed numerous times, residents were not always aware where their greywater ended up.

After CW2 was built in Phase 1, one resident from Silvertown asked that since the research team was fixing the tap at CW2, they would also like to fix the pipeline from their dwelling because fixing the leaking pipe from her dwelling would enable her to use her washing machine. All these indoor disposal facilities are channelled to the disposal points closest to their houses, which eventually take the water to the river.

4.7.3.4. Satisfaction with greywater disposal methods

During informal and structured interviews residents were asked about their satisfaction with the existing greywater disposal methods. The general feeling was that the manner of disposal did not matter so long as there was somewhere to dispose of the greywater. One person pointed out that before the CWs were built, they followed what other people in Silvertown did without much thought about whether it was good or bad. This person went on to say that since they were new people to Silvertown, they had no complaints about the manner of disposal as this was the only method that they knew. A minority of people indicated that they were content with the existing methods of greywater disposal. However, most people suggested that the manner of greywater disposal they had before the CWs were

installed needed to be improved. There were five main reasons why they did not like the way they disposed of greywater. First, there was a concern that the greywater people were disposing of would sometimes collect at one spot and remain there for a long time. This problem was associated with children playing with that dirty water and this raised the risk of contracting waterborne illnesses. Second, the drains would often get blocked and then greywater would overflow and flow through the community. Third, after disposal residents did not want the greywater to be visible. They greywater was recognised as being dirty and unhealthy and therefore needed to be removed from sight. Fourth, greywater disposal would make that area muddy and difficult to pass without getting their feet wet or dirty. Fifth, greywater would give off an unpleasant smell. The unpleasant smell was also associated with dirty, unhealthy water.

4.8.4 Space and pathways

The available open space in Silvertown is generally on the boundaries of the settlement. Where there are spaces between dwellings, these spaces are used primarily as pathways to have access to the houses since in most parts of Silvertown these spaces are so tight as seen in Figure 26. Rapid population increases have contributed to every space being taken for building with careful planning being required to leave spaces for people to access entrances to their dwellings. In some instances, people even must change the entrance to their dwelling to open into an available space.

There is space in some sections of Silvertown, but the original “settlers” usually have claimed ownership. These are either held by the “owners” to sell or build developments that will benefit them by providing rent. Two other spaces were not used for accommodation but were used as vegetable garden spaces. The vegetable garden spaces are situated on either side of the entrance to Silvertown, although

there are some residents of Silvertown that think that these spaces would be ideal for building houses. The vegetable garden on the South side of the entrance has an electricity transformer, so building homes in this space would be challenging. The other vegetable garden on the North side of the entrance is larger and could accommodate several dwellings if it was to be developed for this purpose. However, the “owner” of this land is a CLF member and has earmarked this land for a vegetable garden to help support residents who struggle with access to food.



Figure 26: Tight space between the houses in Silvertown.

Photo: Motshwaedi Sepeng (researcher)

There is a single “road” which runs from the Silvertown entrance to the south of Silvertown around the original central core. This “road” allows residents access for their vehicles and for the service vehicles (the sanitation trucks which pump sewage from the chemical toilets, and which need access to the skip bin. It is therefore necessary for this “road” to be kept clear of any construction. Nevertheless, during

the course of the study, the researcher observed considerable encroachment on this “road” space, although it still remained accessible to the primary service vehicles.

4.8. Service delivery promises.

During the COVID-19 pandemic, it was mentioned in the media that the CoJ municipality intended to remove over 1 600 South Africans from the heavily crowded Setswetla informal settlement in Alexandra. At the time (April 2020), COVID-19 was considered a considerable risk since this area was densely populated with the highest number of COVID-19-positive cases (Maphanga 2020). It was claimed that the residents would be relocated to Marlboro to ensure residents could practice adequate physical distancing. Community leader PD from Setswetla noted that this promise never materialised. Community leader TS noted that while some housing had been provided, it was in multi-storey apartments and was earmarked for the elderly. Unfortunately, none of these multi-storey apartments had a lift. Residents would then be expected to climb several sets of stairs to access the apartments. As a result, the elderly residents of Setswetla refused to move as this would result in serious inconveniences as well as disruptions to their social interactions and social status.

As mentioned before, the original settlers of Silvertown were told by the CoJ municipality that they would be moved to a more suitable location soon after they were settled in 2006. Despite this promise being supported by a legal injunction, the original settlers are still waiting for action to be taken. It is now highly likely that many of the people who made these promises are no longer working in the local municipality, either because they have retired or because they have moved to other (political) decisions. This creates a great deal of mistrust in authorities and particularly the CoJ municipality. Despite promises being made, these promises have been continually broken and inadequate services remain the norm. Some of the older people staying in Silvertown find it hard to stay in the area for various

reasons. Sanitation is not ideal for older people as they must walk from their houses to go to the toilets. There is quite a steep slope for the older people to walk up, especially to access the toilets by the entrance to Silvertown. Flooding related to rainstorms and burst sewage pipes make pathway movement difficult at times, and one occasion one of the older residents of Silvertown was once trapped in their home as they could not step outside because of flooding.

4.9. Setswetla design workshops

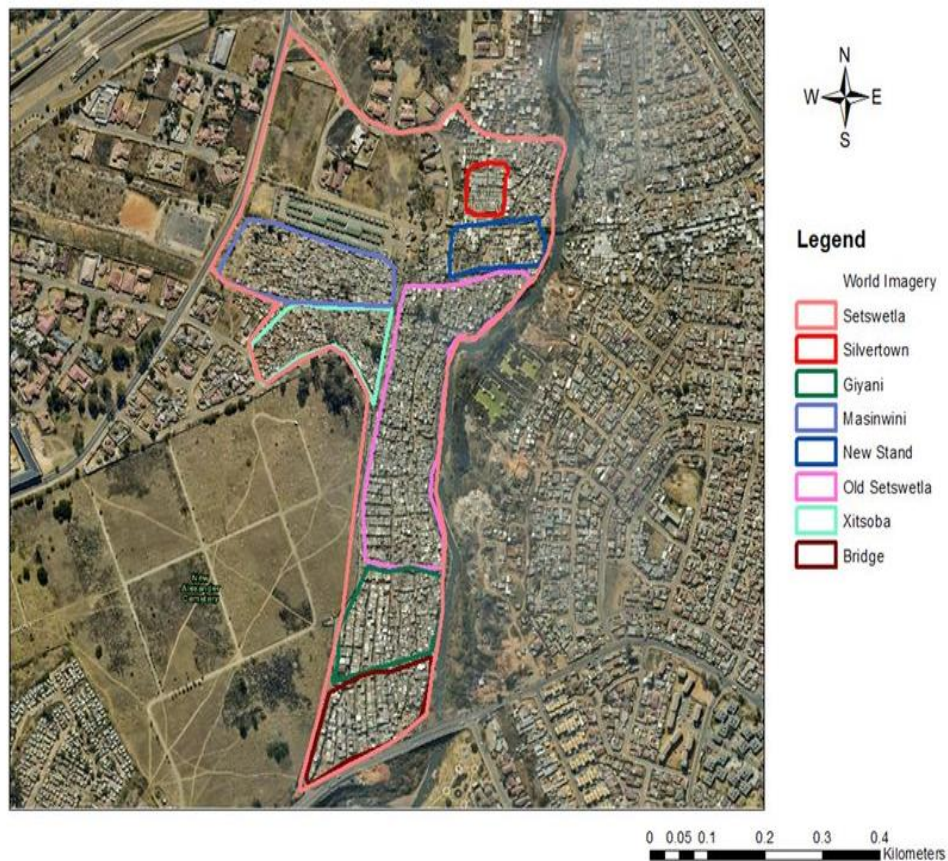


Figure 27: Illustration of the areas of the communities that attended the design workshops.

Map: Clinton Nyathi & Motshwaedi Sepeng (cartographers)

4.9.1. Purpose of the Setswetla Workshops?

The Setswetla design workshops took place in October 2019 and ended in December 2019. The URBWAT project team and members of the community leadership forum organised six workshops. The workshops included different community members from different in Setswetla. The Setswetla sections were Silvertown, Masinwini, Bridge, Old Setswetla, New Stand, and Giyani and Xitshoba. These sections are in Setswetla can be found in Figure 27. The design workshops were held in a venue, called the “gym”, in the Greenhouse section.

The first purpose of the workshops was for the research team to build a relationship with the community. In particular, the research team wanted to get to know the community’s needs better and for the community to get to know the research team’s aims better. Second, the design workshops were intended to give the research team ideas from the community for possible solutions to the greywater disposal (and treatment) problem. Third, the workshops provided the research team with a chance to introduce nature-based solutions to the community of Setswetla (and the constructed wetland concept specifically). After the first workshop the research team expressed frustration that the design ideas from the workshop participants were limited to “solutions” that they had seen in other areas of Setswetla. The research team had expected the design workshops to be participative and collaborative with participants actively contributing creative ideas. Unfortunately, this was not the case. Instead, the research team decided to propose a general solution and then get ideas from workshop participants about whether the idea (a) could work in their context and if it could then (b) to make suggestions for modifications or adaptations to make it work better. Fourth, the research team wanted to identify possible implementation sites. Even though the design workshops did not generate many design ideas from the community, they were still crucial in identifying potential areas within Setswetla that would benefit from greywater disposal and treatment solutions. In addition, they were important in establishing rapport between the research team and the community residents to

show that the research team was genuine interested in getting inputs and buy-in from the community.

4.9.2. Workshop outcomes

The most important outcome of the workshops was the establishment of a rapport between the URBWAT project team and the community. The community, as represented by workshop attendees, acquired an understanding of the research team's objective to develop infrastructure to address the problem of greywater disposal and treatment. Those participants who attended agreed with the URBWAT project team that greywater disposal was a problem and that having some infrastructure to address this issue would help. The second outcome was the research team's decision that Silvertown would be the area for an initial intervention. Silvertown was chosen because there was space available that could be used for an intervention, there was a high degree of excitement amongst participants, and the Silvertown CLF also had two members who were representatives on the Setswetla CLF.

Silvertown was comparatively new compared to other sections of Setswetla meaning that not all the available space had been fully developed. In other areas of Setswetla, there was no more space available to build functioning greywater disposal and treatment solutions. Many other places in Setswetla already had makeshift solutions which played a role in removing and transporting greywater to the river and installing a new system would have meant removing this existing infrastructure. Silvertown was also chosen because the research team had already built a good connection with the Silvertown CLF. The Silvertown CLF taken the URBWAT project team around Silvertown several times before the design workshops.

The workshops did not produce any novel design solutions, but the people's ideas shed some light on what the context as well as possible modifications to make an intervention suitable for the context. The only common design solution across the design workshops was for a sewer system. See Figure 28 for examples of the design solutions suggested during the design workshops. Due to the lack of novel solutions, it was decided by the URBWAT project team to adopt an iterative design and construction process. The idea behind the iterative design and implementation process was to introduce a novel solution and then to work with the community to either make refinements to the intervention or to help develop a new solution. It was reasoned that the residents would find it easier to innovate with a template than to come up with an original solution entirely on their own. The initial conceptualisation was to build, evaluate, and iterate roughly every three months. However, this proved unfeasible given the outbreak of COVID-19 shortly after the handover of the Phase 1 CWs and that it was necessary for residents to become familiar with each iteration and to conduct a comprehensive evaluation of each installation.



Figure 28: Drawings made by the residents during the design workshops.

Sketch: Setswetla residents (workshop sketches)

The solutions produced from the makeshift drainage systems in the Xitshoba and Masinwini section ended up transporting greywater to Setswetla's the main street. These two sections have a similar set-up with small spaces between dwellings and very narrow passages (Figure 29 A). The Masinwini section, opposite the Greenhouse on the South side, is even smaller than the Xitshoba section, with very narrow passages. There is insufficient space between the communal taps and the houses, as seen in (Figure 29 B) to install any form of infrastructure and still allow people to pass through. It can become very muddy because the greywater passes through makeshift trenches and pipes and the water often gets trapped and overflows. Other sections of Masinwini had gullies, but the width of the gullies was very narrow. This was a problem because running water could not easily be

channelled and would end up overflowing and causing flooding. It looked like the taps were connected to drainage pipes that channelled the water away. Some of these pipes were cracked open, which may also have contributed to the flooded greywater in this area. In Masinwini, more than any other place, the drains next to the taps were packed with litter, and people there talked about how some people were even disposing of their faeces directly into these “drains”. He referenced that people are careless, especially when they are supposed to dispose of such solids in portable toilets.



Figure 29: Narrow passage in Masinwini (A). Communal tap in a cramped space (B)

Photo: Motshwaedi Sepeng (researcher)

Xitshoba is to the South of the Masinwini section between the Masinwini section and the cemetery. The only difference between this area and the Xitshoba section is that in the Masinwini section there is marginally more space between the houses.

Old Setswetla is the largest section in Setswetla and as the name implies, is the longest established section of Setswetla. The spaces between the houses are also wider in Old Setswetla. Like in Masinwini and Xitshoba, the taps had concrete platforms for people to place their collection/washing containers. Similarly, there were also makeshift drains that collected and channelled greywater away from the taps and towards the river. Most of the water channelled gets transported into the Jukskei River since Old Setswetla is close to the Jukskei River. It is not as sloped as Masinwini and Xitshoba but there is still enough of a gradient for the water from the taps to end up in the river, as illustrated in Figure 30. A similar issue about solid waste surrounding the taps was also seen in Old Setswetla. In many instances, the litter was obstructing the drainage system. The houses in the Old Setswetla section were mostly brick houses with fewer shacks made from other materials. Immediately below the Greenhouse (to the East of the Greenhouse or the northern side of Old Setswetla) this area was less developed than the South side of Old Setswetla, which even had some double-storey houses. The south side of Old Setswetla also has some well-built gullies connected to the taps. This section of Old Setswetla already had relatively sophisticated infrastructure for the disposal and transportation of greywater, although it was ad hoc (heterogeneous) and in constant need of repair, expansion, and modification.



Figure 30: Sequences of channelled disposed water into the Jukskei River in Old Setswetla

Photo: Motshwaedi Sepeng (researcher)

The sections towards the south of Setswetla (known as the “Bridge” area), closest to Florence Mophosho Road (and the road bridge that crosses from the Alexandra township to the East Bank settlement, were more likely to be built from brick. In the same way as Old Setswetla, the sections of the Bridge and Giyani (next to the Bridge) had the same kind of set-up as Old Setswetla with regards to brick houses and the infrastructure for disposing (and transportation) of greywater. Areas along the road close to the Mazinyo tuckshop and near the crèche have gates that limit access for people to these sections. Taps that are constructed along the road opposite the portable toilets/cemetery use the street to dispose of greywater. Gullies next to the road channel the greywater into drains built into the pathways, which take the water down to the Jukskei River or into stormwater drains. The upper part of the Giyani section in Figure 31 is paved. The portions of Setswetla closest to the river generally have people disposing of their water directly into the river.



Figure 31: Paved areas around the tap in Giyani

Photo: Motshwaedi Sepeng (researcher)

The “New Stand” section is adjacent to Silvertown on the South side. This area has a narrow street running down to a pedestrian bridge that crosses the Jukskei River and is used as a thoroughfare for people travelling from one side of the river to the other. A communal tap is placed on one side of the main thoroughfare in New Stand. Water gets disposed of onto the tap platform or into a shallow makeshift gully that runs down the middle of the thoroughfare (Figure 32 A). As seen in Figure 32 B, the gully channels the greywater and is also close to the houses, like in the Masinwini section. This would make it difficult for greywater treatment infrastructure to be placed here because there is insufficient space especially when it is noted that the thoroughfare is a busy pedestrian path, and cars also use the thoroughfare. The “New Stand” area is still being established and dwellings tend to be shacks found from various materials rather than brick.



Figure 32: Tap by New Stand (A), Trench in New Stand running towards Jukskei River (B)

Photo: Motshwaedi Sepeng (researcher)

4.9.3. Design solutions from the design workshops



Figure 33: Photo showing one of the drawings made in the design workshop.

Sketch: Setswetla residents (workshop sketch)

Unfortunately, the workshops did not produce any novel design solutions, but the people's ideas shed some light on what they would like in a solution. The only common design solutions were for a piped sewer system. Even though some of the portraits for example in Figure 33 needed clarification, they conveyed that greywater disposal was perceived as a problem. The shared message was that there was no central, municipal plan or solution for their greywater disposal, forcing residents to be proactive in finding solutions for themselves. Generally, this was by creating channels (trenches or gullies) that would transport their greywater away from their houses and into the Jukskei River.

Masinwini

The people in the workshops were asked to depict where they were staying and the infrastructure, they used to dispose greywater. The Masinwini workshop showed in their drawings that their houses were very compact. They represented the different points where people were disposing of the greywater produced from their homes. As a result of the compactness of the area, the gullies were close to the houses. In one of the drawings, there is a clear indication that the gullies were made of cement. Later, when visiting the area, it was clear that it was paved and that the gullies were built on top of “paved” (in this instance, “paved” means it was covered with found materials such as tiles, broken bricks, and other rubble) surface. It was also easy to see that people stayed far from the river because one of the drawings showed the disposed greywater crossing the road before reaching the Jukskei River. The gullies on the drawings followed the pattern of the pathways in the area.

Xitshoba

As a result of Xitshoba being on the same side of the main Setswetla road as Masinwini the drawings were similar in terms of people highlighting that the water that they dispose crosses the road to the river. In one of the Xitshoba workshop drawings, you could see a pipe that went underground to take the greywater from their side of the road into the other side and the river. In the same way, as in Masinwini, it was clear from the drawings that people would be stepping outside and disposing of greywater close to their dwelling. There was a big gully on the other side of the road, but people from the workshop who stayed in Xitshoba and Masinwini never depicted the disposal point as this big gully. Regarding potential solutions, people from Xitshoba and Masinwini wanted a bigger drain that would easily enable them to dispose of greywater.

Silvertown

One drawing from Silvertown gave a detailed description of the setting. The other drawings could have been better sketches and easier to understand. The drawings did not indicate where people were disposing of their greywater. The drawings from Silvertown showed that there was a grid street pattern. The taps were shown to be on the boundaries of the settlement. This indicates that it is difficult for people to dispose of greywater outside their homes, like Xitshoba and Masinwini. Water disposal occurred on the boundaries of Silvertown, where they dug gullies for disposal. Another point to note was that these gullies were sometimes depicted as being blocked. The solution to greywater disposal in the area was for the research team to build a broader and deeper disposal spot. Other suggestions were the provision of a piped sewer system to ensure that people are not exposed to the greywater.

Old Setswetla, Giyani and the Bridge

These three sites in Setswetla were all on the river side of the Setswetla main road. The dwellings seen in the illustrations of the Old Setswetla community were arranged in a systematic grid-like layout. Like in Silvertown, the spaces between the houses were bigger than in Xitshoba and Masinwini. The taps for water access were placed on several street corners. The placement of the taps and drains was such that the drains were positioned near the river, allowing for the efficient flow of water. The presence of drains and taps near the road can be attributed to the existence of a concrete gully along the major road within Setswetla. The gullies that were perpendicular to the main street were shown to lead to the Jukskei River. Two drawings indicated that the location of the gullies was close to the Jukskei River. These drawings also showed people disposing of water directly into the river.

4.10. Phase 1 building in Silvertown

4.10.1. Construction of the CWs

The construction of the CWs was based on the discussions from design workshops. It was evident that people in the workshops preferred implementing a sewer-based system. However, this was not possible with the URBWAT project team's funding parameters and the availability of space. In addition, the URBWAT project team had argued against a system that was underground because (a) given the high amount of solid waste in the environment and in the wastewater, a piped system would quickly become blocked and (b) because of the high premium on space for dwellings, an underground piped system would soon have a dwelling built on top of it and this would make maintenance and unblocking the pipes very difficult. Therefore, the URBWAT project team decided to build a pilot CW system so the community could determine whether the CWs could work for them and identify possible design recommendations to improve the CW idea. After the workshops were concluded in December 2019, a follow-up meeting with the Silvertown community was held to discuss building a pilot CW system. This meeting happened on 18 January 2020 on a rainy Saturday morning in Silvertown. Since there was a limited turnout in the design workshops that happened in 2019 (which took place on weekdays and would have excluded people who worked during the week), it was decided to have the community meeting on a Saturday. The Silvertown CLF called the meeting and invited Silvertown residents, and members of the URBWAT project team attended the meeting to discuss the CW option again and to identify possible sites for the implementation. There was a better turnout from the community at this meeting. Again, like in the workshops, women participated in the meetings more than men. The meeting happened outside in an open space, between the residents' homes. In the meeting, the introductions were made by one Silvertown CLF member. The URBWAT project team recapped the plans for building a pilot CW. This meeting allowed community members who were not afforded an opportunity to attend the design workshops to engage with the

URBWAT project team. Two sites were identified for the implementation of two pilot CW systems.

In building the CWs, the URBWAT project team and the community members who attended the workshops agreed both on the placement and size of the CWs. There was also an agreement that the people doing the building should come from Silvertown and if the skills could not be found in Silvertown that they should be identified within Setswetla. Ideally, this would mean identifying builders (and construction workers) from Silvertown, but if these people could not be found, then the builders could come from elsewhere in Setswetla. Two community members from Silvertown handled the nomination process for the builders. The main criterion was that the builder/s should have a background using bricks and concrete, which would be needed to construct the CWs. Nobody from Silvertown came forward, so a builder from old Setswetla was then identified to do the building. This builder had previously built a drain for wastewater disposal for his Setswetla section in December 2019.

4.10.2. Construction process of the CWs

The URBWAT project also aimed to ensure the community was empowered while building the CWs. Whenever feasible, the fundamental construction materials, including bricks, cement, gravel, and sand, were procured from local sources in and around Setswetla. The labour was also recruited from Setswetla as the builder from Old Setswetla who came with two workers (also from Old Setswetla). The building of the first phase of CW1 and CW2 started in January 2020 and concluded on March 12, 2020. The URBWAT project team felt it was important to be directly involved in buying materials and ensuring the CWs were built as planned. On the first day, the builder came with two of his workers, and they started by removing the existing drain that the residents used to dispose of their greywater. The concrete slab was laid during the first week, and they waited for it to dry. The building happened

simultaneously on the two CW sites, with ground breaking starting at CW1. There were challenges faced during the building process. There were times when the tap at CW1 stopped working, making it difficult to mix concrete and cement. There were also days when the URBWAT project team would arrive, and none of the construction workers were there, or the construction workers would arrive, but the builder was absent. The local materials supplier who provided most of the building material was very cooperative. Buying the materials locally meant that the delivery of materials was almost instantaneous. Other materials (e.g., wetland plants, plumbing supplies such as piping, etc.) which could not be sourced locally had to be bought at a nearby building store in Alexandra, but necessitated waiting for one of the URBWAT project team to transport the builder or to pay for transport to the building store.

On Monday, 16 March 2020, a handover meeting was held in the evening in Silvertown. The handover meeting was conducted to formally pass on responsibility to the community and explain how the CWs worked and what could go into the CWs (as well as what should not go into the CWs). The handover of the CWs was also done because South Africa was scheduled to go into a total lockdown on Thursday, 19 March 2020, due to COVID-19. Handing responsibility to the community would allow them to use the CWs during lockdown. At this stage, it was unclear how long the COVID-19 lockdown would last, with authorities suggesting it might last three to four weeks to prepare healthcare facilities for an expected influx of COVID-19 cases. Ultimately, a hard lockdown (no movement of people being allowed between locations) lasted six weeks, but “softer” lockdowns still prevented the URBWAT project team from visiting Silvertown for approximately five months. At the time of the first two lockdown levels, informal settlements, such as Setswetla, were considered highly vulnerable because they were densely populated with people who had limited access to healthcare services and many might also be immune-suppressed due to malnutrition or comorbidities (i.e. other diseases, diabetes, etc.). From an ethical standpoint, the URBWAT

project team were concerned that they might inadvertently introduce COVID-19 into the community (or at least be accused of introducing COVID-19 into the community if there was an outbreak shortly after visiting).

4.10.3. State of the CWs

As a result of the COVID-19 lockdowns, after the CWs were built, they were left to the community to use without any external supervision by the URBWAT project team. The COVID-19 lockdowns also meant that it was not possible (either physically or ethically) to access Silvertown and to document everyday use. Under lockdown level five, the South African government rules meant people were not allowed to leave their homes (except to get food or to seek medical care and could not travel more than a few kilometres for these purposes). Instead, information about the CWs was retrieved directly from community leaders in Silvertown via WhatsApp calls, messages, pictures, and videos. A few issues were documented immediately after the first level 5 COVID-19 lockdown. A resident erected a shack next to CW1 in the first instance. This was followed shortly by another instance where cement was poured into the inlet of CW1. This second instance blocked the entry into CW1. Through community pressure, the person who erected a shack next to CW1 volunteered to clean up the cement in the inlet of CW1.

The damage to the CWs was mainly on CW1. However, CW2 was also underutilised because the tap was locked by community residents and could only be used by community members who had the key. However, the lack of use of CW2 meant that the wetland plants in CW2 were dying as insufficient water was getting into the CW. There were also reports that rubbish was thrown into the inlet for CW1, but as far as could be determined, this was not to a point where it caused a complete blockage. On the other hand, the CW1 inlet would flood because of a blockage in the pipe at the point where it connected to the CW. It also did not help that the taps were either leaking (which caused flooding next to the CWs) or broken.

4.10.4. The suitability of CWs

When the CWs were designed, built, and presented to the community of Silvertown, the residents said they were happy with the infrastructure. It was not easy to analyse whether the CWs were suitable infrastructures initially because of the COVID-19 regulations, which prevented direct observation by the researcher or the URBWAT project team directly after construction. The informal reports from the community were that people were using the CWs even though, at some stage, people had to stop using CW1 because the tap was broken. When the COVID-19 restrictions were relaxed in August 2020, the researcher could return to the site and see how people used the CWs. Most people the researcher encountered claimed that they used the CWs, although some hesitated because they did not know what they were for. What was observed, though, was that the CWs were normally used when people were doing their washing (clothes, carpets, shoes) but not when they were disposing of dirty water from their homes.

People used the CWs because they gave people an alternative to dispose of their greywater. One person said they were the appropriate structures, but only if they were connected to their home pipes instead of them having to walk some distance to dispose of their greywater. Some people thought they were suitable structures because they could clean the wastewater. Two people pointed out that the CWs would be perfect if only people used them correctly. Another person added to this point and thought the CWs were making the place look good. Some also believed they were suitable structures and appreciated them. One person thought they were both suitable and not suitable structures but only explained why they were not suitable. They indicated that the CWs could have been better because they became blocked easily. They suggested using bigger pipes to accommodate the variety of solid waste in the water. There was a small minority of people who did not think the idea of the CWs was good. One of these people said that the CWs could be improved by putting a big mesh on the side of the CWs to channel the stormwater

into the CWs and stop the water from getting into their homes. These people also thought that the CWs were not working for the people of Silvertown's.

4.10.5. Types of materials that get disposed.

The main disposal in the CWs was liquid waste, usually bathing water or washing water (Figure 34). There were occasions when solids were disposed into the CWs. One perceived advantage of the CWs was that they were close to the skip bin. This was especially the case for CW1. This meant that when people take out any waste from their homes, they could also dispose of the greywater from their homes. However, having the skip bin near CW1 also caused some problems, especially if the skip bin was full or overflowing. In some instances, this meant that solid waste could get blown from the skip bin into the CWs (but especially CW1). Some people also appeared to consider the CWs as an extension of the skip bin as materials like food scraps could be seen thrown onto the plant area of the CWs as well as solid food waste present in wastewater. This is unsurprising as common domestic materials were thrown away when people disposed of their greywater in the gullies.



Figure 34: Washing being done at CW2 in phase1.

Photo: Motshwaedi Sepeng (researcher)

One morning, faeces were found next to CW1. At this time, the idea of CWs was still relatively new to people, but to find faeces was still surprising. Without being

able to interview this person, in unstructured interviews it was suggested that this had happened because the chemical toilets are not necessarily accessible to everyone, and some of the portable chemical toilets are situated quite close to CW1. In Phase 1, the physical presence of the CWs did not integrate well with the community. For example, the person who erected a shack right up to walls of CW1 showed that for some community members, CWs were not a priority. In Phase 1, the community felt that the CWs were just infrastructure placed there by an external project and had little meaning for the Silvertown residents.

4.11. Formal observational evaluation of Phase 1

Before embarking on the second iteration (i.e., Phase 2) a study was commissioned to undertake a formal observational analysis of how the CWs were being used. While this commissioned study did not form part of this PhD it is worthwhile summarising how frequently the CWs were being used. Observations occurred over the course of three days (a Friday, Saturday and Sunday) in November 2020. There were some concerns over safety and so observations occurred during the day from 08h00 to 15h00. Six student volunteers worked in pairs with rotation between the three observation sites so as to reduce observation fatigue. Data on each site user (age, gender, type of activity, type of container, size of container, and length of activity) were collected on a data sheet. The frequency of use over these three days is shown in Table 5

Table 5: Activity type in relation to site use

Site	Total Use	Collection	Washing	Disposal
CW1	5	-	-	5
CW2	20	9	1	10
CW3 ²	128	61	37	30

From Table 5 it is possible to see that CW1, despite being identified as a regularly used tap during the initial investigations, was hardly used during the observation period. This was because the tap was broken at the time. Instead, the residents who would normally have used the tap at CW1 had shifted their use to the CW3 site which was used regularly during the study period. During these observations it was also noted that users of the taps had to adopt exaggerated stooping postures when collecting water and when conducting washing activities. Finally, it was noted that the large containers used to wash clothes were too heavy to lift up (especially when filled with water) and to empty into the raised CW inlets. Consequently, these containers would just be emptied onto the ground or into the gully (if there was space next to the gully for carrying out the washing tasks).

4.12. Phase 2 building in Silvertown

4.12.1. The building of the wall and the improved entrances

The stormwater from the road immediately above Silvertown (Gousblom Crescent) would regularly overflow into the area during the rainy season (October to April)

² CW3 is part of phase 3 which is not part of my research, therefore for context the tap at future CW3 I have referred to it as (CW3).

and would often flood the dwellings in the centre of Silvertown. This stormwater would come from two sources: (1) stormwater would flow directly off the road (especially if the storm was intense) and (2) stormwater would flow off the road from a stormwater drain that emptied into Silvertown adjacent to the entrance (right next to CW1) and into the makeshift gully. The residents near CW2 would also have a problem with stormwater, because with intense rainfall the stormwater would overflow from the gully and into people's dwellings.

Prior to the extension and construction of the CWs two additional walls were built in Silvertown adjacent to the CWs. One wall was at the entrance to Silvertown adjacent to CW1, while the other wall was built as a barrier adjacent to CW2. The walls were built to channel stormwater and any washing water spilling off the washing area past the CWs rather than direct it towards the houses. Therefore, these walls were not rectifying any flaws that were identified from the Phase 1 CWs but rather addressing emergent problems that were noticed while observing the Phase 1 CWs.

Residents living immediately below the wall at CW1 and immediately adjacent to the wall at CW2 expressed great satisfaction in the construction of these walls. However, as informal settlements are not intentionally designed, there are many gaps regarding services and infrastructure. There were some people who were not happy with the walls that were built. A resident (further downhill from the CWs) complained that the stormwater was redirected by the wall (at CW1) towards her house. When discussing this situation with other residents in Silvertown they indicated that she had built her house to face the wrong direction. Usually, the houses in Silvertown do not have doors that face towards the entrance to Silvertown (since that is uphill towards the highest point) but rather doors are built perpendicular to the entrance to prevent stormwater from entering one's house during the rainy seasons.

When the building of CWs started in 2020, the stormwater rarely flooded from this gully since the existing water level in the gully was low. However, flooding was always a risk, especially in an intense storm. Since stormwater protection was considered for CW1 at Phase 2, it was also decided to provide similar stormwater protection for CW2. This proved fortuitous because shortly after the Phase 2 building had been completed, a sewer burst next to Gousblom Crescent above Silvertown. The burst sewer was not fixed for approximately three months. This coincided with the rainy season, and the sewage (blackwater) combined with the stormwater raised the water levels in the gully to such an extent that it flooded CW2 but did not overflow into the houses in the community.

The walls at CW1 and CW2 also acted as the socialising point where people could sit and socialise in addition to providing some protection from stormwater and sewer spills (but not both, as we saw with CW2). The wall at CW1 was used as a communal meeting space because it faced the entrance to Silvertown, especially on the weekends when people would gather for drinks. The wall was also used as a communal space when people were doing washing. Instead of returning home, they would sit on the wall talking while waiting for other people to finish washing.

4.12.2. A ramp and staircase at the entrance of Silvertown

When the wall was built at CW1 at Phase 2, it had to incorporate the existing access points to allow people to enter the pathways leading to their homes. The building at Phase 2, therefore, includes building access points. A set of stairs was the initial idea proposed by the research team. The staircase was built at the access point closest to the tap (Figure 35 B). This access point did not previously have steps and was a slippery, steep soil bank. The staircase was built with slightly raised sides so that people, especially older people, would have somewhere to balance when using

it. More people used this staircase in the evening, especially when coming home after work or shopping to buy cooking items.



Figure 35: A photo showing a ramp (A) staircase (B), and wall (C) built in Silvertown.

Photo: Motshwaedi Sepeng (researcher)

The other access point on the side furthest from the tap was also modified. After consulting with the community, it was decided that this access point should have a ramp (Figure 35 A) rather than a staircase. During the researcher's observations in Silvertown, it was noted that the older residents, predominantly older women, tended to utilise a certain entry point due to its relatively gentle incline. A ramp was

therefore a good idea for them because they would not have to climb stairs (especially under poor lighting conditions at night). It was also thought that wheelchairs (for older people) and wheelbarrows (for construction) could also use the ramp. However, after building the ramp, it was noticed that older people did not use it because it was too steep and needed to have rails/supports for people using it. Initially the researcher's observations were that the people who most frequently used the ramp were those aged 18-26, closely followed by those aged 27-39. A rail was suggested as solution, but the community felt that a rail would probably have been stolen. There was a similar concern about installing metal taps rather than the preferred plastic taps. After the final workshop in 2022, it was decided by the community and the URBWAT project team that a rail should be installed to accommodate the staircase and the ramp.

4.12.3. The enhancement of the gully

The Phase 2 project in Silvertown had a notable favourable influence on integrating the existing infrastructure, particularly in enhancing the gullies. In the observations from Phase 1 it was evident that even with the presence of the CWs, some residents would still prefer to dispose of some wastewater outside the built system. The alterations that came with the extension of the CWs for Phase 2 therefore recognised that disposal next to the CWs also plays an integral part in how greywater gets disposed. Building gullies was new to Silvertown but had been used extensively in other parts of Setswetla. In CW2, the extension of the wall meant that the wall acted as an enhanced side retainer for the gully, as seen in Figure 36.

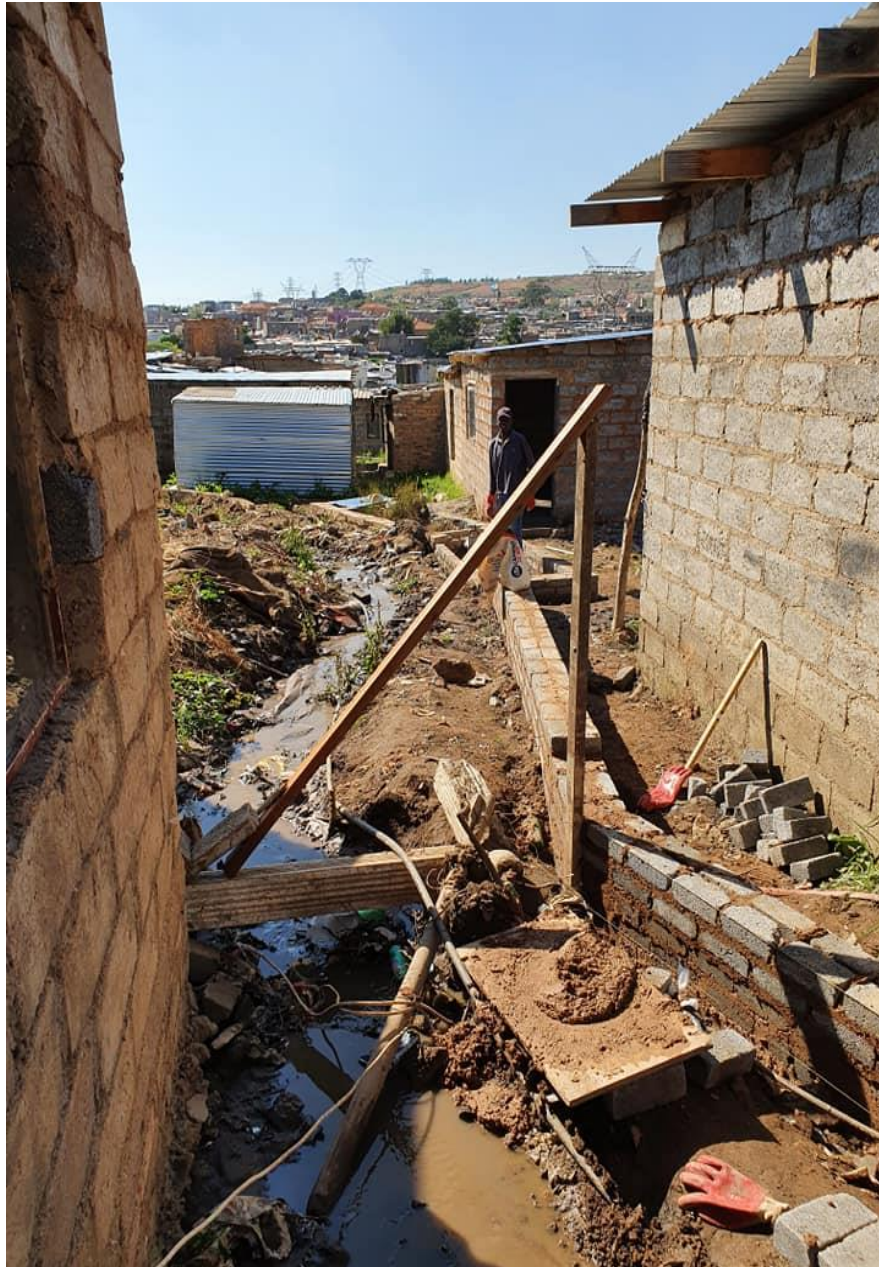


Figure 36: A built wall to separate the CW2 and the makeshift gully.

Photo: Motshwaedi Sepeng (researcher)

The gully at CW1 typically transports a range of different wastewaters, including greywater and stormwater. Another wastewater that the gully transports is sewage from burst sewer pipes. As mentioned, a burst sewer in Gousblom Crescent next to the New Stand area burst during Phase 2. This sewage gushed out onto Gousblom

Crescent and then into the stormwater drain on the side of the road, which emptied just above CW1 on the Silvertown side of the street. According to unstructured interviews, this (a burst sewer) was a fairly regular occurrence since, and had actually help naturally form the gully. This sewage causes several problems in Silvertown. When there is too much sewage coming from the burst pipe, it makes it difficult for people to walk alongside the gully. This forced people to take a different route or to walk through the sewage. An older man staying along the path of the gully by CW1 struggled to get out of his home because the sewage prevented him from leaving his dwelling. If the sewage was combined with stormwater, there was also a high likelihood that these two wastewaters would rise above the gully and flood into people's houses. The sewage also made it difficult for people to get to some of the portable chemical toilets and the waste skip.

One of the changes in Phase 2 was to make the walls of the CWs wide enough so that residents could walk on top of them (Figure 37 A) to use as a pathway to avoid sewage. The URBWAT project team recognised that the gully was a key part of water disposal; therefore, it also needed to be incorporated as part of the CWs. Rather than remove the gully entirely, the design at Phase 2 involved upgrading the gully next to CW1 by sealing it with concrete (Figure 37 B). It was also made wider to accommodate the combined volume of sewage and stormwater.



Figure 37: The newly improved CW1. Extend platform used for walking (A) and the cemented gully on the side (B)

Photo: Motshwaedi Sepeng (researcher)

The Phase 2 building (extensions) of the CWs in Silvertown resulted from formal data collected in Phase 1 about how people were using the CWs as well as from observations and the interviews conducted by the researcher. The findings from these various data sources suggested that:

- The CWs sites were underutilised (especially CW1 where the tap was broken during formal observations)
- There was insufficient space around the taps for more than one person to do their washing at a time (and if a person was washing it was difficult for other people to carry out other water-related activities such as water collection, rinsing of containers, or kitchen utensils).
- The inlets for the CWs were too high, making it difficult to lift and empty containers (especially heavy containers used for washing). Instead, containers were emptied into the gully next to the CWs.
- The inlet to the CWs was not obviously an inlet. It was a raised platform with a plastic grid, but many residents used this as a space to place cleaning materials such as soap or detergent containers.
- When washing (and also when collecting water and rinsing containers), users would have to stoop and bend their back considerably. This led to many complaints of back, hip, and shoulder pain being reported in the unstructured interviews. This was particularly concerning since people were lifting containers of 20L and 40L.

CW1 model



CW2 model

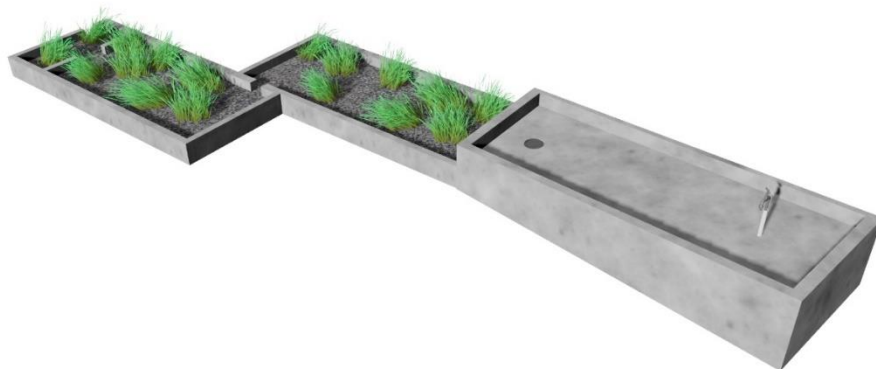


Figure 38: Graphic designs of the improved models of CW1 and CW2

Photo: Motshwaedi Sepeng (researcher)

Figure 38 shows the graphic design models of the CWs that were built in Silvertown. The design recommendations that emerged from this data included (a) having a raised platform for washing tasks and collecting water (so users do not have to bend down too much); (b) integrate a brick ledge along the periphery of the raised platform so that water does not spill onto the ground (and onto users' feet) when washing and collecting water; and (c) increase the size of the raised platform surrounding the tap to accommodate multiple water-related activities simultaneously (e.g. two people washing at the same time or having two taps so that someone can wash and someone else can collect water).



Figure 39: Flooded CW2 (A) and Flooded CW1 (B)

Photo: Motshwaedi Sepeng (researcher)

To accommodate more possible water disposals, it was also necessary that the CWs were lengthened. Looking at Figure 39, when people disposed water in the CW inlet, especially after washing, the CWs would get flooded. Additional flooding water would come upstream from the burst sewage pipe, which was sometimes gets mixed with stormwater would flood CW2, as seen in Figure 40 showing a sequency of this. The same thing would also happen when it rained. To prevent the CWs from overflowing, the residents would dispose of their water in the gully on the side of the CWs. This meant that under certain conditions, people were not using the CWs. With the CWs being extended, there was more capacity to retain wastewater, and the flooding problem was believed to be resolved.



Figure 40: A sequence of water flows ultimately result in the flooding and destruction of CW2.

Photo: Motshwaedi Sepeng (researcher)

A: Burst sewage pipe next to the toilets in outside Silvertown

B: Flowing sewage water on the road entering Silvertown through the stormwater pipe

C: Sewage coming from the road flowing in the gully past CW1

D: Flowing water passing and flooding into CW2

4.12.4. Phase 2 Construction of the CWs

Moving into Phase 2 of building because of the iterative process of design the CWs were redesigned to user. Unlike in Phase 1, when the members of the URBWAT

project team took the administrative responsibility of buying the material, in Phase 2, that responsibility was passed on to two community members. The community members had always been part of the project from the workshop to the Phase 1 building; therefore, the members already had great knowledge of the project, making it easy for the members to handle the project management. There were times in Phase 1 when the “Phase 2 building managers” would advise us about where to buy the material. Before the start of the building, the names of the interested builders and building assistants were submitted to the project managers for consideration of building in Phase 2. In Phase 1, the builder was taken from Setswetla as no one from Silvertown raised their hand. In phase 2, a builder from Silvertown was used. The person had just returned to Silvertown, and he had previously been building in Tembisa. Like the previous builder, the good thing about him is that he had his own working tools. Also, unlike Phase 1, the construction workers were also sourced from Silvertown. Things went smoother in terms of the administration of the building. In Phase 1, there were days when there was a struggle with getting some of the materials. This was different in Phase 2, as the project managers were familiar with the place and knew where to go to get the building materials.

The construction in Phase 2 started on 16 May 2021. First the gravel from the Phase 1 CWs was removed. Next, digging the foundations for the extensions happened, followed by the bricklaying for the sides of the CWs. However, at this point, the construction workers reported that the builder had left for a construction project elsewhere. This delayed the construction as the builder would sometimes not come to work, leaving the assistants to do the job. This may have compromised the quality of the construction work. To make matters worse, there were also other days, such as the days when he had received his wages, when he failed to come to work. This slowed down the building process until the URBWAT project team and the community members agreed that the builder should be fired. The builder was

released from his duties, and one of the construction workers led the building until the Phase 2 building was concluded on 3 June 2021.

4.12.5. The state of CWs

Straight after completing the construction of Phase 2, there was no deliberate damage to CWs, but the problem of litter entering the CWs continued, as well as the occasional broken taps. Since the completion of Phase 2 of the building, the CWs have reduced flooding incidents from water disposal and tap leakages (as well as by creating a physical barrier between stormwater and sewer spillages and residents' dwellings). One of the reasons was that the structure's height and capacity had been increased. The other reason is that residents normally dispose of greywater from the house into the gully instead of into the CWs. People disposing of greywater from houses into the inlet of the CWs seldom occurred. One of the people who stays close to CW1 said that at night, people may be disposing of their bathing and dishwashing water directly into the CWs. This person also said that safety is another reason people throw water now into the CWs at night rather than into the gully.

The researcher also noticed that some of the plants had died. In unstructured interviews one of the reasons for this was that people pour hot greywater (from cooking) onto the gravel part of the CWs where there are plants. While the URBWAT project team had encouraged this act of direct disposal of greywater into the CWs, the URBWAT project team had expected the greywater to be cold when disposed. There was therefore a mismatch between the research team's expectations and the resident's expectations. People could be encouraged to dispose of hot water only on the gravel bed rather than directly onto the plants.

The CWs mostly get greywater inputs from when people are washing clothes (or other items like shoes, rugs, bedding, or kitchen utensils), when the tap is leaking, when people drink water from the tap, and when people are rinsing containers after greywater (and chimba) disposal. When people are washing, there was large quantities of greywater that enter the CWs through the inlet since the CW inlet was directly connected to the washing area. As was explained when discussing the general services in Silvertown, some people also leave the tap running due to water pressure issues. There were occasions when users left the tap running while washing. This was done to rinse clothes in one container (or even on the washing surface) while other clothes were being washed in another container. Similar incidents happened with people rinsing their buckets.

Observations of Phase 2 showed that the CWs were mainly used for disposing water when washing or rinsing activities occurred at the tap. Water that was taken away (e.g. for washing of people, dwellings, or for cooking), then this wastewater would be disposed in the gully. It was common for people to come from their homes with buckets full of greywater and dispose this greywater in the gullies next to both CW1 and CW2. People had learned from Phase 1 that the CWs would get full quickly; therefore, they would choose which greywater would go into the CWs and which greywater would go into the gullies. One of the reasons why people would not dispose of greywater in the CWs was that they were still new to the area. These people were worried that if something went wrong, they would be blamed. It was therefore perceived as safer by these people to dispose of their wastewater into the gullies.

The extension of CW1 took place in a space where people used to walk. The design of CW1 therefore integrated the walls into the existing pathway. However, it should be noted that the space for walking was larger before the CW1 extension. Ever since the extension of CW1, people have either walked on the side or on top of CW1 on

the wall designed as a pathway. In addition, women carrying children or people carrying heavy things are forced to go around CW1. When people come from the Maponyane section, they prefer to walk on the walking path on the side of CW1. However, when they return to Maponyane, they walk on the CW1 wall. This is because when coming from Silvertown towards Maponyane, there is only a small step up onto the CW1 wall, whereas when they come from the Maponyane section towards Silvertown, they must both step over both the gully and there is a much higher step up onto the CW1 wall. It was observed that most people would still choose to walk next to the CW1. The reason for this is that it is considered less dangerous to walk next to CW1 compared to walking on top of the wall of CW1. Unless you walk carefully on top of CW1, there is always the danger of missing your step and falling into the gravel part of CW1, which usually has dirty water on the surface. When people walk in groups, it has also been observed that they prefer walking next to CW1 rather than on the wall. No person over the age of 50 was seen walking on the wall of CW1. The same can be said of children, as they preferred to walk next to CW1. However, when there is a great deal of water (blackwater or stormwater), those who can manage to step onto CW1 have preferred to walk there. Similarly, when there are cars are parked so that they do not provide walking space next to CW1, people are left with little choice but to walk on the walls of CW1 or to use the stairs and walk through the centre of Silvertown.

Before the extension of CW1, people would need to walk between the undeveloped disposal gully and the houses when passing by. However, walking on the wall of CW1 has resulted in the cement on the broader wall of CW1 being peeled off due to the constant movement of people. The other possible reason the cement has peeled off is that the builders did not apply sufficient cement for a pathway. Flaking of the cement also happened quite a lot on the outer layer of the washing area of CW1. This was also a high-use area of CW1.

The other common thing, especially after the extension, was that the gravel was still new. This would give children in the area a chance to take out the stones and use them stones for their games (a game called Diketo). The game of Diketo (Stones) bears similarities to the game of Jacks, however, with the distinction of using loose stones instead of specialised objects. In the game of Jacks, the participant engages in the act of propelling a ball upwards and, after that, swiftly seizing a single jack prior to the ball contacting the ground. According to Janks (2006), in the game of Jacks, catching a stone thrown into the air requires the action of picking up or displacing a specific quantity of stones using just one hand. Children were always playing on CW1, especially in the afternoon, but they would no longer take out the gravel for their games once water was on the surface. There have also been occasions when the children have been seen playing with the plants in the CW1. There are concerns that the water in the CWs would pose a health hazard for the children playing so close to the CWs, especially when they appeared unsupervised most of the time.

The extension of CW1 was also advantageous because it stopped the stormwater from getting into people's houses. The extensions acted as a barrier, blocking stormwater (and sewage) from running into people's homes. So, while the CW1 extensions may have restricted the movement of people by directing where people could walk, the structure prevented stormwater and blackwater from getting into homes. It was this specific benefit of CW1 that other people in the Silvertown area wanted to see repeated near their homes (rather than the greywater collection and treatment).

In the same way, the extension of CW2 prevented stormwater from flooding houses. One of the residents who stayed a few houses away from CW2 told the researcher that the stormwater used to sometimes reach into their house. However, since the Phase 2 construction of CW2, this has no longer happened. How the CWs were

designed in Phase 1 meant that the taps were separate from the CWs. This meant that there was a gap between the tap and CW2 where the stormwater could infiltrate when it rained a lot. Connecting the tap to the CW by creating a washing area reduced this stormwater flooding risk. In addition, the increased height of the washing area reduced the flooding risk.

4.12.6. The suitability of the CWs

During Phase 2, most people using the taps where the CWs are situated did not see any reason not to use the CWs as it was clear the CWs and the taps were interdependent. Evaluations of the suitability of the CWs was helped by the fact that the COVID-19 restrictions were far less than in Phase 1 (but only ended altogether on 22 June 2022, shortly before data collection ended). This allowed for more careful evaluation of the suitability of the CWs from interviews and observations. The acceptance of the CWs by the residents made the CWs part of everyday life in Silvertown. The usefulness of the CWs came from the fact in Phase 2, unlike in Phase 1, the CWs were perceived to providing people with solutions to broader problems. On the other hand, the leakage of the taps attached to the CWs affected the flooding of the CWs. The plastic taps were not durable enough to last long; therefore, they would start to drip after some time, and if metal taps were installed, they would be stolen within hours or days.

The use of the CWs was considered as automatic and natural by residents. In essence they could carry on with their greywater disposal as was practised before the introduction of the CWs. The one thing that did change was the residents views about different types of greywaters. In Phase 1, people feared using the CWs in case they would damage it or use it incorrectly. In Phase 1 they would therefore dispose of their wastewater on the side of the CWs. In Phase 2, even when residents were satisfied with using the CWs, most residents would still differentiate between which greywater could go into the CWs and which should not. Based on the observations

and the formal and unstructured interviews, dirtier water, like night water, was put into the gullies. There were two reasons for this practice. The first reason was that they viewed greywater from their household, especially when mixed with urine from during the night or with vegetable and animal matter from cooking, as too dirty to be in the CWs. The second reason stated was that putting this household wastewater into gullies would help evacuate the water quickly, rather than spending time moving through the gravel bed of the CWs.

Therefore, the wastewater that went into the CWs was mainly water from the tap, such as washing or rinsing water. The Phase 2 CW enhancements became suitable for activities like washing because instead of people extending their backs when washing, they could place the washing tubs on the raised platforms and only bend their backs slightly when doing the washing as seen in Figure 41. There were several people who said the washing areas were appropriate because they made washing easier than before. Other people from the other parts of Silvertown and from other sections of Setswetla noted that they would love this intervention, especially for washing reasons.



Figure 41: Washing activity taking place at CW2

Photo: Motshwaedi Sepeng (researcher)

4.13. Formal observational evaluation of Phase 2

A formal observational analysis was conducted by a master's student over the course of one week (Tuesday to Monday) in September 2021. Once again there were concerns over safety and so observations occurred during the day from 08h00 to 15h00. Three student volunteers and three trained community residents worked in pairs with rotation between the three observation sites to reduce observation fatigue. As with Phase 1, data on each site user (age, gender, type of activity, type of container, size of container, and length of activity) were collected on a data sheet. The frequency of use over the observation period is shown in Table 6.

Table 6: Activity type in relation to site use Phase 2

Site	Total Use	Collection	Washing	Disposal
CW1	175	86	41	48
CW2	63	33	10	20
CW3	259	12941	43	87

At Phase 2, CW1, was shown to be regularly used. CW2 was used the least during the observation period. This was probably due to the location of the CW, which meant that it was only accessible by a smaller number of households. Unlike in Phase 1, there was a significant change in the adoption of exaggerated stooping postures when collecting water and when conducting washing activities.

4.14. Conclusion

The results of this study take us on a narrative journey of understanding the extent of the CWs as heterogeneous infrastructure on existing configurations in Silvertown. The main aim of the research was to understand the configurations formed with the introduction of the CWs, the factors shaping the residents of Silvertown's relationship with the CWs, and the extent of use of the CWs. The iterative design process was an important dynamic that produced Phases 1 and 2, but also the outcomes of the building and the use of the CWs at the different phases. The design workshop was a positive stepping stone in getting the URBWAT project team and residents to find commonality with each other about the greywater issue and the CW solution. Silvertown was chosen as the starting section for the URBWAT project because of the availability of space to build, compared to places like Masinwini, which had limited space. Other sites like Giyani and Old Setswetla already had makeshift greywater infrastructure.

The construction of the CWs in Phase 1 occurred in 2020, just after the conclusion of the design workshops. People were hesitant to use the CWs as some people, including those people who attended the workshop and meetings, claimed to need to be more knowledgeable on the use. Phase 1 also had additional problems related to sabotage and lack of evaluation because of the COVID-19 restrictions on movement. Phase 2, on the other hand, began in 2021 following the formal observational evaluation that was conducted for redesign, following evaluation results from Phase 1. The evaluation from Phase 1 brought impactful innovations like the formal gully next to CW1, the wall extension for both CW1 and CW2, a staircase, and a ramp. These innovations helped integrate the CWs into the functionality of the existing infrastructure, especially the gully, which allowed residents to choose where to dispose of their wastewater. The suitability of the CWs as a whole from Phase 1 to Phase 2 depended on the residents who were using the taps next to the CWs and their required activities.

Chapter 5. Discussion

5.1. Introduction

This chapter will help the reader understand the significance of the data by highlighting the critical parts of the research in relation to the theory, its practical and theoretical consequences, and the improvements it can make for future advances (Taherdoost 2022). I started highlighting the gaps that exist in the framework of HIC and indicated how my study in Silvertown analyses the way different configurations work, looking at both greywater and related infrastructure. The chapter then continues by presenting the primary arguments and contributions to the existing body of knowledge based on the findings. This includes giving a comparative analysis of the two phases. The chapter then continues by presenting the primary arguments and contributions to the existing body of knowledge based on the findings. This includes giving a comparative analysis of the two phases. The chapter continues by discussing the various infrastructural and social challenges that affected the effectiveness of the CWs. This is followed by other challenges that affect the functionality of the other services systems in Silvertown. In relation to HIC theory, in Silvertown this research shows how the people who making the infrastructure are a primary contributor to the heterogeneity that has maintained the functionality of these informal settlements. The URBWAT project's impact goes beyond the CW installation by establishing additional infrastructure like walls, stairs, ramps, and pathways. Before concluding this chapter, a discussion of Lefebvre and Simone's contributions about space as complicated social construction and people as infrastructure is considered, by discussing how past inequalities are still occurring through the lens of political ecology.

5.2. Added knowledge to the body of work on heterogeneous infrastructure configurations.

5.2.1. The uniqueness of the case study of Silvertown

The case study of Silvertown was different in that there was an investigation on a service (greywater solution) that has not previously been considered essential in the

context of South African informal settlement sanitation. In this research, I have used the lens of HIC to explore how the inequalities of sanitation are embedded in the infrastructural configuration of the network (Rusca et al. 2017). Greywater sanitation in this regard has not been explored using the HIC as an analysis. What has been covered is sanitation and access to toilets. Before data collection, I realised that in the literature on urban studies and HIC, the focus was on access to toilets and black water treatment sanitation in the work of (Alda-Vidal et al. 2018; Lawhon et al. 2018). Therefore, my study agrees with HIC that the “modern infrastructure ideal” does not provide universal, especially in an informal context. My research adds empirical HIC knowledge on the conditions under which particular socio-technical artefacts work by analysing greywater through establishing the CWs in Silvertown.

Blackwater sanitation heterogeneity is among the other service and infrastructural examples used to highlight or explain HIC; little has been written about the heterogeneity among the other types of wastewater (sanitation) systems. Even McFarlane et al. (2014) show how various social processes enable different access modes to sanitation options. Toilet access has been presented has been highlighted, and HIC has been outlined. I wanted to go beyond human excreta analysis of sanitation to domestic wastewater disposal and greywater. The investigation for this research was necessary because there is a lack of any code of practice for the use of greywater in South Africa, according to (Carden 2006); essential water supply and basic sanitation have been attempted frequently without giving adequate attention to greywater management in those areas that are not sewered like Silvertown (Carden 2006). Indeed, this research has gone beyond human excreta analysis of sanitation to household wastewater disposal. Silvertown case study has added much needed empirical knowledge to the body of work on water and sanitation regarding greywater.

Silvertown presented the opportunity for a different focused sanitation type to be outlined. This has also explained the broader heterogeneity that results from the absence of municipality support, which leads to people making the infrastructure work for themselves, as pointed out by (Simone 2004), but in the context of an informal settlement. The HIC of CWs as multiple and partial infrastructures includes different coverage, technologies, operations, logic and ownership layer infrastructure (Lawhon et al. 2018). What I have presented from the result, I call it “system interactions”, this is where I elaborate on the interactions between the services and infrastructures in Silvertown. These artefacts are socio-technical because their operations have been presented as system interactions that are enrolled in dynamic networks that shape the extent of everyday life Silvertown. Based on the various connections and disruptions between them, I am now questioning using the term system as a layout and considering it as a configuration in line with HIC. This is because the infrastructure and services in Silvertown involve multiple technologies, relationships, capacities, and operations, which entail different risks and power dynamics (Lawhon et al. 2018). Other studies of HIC have presented and analysed service and infrastructure case studies separately with no interlinking in showing that HIC can have positive attributes of longitudinal configuration if the iteration considers the social-laden choices of social or technological intervention (Lawhon et al. 2018; Sseviiri et al. 2020).

There is a good point made by urban studies on infrastructure that development studies on networked that is managed by the municipality has made the point that such technologies are insufficient and static (Nakyagaba et al. 2023). In this research, there is an analysis of CWs as configuration within the sphere of water and sanitation. Still, because of the closeness of the settlement, informality sometimes lacks order of how service is used. CWs have been enrolled in dynamic networks, in this case, within other systems. It hard to ignore the interconnectedness of nature and how the other infrastructure present influences the CWs. The dynamic network in this research has added a different demission to HIC that are rippled and multi-layered which shows lack of provision and authorisation but also a community trying different manners of survival to meet the standard of modern life.

As stated in Ernstson et al. (2022), I examined HIC as a solution to address deficiencies in State-controlled monopolistic services.

In the findings, both physical geography (space and place) social geography (who is doing what) have been found to contribute to the heterogeneity of everyday life in Silvertown which is dynamics I intended understand at the beginning. Silvertown is also different from other parts of Setswetla. This is determined by the physical geography of the place, the slope and proximity to the river and infrastructure like skip bins, taps and other services and infrastructure is general. For example, the level of the HIC that people can engage in who are situated close to the river are more dynamic than those who live in the main Silvertown. The illegal land grabbing in Silvertown, close to the river, has meant that incoming people who want accommodation can negotiate with the people in the main Silvertown.

The lack of service delivery and order has meant that heterogeneity is the way of life. When Simone (2004) was talking about “people as infrastructure” the reference also in Silvertown is that people are just coming to get accommodation and to improve their lives. The people have adopted various methods from other places they have encountered in their lives to make sure that greywater and other disposed water gets channelled into the river. The physical slope, slanting towards the river has meant that depending on the hierarchical status of where people live, there are different heterogeneous adopted infrastructures that people used or use to dispose of their greywater. The dynamic network of power discussed in HIC constructs the social norms of how things occurred. The heterogeneity of sanitation in Silvertown has meant that people close to the river can have a leeway of having toilets which they can empty into the river unlike the people who are more inwards who might be questioned for doing that. This is an addition to the story of Amaka Lawhon et al. (2018) whereby there are illustrations of HIC about the different methods to relieve herself and not just through using the a “uniform” manner of using toilets. Here in

Silvertown, we see the heterogeneity of physical geography in relation to Amaka example.

Greywater disposal with reference to the application of the CWs seem to be applicable to people who are not close to the river. The heterogeneity of building drains and pipes to remove or discard greywater is because greywater is visible and cause immediate problems like mosquitos. Those close to the river they sometimes dispose directly into the river. The ones that have connected pipes from their homes into the street also see their waste ending up either in the street or in the river. The people who are caught in between, (far from the river and at a distance from the CWs or available drains and streams) find disposal outside their homes. The ones using the CWs as result proximity it makes sense for them to dispose of their greywater in the. The physical geography and infrastructure availability in Silvertown contribute to the idea that specific types and levels of infrastructure provision are intertwined with and arise from broader technological, economic, and global processes such as globalisation, liberalisation, privatisation, and digitisation (Rutherford et al. 2015). Additionally, these processes have led to negative social and spatial consequences due to the disintegration and fragmentation of network systems.

In the cases presented, HIC is about what kind of services, but here in Silvertown, I am describing the why of the heterogeneity. Firstly, I talked about the geography of where infrastructures are placed, where people are placed, and what becomes available to people in that regard. In that regard, I have given documentation of the history of Silvertown and why the heterogeneity is continuous. Secondly, I show that these configurations are shaped by social geography, where Silvertown is located, and the purpose for which people use the space. For example, those who are the original dwellers of Silvertown dictate and influence how heterogeneous configurations occur. The analysis of greywater in Silvertown has emphasise that there are different relationships that vary over time and space (Cass et al. 2018;

Nakyagaba et al. 2023). Space is fundamentally a matter of politics. This is because space inherently has political implications, thereby giving rise to the politics of space (Heinickel et al. 2019). Historically, how Silvertown was formed was political, and we have come to understand that this history has created heterogeneity within the community. I the same conceptual idea of “infrastructural past” of postcolonial and Southern cities where most of ordinary people’s experience was never put on record (Ernstson et al. 2022). But the difference in Silvertown is that infrastructural services of greywater have never been formally recognised as a basic need like other services and infrastructures that have been recognised. Over time, this heterogeneity has created off-grid sanitation technologies. This has made case studies to explain HIC in a different context because, over time, this is how people have made sense of the predicament they find themselves in. This research has shown that it is essential to consider this heterogeneity and informality in investigations of informal settlements as HIC is always continually constructed.

5.2.2. HIC investigation longitudinally.

Through my longitudinal study conducted in Silvertown over the years, this study has endeavoured to address the academic demand for research on an additional factor influenced by everyday circumstances: the varying responses of heterogeneity to contexts of precarity. The longitudinal investigation meant that the CWs were enrolled in dynamic infrastructure and service networks that cater to greywater disposal and provide possible intervention. Coming into communities like Silvertown, it is essential to realise that the informal nature of the place has embedded itself into everyday life occurrences. Service and infrastructure are not all uniform. In Lawhon et al. (2018), in arguing for HIC, we are told that the idea of universal provision is not equally distributed. Therefore, the case study of Silvertown has shown that it was not just the greywater disposal that needed more service, but others required attention about the functioning of the CWs. The CWs were not a single structure of influence, but the documentation over time created the possibility of intervention. The Silvertown project has expanded its inquiry beyond discussions about the ownership of the state, community, or private entities

and the formal or informal systems. Instead, it focuses on a comparative analysis of the factors that enable gradual transformation (Lawhon et al. 2018). The incremental change in this sense is what phase 1 data collection deduced: the need for structures of additional value to the community of Silvertown. There is an incline coming out of the houses towards the tap where CW1 is situated, and kids and older people were seen struggling with the slippery surface. There was also the problem of water flooding into people's houses when it rained and when there was an overflow of sewage from leaking pipes. This also meant that some trenches, like the one by CW1, needed modification. Indeed, in addition to understanding how people were relating to the CWs, concerns over the creation of pathways and mitigation of flooding. My research intended to raise collective demands, which might lead to demands grounded in everyday realities (Silver 2015). In the end, the focus was not just on the CWs but the need for an additional infrastructure of influence, a staircase and a ramp for a better pathway, walls to limit flooding and lastly, the building of gullies to enhance the trenches formed and created for wastewater flow.

However, we have come to understand that there are interconnected links among the many infrastructure components (Lawhon et al. 2018). Silvertown, as a system that serves its community, has diverging social, spatial, ecological, political and economic implications. There are physical and social dynamics of how people have heterogeneity made sense of this environment. The research has provided answers to the social, financial, and ecological justifications of modernist systems that have been challenged by Rutherford et al. (2015), particularly in Southern contexts of informal settlements, where infrastructure disruption is familiar rather than rare (Graham 2010). Empirical chronological documentation and the outcome of this heterogeneity in Silvertown explained HIC in an informal context with a greywater problem and the viability of implementing nature-based solutions in the form of CWs. There is evidence of a risk and power relationship, a socio-technical artefact referred to in (Jaglin 2014; Lawhon et al. 2018; Smith 2023). Silvertown, as an informal settlement, possesses dangers such as the ones documented: poor

sanitation, illegal electricity connection, flooding, etc. The hierarchical system within Silvertown and Setswetla is outside the normative trajectories of urbanization (Simone 2004) that sustain everyday life. Simone (2004) talks about transnational economic networks; in this study, there are different societal structures that make the infrastructure and service work in Silvertown. How infrastructure and service work in Silvertown in the reimagination of Simone's (2004) work explains the past, present, and future heterogeneity. This perspective explains how modern infrastructure is ideal rather than an abstract idea of how it is bound to be. Everyone needs equal access to electricity, waste collection, water access, toilets, and housing, but social networks sustain everyday life in Silvertown. Lawhon et al. (2018) highlight that although the norm of the infrastructure ideal is widespread, informality nevertheless prevails as the majority state. Therefore, the implementation of the CWs must be carefully planned within the framework of the confinement's socio-technical concept. This study has investigated the circumstances in which socio-technical objects function, recognising that infrastructure is not just built on physical components (Simone 2004). The realisation of the embedded social relation (the people's inputs and responsibility necessary using the CWs) to make them work for themselves. The design and the building in phase 2 proved to show that the "iterative", the continual process of planning, analysis, implementation, and assessment, could lead to desired results. The critical part here is building with the idea of what people want about what is possible. Still, the difference is that this was based on a service that the municipality has not given the necessary attention to. It is like the idea that the emergence of anything "locally" might be influenced by several factors rather than only being a consequence of colonialism and globalisation forces (Lawhon et al. 2018).

5.2.3. Introducing HIC into development approaches that are already diverse.

HIC is a positive attribute; it encourages adding ideas that fit in with what is already thought and displayed as an infrastructure. With careful planning, it is possible to integrate something already heterogeneous in the informal settlement. I am talking

about what is already complex, dynamic, and multiple. An example is the CWs. In developing the CWs, we had to be careful of this dynamism. It was realised that more is required to put CWs next to the tap. What was rather found was that greywater is mostly disposed of where it is generated. In the phase 1 implementation, putting CWs next to a tap would work based on seeing what has worked in another part of Setswetla, like having drains adjacent to the tap. On certain occasions during the data collection, the realisation was that drains solved different problems. In other places, the reason for the drain was not necessarily to solely dispose of greywater but to make sure that the greywater would not block the path. In the case of Silvertown, where the CWs were implemented, there was not an obvious path, but there was an obvious ditch, and all the CWs did in phase 1 was create a complicated way of depositing water. The game changer was in phase 2 when we realised that in the perfect mind of the residents, they were using a ditch, just tilting a bucket into a ditch. This practice was then implemented into the phase 2 building. Therefore, a couple of things can be brought together: raising the point of disposal (platform) and helping by protecting against sewage flooding. This positive attribute gives HIC the acceptability of implementation on the existing connection.

In a way, Silvertown, with the implementation of the CWs, has just given an empirical example of showing that in such a dynamic environment, you cannot just create something new but rather look at how the infrastructure integrates. This is what HIC states: eliminating the use of the phrase “alternative” e.g. (Rutherford et al. 2015). Although the norm of the infrastructure ideal is widespread, informality nevertheless prevails as the prevailing situation. In Silvertown, we employ “heterogeneous” to acknowledge social and material aspects and question the distinction between formal and informal. This is precisely what happened in phase 2 with the documentation that gave rise to understanding the dynamism involved to ensure that design and building incorporate networked services related to greywater disposal, such as raising the platform for people to dispose of greywater ergonomically. Instead of creating another infrastructure that is not integrating,

questions were asked of how the CWs integrate, what the reason is for the way it is set up now, why it is set up like that, and what other problems are there that can be solved. It was going around to find out about the issues related to CWs in phase 1 mistakes and observations of the daily activities. HIC becoming a positive attribute is integrating gaps in development into the solution that inspires change. As discussed in (Lawhon et al. 2018), the central idea of HIC involves attaining this desirable characteristic. This analysis goes beyond whether the state, community, or private entities and the distinction between formal and informal infrastructures should hold ownership. Instead, it focuses on comparative thinking about the circumstances that enable gradual progress. The iterative process that established a “community of practice” between Silvertown and the URBWAT project team involved integrating “new infrastructure implementations” into a network configuration consisting of numerous and incomplete infrastructures, incorporating various coverage technologies (Anand 2011). It was also found that the CWs blocked all the sewage that ran down and threatened to flood the people’s homes.

Additionally, walls, gullies, a ramp, and a staircase were integrated to consider what the community alluded to. Building a wall to stop the flooding related to sanitation is part of the “reconfiguring” alluded to in HIC (Rutherford et al. 2015; Lawhon et al. 2018); the point is that infrastructure is inherently dynamic, experiencing ongoing alterations in building, assembly, repair, and maintenance (Geels 2002). This blueprint aims to establish a structured framework that enables individuals to make well-informed decisions, particularly those that are challenging and politically charged. (Lawhon et al. 2018).

5.2.4. HICs are continually constructed.

This research has shown that infrastructural development is fluid (Sseviiri et al. 2020), especially in the context of informal settlements or places that are underserved. Coming to Silvertown with the idea of CWs, heterogeneity of doing things was found, and this is to say that infrastructure and development are attached

to dynamic networks of power that shape their existence (Lawhon et al. 2018). Silvertown is a place that is in flux. It is always constructed and reconstructed. The CWs' existence constantly embroiled the dynamism of unpredictable everyday life in Silvertown. Compared to before, when the people of Silvertown came, the availability pattern was based on less movement about the available services. The pattern of availability of the infrastructure and services is based on residency embroiled with heterogeneity of people making the infrastructure work for them. An interesting heterogeneity is that people make connections on the formal taps. Before, as it was said, there were few taps in Silvertown, but now people have created a couple of connections to ensure they do not have to travel far to access water from one tap. This research found that each time there was a connection to a tap, a spot would be where a potential greywater was being generated and where it needed to be disposed of. As a result of the connection between accessed water and greywater disposal, the heterogeneity grows as people connect to water to have dignified access where they do not have to get out of their dwellings and walk to collect water. The heterogeneity is dynamic; what is constructed is also reconstructed as the society within is directed by informality and, to an extent, lawlessness. The practices observed in Silvertown reflect Simone's (2004) concept of "people as infrastructure" when the reference is to the uncertain and often unstable process of revitalising the inner city. This is particularly relevant as the policies and economic ties previously anchored the inner city to the surrounding areas have largely eroded. The HIC grows based on having, as other parts of the HIC change. Another good example is also the mobile toilets. As the residents realised that the hired company would not clean the toilets properly, they implemented a roster among themselves to clean the toilets. There is a disconnection because staying in Silvertown legally feels that those who are illegal occupants would use the toilets without taking responsibility. The configurations heterogeneous artefacts normative ideal did not work where people shared the toilets as groups, not everyone having access to all the provided mobile toilets. The Silvertown case study adds to the work on HIC that shows how infrastructures have become layered by multiple and partial infrastructures, including different

coverage, technologies, operations, logic, and ownerships (Lawhon et al. 2018). The same can be said about locks put around the taps to make sure that there is controlled use of the taps to ensure sustainability.

The CWs in phase1 were implemented but because of the nature of dynamic changes that is embroiled by social organising, ownership, and power relation within the community. CWs were forced to be involved in the iterative process fulfil the disconnection which meant to connect people to meet their greywater disposal needs. It is said in Lawhon et al. (2018), kinds being mixed are not clear from the outset. The key here was to understand the presence of multiple technological artefacts, uses and users (McFarlane et al. 2014). The CWs in phase 1 were infrastructural, but because of the nature of dynamic changes embroiled by social organising, ownership, and power relations within the community. CWs were forced to be involved in the iterative process to fulfil the disconnection, which meant connecting people to meet their greywater disposal needs. Lawhon et al. (2018) say that mixed kinds must be clarified from the outset. The key here was understanding the presence of multiple technological artefacts, uses and users (McFarlane et al. 2014). The HIC of the CWs in Silvertown is different from the application solution such as water (Ernstson et al. 2022; Ernstson et al. 2022; Karpouzoglou et al. 2023), waste management (Sseviiri et al. 2020), toilets (Lawhon et al. 2018; Nakyagaba et al. 2023) and electricity (Smith 2023). The application of CWs in this complex environment was not easily determined; therefore, deciding what to do required the adjudication of values (Lawhon et al., 2018). The documentation in understanding helped see that a nature-based solution as a northern-derived ideal needed consulting and tweaking in serving the community. An example is used in (Lawhon et al. 2018) to show the versatility in a northern context. Waste may pile up until state services return, but in Kampala, despite spatiotemporal frictions, the variegated structure of solid waste services allows a continuous flow of the waste material.

What is essential here is upholding the idea that HIC can be continuously constructed, and the CWs project realised the fluidity of patterns in Silvertown to inspire the continuous design and built/ service rather than accepting the situation as a single network system. The idea of CWs allows for interrelationships between different artefacts and their associated social relations that enable and constrain possibilities for use, intervention and broader progressive politics (Lawhon et al., 2018). The research showed the importance of recognising the dynamism; for example, if there was no iterative process, then different parts of the connection, such as the disposal streams, could have been ignored and given CWs the connection. In recognising the significance of this other part of networks, when the CWs are not working, the improved stream can also transport the greywater.

5.3.Summary of main arguments and contribution to the literature

In the literature review, HIC was presented as the theoretical framework to help explain how despite the inequalities of neoliberalism, infrastructural configurations can still operate effectively in the Global South. According to Keil (2009), neoliberalism seeks to diminish the provision of governmental services and security systems while emphasising the importance of personal responsibility and self-care. Gatwiri et al. (2020) notes that those with higher socioeconomic status often possess the financial means to access government services and security systems to engage in equitable competition within an unrestricted market. Conversely, individuals from lower socioeconomic backgrounds need help buying (or in many cases developing for themselves) these services, resulting in marginalisation from the wealthy. The ideology of neoliberalism, as observed in the late nineteenth century and its subsequent manifestation in urban revanchism, is not a concept that can be easily dismissed. However, if the problem is not addressed it can result in other economic, political, and social problems in the Global South.

Unlike your typical informal settlement “story” of land grabbing which is told by those who are wealthy and who have power, from the beginning, the people of Silvertown were moved by the municipality from Wynberg to be placed in Silvertown. Promises were made to these original settlers of Silvertown which were later supported by legal injunctions, and yet the people of Silvertown have remained neglected by the municipality. Instead, they have had to develop their own services to augment the minimal services offered by the municipality. This research has shown that the people of Silvertown, still have many state dependencies with regards to accessing services and infrastructure. Some of these services must meet the appropriate standards to serve everyone. For example, people wanted water close to their houses instead of having few taps available. In Silvertown, the people serve as infrastructure, representing the social infrastructure referenced by Simone (2004). Social infrastructure represents the types of activities that people engage in to ensure that the physical infrastructure serves them accordingly.

The HIC work references several aspects of the diversity of infrastructure and is intended to contrast explicitly with the uniformity of the modern infrastructure ideal (Lawhon et al. 2018; Ernstson et al. 2022; Sseviiri et al. 2022). In this study a different kind of infrastructure was introduced, and evaluation was performed to determine its suitability. As Lawhon et al. (2018) mentioned, there is a need for empirical examination of HIC in context. This research explains what it means for infrastructure to operate in Silvertown based on the expected uniformity (i.e., a full range of services to be provided by the municipality to ensure smooth community functioning) but in context of infrastructural heterogeneity. It should be noted that the CWs must not be seen as separate infrastructure from other methods of (greywater) disposal in this context but formed part of the configuration of options available to residents.

At the beginning of the URBWAT project, looking at the informality of Silvertown as a settlement, the thinking was that HIC would be the perfect framework for analysis - an analysis that would include the dynamics that might form when introducing CWs as a novel manner of greywater disposal. Lawhon et al. (2018), is the key literature used for framework analysis of HIC for this research. HIC is particularly relevant to “worlding” within Southern theory. This term suggests that what emerges locally can have several origins and is not just a product of colonisation, globalisation, or developmentalism but also of local invention (Roy et al. 2011). There are several examples from the results which have shown that the heterogeneity relies on multiple technological artefacts, that have multiple uses and multiple users as argued by McFarlane et al., (2014). This socio-technical variety of artefacts plays a crucial role in the functionality of urban delivery channels, (as highlighted by (Jaglin 2014).

The results have also shown that for some people, the infrastructure or service incorporates HIC characteristics. In 2021 during the data collection there was a participant from Silvertown who said that it would be better to have systems that would serve them without dependence on external parties. Again, during the phase 2 of data collection in 2021 there was a suggestion that in avoiding cleaning the CWs, there should be a big pipe that will take all the greywater away.

There are several examples of these taps and connections, such as electricity connections. This is why when the URBWAT project came to Silvertown, configurations needed to be fulfilled to support the daily operations. This is not to say that Silvertown had no systems to support the day-to-day operations. Waste removal systems, water access, chemical toilets, etc., are all part of the systems in Silvertown that were in place. The problem was that people wanted these systems to work optimally for them, so heterogeneous configurations were connected to these existing systems. In this regard, this research has provided an example of what

has been argued for in HIC: that systems are supposed to be perfect, but in some respects, they are insufficient for the people. This research has demonstrated and emphasised the significance of overcoming the artificial separation between “the social” and “the technical” when assessing service delivery and infrastructure. Instead of prioritising one over the other, it is crucial to recognise and emphasise their interconnectedness and reciprocal influence (Rutherford et al. 2015).

The implementation of the CWs exposed the interconnectedness of the different systems of services in Silvertown and the interconnectedness of the various configuration with the CWs. The evaluation in Silvertown has added another example to what has been echoed by (Lawhon et al. 2018; Sseviiri et al. 2022) that while “systems” are not explicitly present (the term “configurations” is preferred), diverse infrastructure components are nonetheless connected. The provision of services from the municipality and related infrastructure that has been connected made this happen. Water collected from the taps, used, and then disposed has created various disposal greywater gullies. The appeal of the CWs made some people value the CWs to the point where very dirty greywater was disposed of outside of the CWs with the fear that the system might not handle it.

5.4. Comparisons between Phase 1 and Phase 2

5.4.1. The building processes.

The construction of the CWs in Phase 1 was built on the preparation from the design workshops. It was difficult to gain people’s trust as the URBWAT project team were viewed as outsiders. There was a lot of deliberation and planning that came into play to ensure that the building processes were organised. The builder and his workers were committed most of the time, which helped the progress. The fact that some community members helped with identifying the builder and where to purchase building materials from within the community contributed to the success.

The fact that the residents understood that the project was based at a university (and not from a commercial enterprise or a government entity) also provided the research project with some level of trust. The only delays happened when the material had run out and the supplier could only deliver the next day. The critical point that worked in Phase 1 was that the builder did not have other jobs at the time, making him more committed to this building project.

On the other hand, the construction of Phase 2 had a few problems. At first, the construction process proceeded much smoother than in Phase 1. The builder and the construction workers were all from Silvertown and the construction was moving along at a good pace. However, after a few days he would leave the construction workers to do the work while he was doing other jobs elsewhere. When he realised that the project management was done by someone from Silvertown and not from the URBWAT project team, it was evident that he took advantage of this situation. Nevertheless, the project managers showed good leadership in conjunction with the construction workers to acknowledge that the builder was delaying the project and therefore needed to be replaced. This was the most significant difference between the URBWAT project team as project management (Phase 1) and members of the community as the project management (Phase 2). When the URBWAT project team was present, people wanted to demonstrate that they were doing things correctly. This was also evident during the data collection (especially the formal observations, but also possibly the interviews and ethnographic observations) where it is possible that the residents tried to act more formally.

5.4.2. CWs and solid waste

In Phase 1, the fact that CW1 was damaged almost immediately after being installed was an indication that greywater disposal (and the CWs) were a lower priority for the residents than the other issues facing the community, such as finding jobs, housing, and equitable access to services like toilets, water, and electricity. De Wet-

Billings (2022) mentioned that in the case of South Africa, growing inequities cause the government to be increasingly concerned with socioeconomic issues. Therefore, environmental problems (such as whether the physical environment will be damaged by greywater pollution) are low on the population's priority list. The other aspect is that the original members of Silvertown showed that their power held significant weight on whether specific issues would be addressed and they made sure that the sabotage of the CWs stopped.

It was obvious though that there needed to be a stronger connection made between the waste that is generated and the knowledge about its effects on the environment. Phase 2 showed that the solid waste problem and taking full responsibility for the infrastructure was beyond the scope of only dealing with greywater disposal, transport, and treatment. In Silvertown, there is a disconnection between generated waste and awareness of its effects. This was evident in other studies. For example, one of the participants questioned by Schenck et al. (2022) said that "even if the municipality places bins all around, people will still litter," and "people are too lazy to carry the waste to the bin."

Also, throughout the time spent in Silvertown, it was clear that there were strong hierarchical social systems, with people more than willing to listen to the leaders in the community. However, even this was not sufficient to control all people's behaviours. It was also too much to expect community residents to take extra measures to keep the CWs clean of solid waste. While the littering problem was obvious at the beginning of the project, it was hoped that this would not affect the functioning of the CWs. In retrospect this was probably a naïve expectation. Littering is a significant issue in developing and underdeveloped countries (Chaudhary et al. 2021). For example, ten rivers, all in developing countries, account for nearly 90% of all the plastic pollution in the world's seas (Schmidt et al. 2017). Solid waste is a problem that extends well beyond the CWs, and some of

the associated issues include obstacles like inadequate or restricted access to facilities, mistrust of the government, the cost of waste diversion programmes, the value-action gap, and unpleasant emotional reactions to trash (O'Connell 2011).

5.5. Reflections on the design workshops

In Phase 1, the utilization, or lack thereof, of the CWs can be attributed, in part, to the low attendance at the design workshops. Several factors contributed to this, including the plan to implement the CWs project in different sections of Setswetla, not solely in Silvertown. It is possible that placing greater emphasis on Silvertown during the design workshops could have facilitated greater planning and design solutions earlier in the process. This could have involved as many community members as possible to provide input throughout the design, construction, and utilisation phases. It could be argued that the limited workshop attendance had a ripple effect on the building and use of the CWs.

During the construction process, community members began offering input to the building team, sometimes resulting in wasted time. For instance, residents insisted on using the tap near CW1 despite ongoing construction activities. This necessitated a temporary pause to the construction to allow people to use the tap. Eventually, one of the community leaders in Silvertown resolved this issue by placing a padlock around the tap to prevent its use during construction. It is worth noting that alternative taps were available for community members to access water if they understood the project's importance.

Furthermore, CW1 sustained damage shortly after Phase 1 of construction, which may have been avoided if more people had attended the workshop since the workshop aimed to provide practical, user-centred solutions to challenging issues. However, the workshops should have addressed the possibility of sabotage because

it was obvious (even early in the design process) that people wanted to utilize the space for other purposes. This sabotage highlighted the contentious nature of residential space in informal settlements due to urbanization. Another problem that could have been avoided with better communication was the presence of underground electricity cables near the site of CW2. This was only discovered during the construction of CW2, and it posed a potential danger if not addressed promptly. Rectifying this issue caused a delay in construction for several hours. Community members could have raised awareness of this hazard during the design workshops. In addition, it was discovered that the pipe leading to CW2 was leaking, which was unexpected given the lack of prior electrical malfunctions. The utilization and maintenance of the CWs would have been more efficient if more people had attended the workshops to gain a comprehensive understanding of the project and to provide their inputs and concerns.

5.6. Iterative design process

Many of the actions undertaken in Silvertown underscore the importance of an iterative process in the design and implementation of infrastructure. The initial objective of the study was to install CWs in various parts of Setswetla, with Silvertown serving as the pilot site. The project's success in Silvertown would determine the subsequent development of CWs in other locations. Emphasizing impactful development in Silvertown necessitated the evaluation of project's success, for which the iterative design and implementation process proved essential.

The iterative process played a crucial role in facilitating the establishment of additional infrastructure in Silvertown as was used to constantly refine the effectiveness of the CWs as well as how CWs integrated with existing infrastructure. An integral aspect of this research was to document, evaluate, and critique the various stages involved in the design, construction, and utilisation of the CWs while considering the emerging dynamics. This approach also empowered

as it fostered a community of practice, facilitating interactions and idea-sharing between the URBWAT project team and the local community.

Evaluation through data collection was essential to comprehend outcomes and identify areas for potential improvement. The iterative process successfully evaluated the CWs, irrespective of whether their construction and implementation were successful or not. The results of the CWs implementation in Phase 1 necessitated the development of additional infrastructures that effectively supported the community's needs while also aligning with the URBWAT project team's goal of establishing CWs as greywater disposal infrastructure. These additions were not merely external but integral components, contributing positively to the CWs' effectiveness.

The community's involvement in the design, construction, and utilisation phases was crucial for the success of the process. The project ensured that community input was considered by forming a multidisciplinary community of practice. Neglecting community involvement would have resulted in community members demanding the removal of the CWs. The findings from the Phase 2 usage indicated that people recognised the value of the CWs. This was evidenced by their positive response to the addition of a washing platform, which enhanced water access and the washing process, while also facilitating easy disposal.

The iterative process was shown to be a pivotal factor in successfully developing infrastructure within informal settlements. Had the research team proceeded without continuous assessment and adaptation, as demonstrated during the vandalism of CW1 in Phase 1 and other problematic encounters, the research project's investment would have been wasted. The active consultation and design

process aimed at improving the CWs was crucial in mitigating potential issues and to find ways past obstacles to ensure project success.

5.7.The extent of wastewater disposal in Silvertown

Before the implementation of CWs, people in Silvertown disposed of their greywater wherever they deemed suitable. Those living near the river would dispose of their water directly into the river, while others in the heart of Silvertown would dispose of their water near the taps, or either inside their homes (for those few households who had installed their own pipes), or directly outside their homes. Currently, those living near the river continue to dispose of their greywater into the river. This indicates that the issue of greywater disposal raises more profound moral questions than initially anticipated. The CWs covered only some of the Silvertown area, and those near the river needed other essential services like access to water and toilets, so greywater disposal for them is a secondary concern. Assessing the moral implications of greywater disposal for individuals not directly served by the CWs becomes challenging.

The research team strategically determined the placement of the CWs in Silvertown based on factors such as available space and the presence of taps. The areas where the CWs were installed were generally busier than other parts of Silvertown. Consequently, people in different regions of Silvertown still need designated spots to dispose of their greywater properly, and still often resort to disposing of greywater near taps. The scale of CWs implementation needed to be more than two CWs in order to accommodate everyone and to make a substantial impact on the environment. Instead, at this stage the CWs have raised awareness among Silvertown's residents about the need to dispose of greywater to reduce associated risks. However, long-term environmental management, particularly concerning the destination of the wastewater, was not the primary concern for residents. In other words, although people knew the importance of proper wastewater disposal, it was

not consistently practised. This is unsurprising, considering that some individuals still prefer a piped system to transport their wastewater. There may still have been a disconnect between the URBWAT project team's project goals and the residents' idealized perception of the CWs.

However, expanding the scale of the CWs to encompass the entire Silvertown was not feasible due to space limitations in many sections of the settlement (and the research budget) and the reliance of the CWs on centralised disposal points. Additionally, the proximity of taps to the CWs was a crucial aspect of their design, and this infrastructure was predominantly present in Silvertown where the CWs were implemented. The need for more available space and taps in other areas poses significant challenges for scaling up the CWs.

Moreover, financial constraints and time limitations were significant factors that hindered the scale-up of the CWs across Silvertown. The project had a designated budget for a three-year duration, with a significant portion of the budget specifically allocated for the construction and monitoring of the effectiveness of the CWs. The budget was not specifically aimed at large scale infrastructure implementation. Additionally, the iterative process, which proved essential, necessitated careful evaluation to ensure the CWs met the community's needs. Achieving the objectives of the iterative approach, which involved evaluating the design, construction, and utilization of the CWs, required a substantial amount of time between Phase 1 and Phase 2 within the three-year timeframe. Consequently, scaling up the CWs to cover the entirety of Silvertown within three years would have been challenging to accomplish.

5.8. Obstacles that impede the CWs' ability to function well

5.8.1. External challenges to the CWs

The unforeseen external circumstances also contributed to the design of the CWs. Functioning taps and water pressure to continue to prove challenging. As much as the CWs are primarily disposal structures, they need a water tap nearby because most disposals happen when people use the tap. The CW plants need some water to survive (for example, in Phase 1, some of the plants in the CWs struggled to survive due to insufficient water in the CWs). Also, if there is no working tap and the only liquid that is disposed is urine then it is highly likely that residents would not dispose of this in the CWs. The results have shown that residents tend to use the CWs for disposing primarily greywater from washing activities and the greywater from other activities in the household tends to go into the gully. Based on this pattern of behaviour, if the water pressure becomes low, the future functionality of the CWs could also be in danger.

It must be remembered that residents wanted services that improved their lives. Therefore, there was a trend for residents to install connections from the main taps into their homes. This will not only reduce the water pressure but will also alter the disposal activities as it may shift the washing activities from the taps into households. The proliferation of piped connections into resident's dwelling is not the only issue causing low pressure problems. Other factors such as pipe and tap leakages and people leaving the taps open also cause pressure problems. The primary problem, of course, is that the area is too densely populated for the number of available taps. Some of the taps, like the one at CW2, do not have pipes that are dug deep, which makes them vulnerable to leakages from construction activities. There is a significant external challenge that is difficult to solve. One of the community leaders said they have no control over many things in the area. He mentioned people occupying the space illegally and causing some of the knock-on

problems happening. Importantly, he noted that these kinds of problems fall on deaf ears when they are reported to the municipality.

CW2 was seriously affected by a combination of stormwater and burst sewage pipes. One of the burst sewers was not directly because of activities in Silvertown (or even Setswetla) as that sewer comes from a more affluent community (Marlboro Gardens) further uphill. However, densification and insufficient maintenance in other areas has a knock-on effect for the people of Silvertown. The problem was probably not helped though by people building close to the gully and giving stormwater and blackwater few opportunities to disperse, thus creating greater concentrations in smaller areas. Another sewer adjacent to Silvertown also burst. These burst sewers created a continuous flow of water from Gousblom Crescent Road, near the toilets, and resulted from someone constructing a house on top of a sewerage pipe.

Stormwater on its own is possibly a type of water that the gullies (and the CWs) could have handled. The CWs could have handled occasional flooding with stormwater given the relatively low concentration of pathogens (compared to blackwater). The problem is that the blackwater has significant quantities of solids which settle in the gully, causing the level of the gully to rise. When combined with stormwater this caused the gully to overflow into CW2, resulting in an influx of stormwater and sewage, contaminating the CW.

5.8.2. Challenges affecting the CWs from behavioural interactions.

Unfortunately, the CWs are not only affected by the external factors, but there are also aspects that arise as direct result of the behaviour of people. There is lack of accountability from the community regarding responsibility for taking care and maintaining the CWs. The CW is a system that deals with waste, and it was evident

that they would become clogged over time. A system for monitoring the CWs to make sure that they get regularly cleaned needs to be implemented. In Phase 2 the gravel in the CWs was removed, washed, and replaced to make sure that the CWs function successfully. However, residents were very reluctant to be involved with the maintenance of the CWs. There appeared to be an expectation on the URBWAT project team to handle the maintenance and up-keep of the CWs since it was the URBWAT project team that had installed them in the first place. The CLF members noted that they cannot control everything that is going on in the community. The CWs were seen as a public infrastructure which can also be expensive, especially if the gravel might need to be removed and cleaned. If the community was to be responsible for the maintenance, then they also did not want people from other sections be allowed to use the taps. They felt that they were responsible for fixing broken taps and leaks and people from other sections did not contribute significantly and therefore should not be allowed to use their infrastructure. So, in a similar manner they felt that people from other sections would not know how to properly interact with the CWs (they might throw the wrong things into the CWs, and they would not be responsible for fixing these problems or for cleaning the CWs). However, it will be difficult to expect a community that is having significant social issues like poverty to be able to maintain the CWs especially as there may be financial implications (for example, who will pay for people to remove, clean, and replace the gravel).

Another problem that occurred was the health (and in some cases the death) of plants. People's actions towards the CWs contributed to this problem as some people were pouring hot water into the CWs, sometimes directly onto the plants. In encouraging people to use the CWs, they were invited by the URBWAT project team to dispose of their greywater onto the gravel area which included the plants. However, the URBWAT project team had expected the greywater to be cold. Cooking water could be disposed but it was expected that residents would wait for

the water to cool before transporting it. This was clearly a misconception and further design work would need to be done to resolve this issue.

In other HIC studies the solutions that have been provided, like water access in Rutkowski et al. (2017) or waste recycling in Schindler et al. (2019), have generated income. In those cases, it was easier for people to see the value in the solution because it directly impacted on their economic livelihoods. In Silvertown, however, the direct benefit for residents is not so obvious as for many people greywater disposal was not a problem that needed immediate solution. There were other problems such as job creation, adequate toilet facilities, electricity provision, adequate housing, and a reliable water supply that were viewed as far more pressing issues.

Also, the residents had already developed methods for disposing greywater which they felt were appropriate for their needs. When small amounts of greywater were produced, residents were inclined to dispose this greywater at the closest convenient spot, even directly outside their dwellings. The larger the amount of greywater being generated, from the washing for example, the more likely that a suitable communal spot needed to be identified. In these cases, greywater was usually disposed close to where it was collected, and makeshift gullies had been constructed to transport this greywater away. The environment creates common cultural knowledge, which affects an individual's morality in affective, cognitive, and behavioural patterns (Bentahila et al. 2021). Morality is crucial to the operation of every human group because it regulates social interactions and behaviours (Bentahila et al. 2021). In Silvertown there was not culture that each greywater production needed to be disposed of in the gully. The CWs created a different environment and a culture for of disposing greywater to try and change how Silvertown residents disposed of their greywater. It is questionable though whether this new way of disposal created by the CWs will be sustained.

5.9.The contestation of space

The issue of space contestation emerged as a significant challenge both before and after the construction of the CWs. Before the project initiation, it became apparent that the individuals residing along the Jukskei River were relatively new occupants. Some of these people had been relocated to the Greenhouse in 2016 following the devastating floods that affected Setswetla. However, the land along the banks of the Jukskei River was quickly re-occupied by new occupants. Furthermore, shortly after completing Phase 1, a resident built his shack right next to CW1. These instances highlight various gaps and challenges, including the lack of regulations and policies to control rapid urbanization and prevent land grabbing in informal settlements. This highlighted the pressing need for affordable housing despite the awareness of the associated risks. Such complexities and underlying factors are only readily apparent when studying the site. Addressing these complex issues requires a multifaceted approach that involves effective policy implementation and regulation to curb unauthorized construction and land encroachment.

Huchzermeyer (2003) reported that the extension in policy (known as the “Grootboom case ruling”) had yet to provide provincial and local governments with clear guidance on addressing the significant number of households living in informal settlements. This remains the case in Silvertown concerning land occupation. The municipality needs to demonstrate more involvement in regulating such issues. Instead, residents have tried to assume control over activities in and around informal settlements. This has resulted in ineffective self-governance of the number of dwellings within informal settlements because there are no enforcement measures. The historical development of Silvertown was initially concentrated in the central section and gradually expanded, further exemplifying the municipality’s reduced control and direction over the governance of informal settlements.

Over time, residents seek to modernize their living conditions to meet their needs better. In Setswetla, like many other informal settlements, there is a prevalent practice of unauthorized water connections from the main taps to individual homes. However, these illegal connections negatively impact the water pressure in the pipelines (Mothetha et al. 2013). When the project commenced in 2020, the water pressure from the main tap (CW1) was satisfactory, with only minor issues near CW2. However, over three years in Silvertown, it became apparent that the water pressure was gradually decreasing. The CWs were designed in a way that the plants rely on the presence of water. Fortunately, the water pressure did not drop to the point of no water flowing into the CWs throughout the day. The only significant problem occurred during Phase 1 when CW2 was less frequently used due to intermittent tap closures and low pressure caused by the tap near CW1 being used instead. These observations demonstrate that external factors, such as water connections and pressure fluctuations, can impact initiatives such as the CWs. Silvertown has been relatively fortunate compared to other parts of Setswetla, as fewer people have connected water to their homes. However, reports indicate that such connections occur in neighbouring sections, raising concerns about their potential impact in the future.

5.10. The complex dynamics of shared space

Silvertown, a small area with limited resources, fosters a sense of communal space and interactive activities. The residents are compelled to interact with one another due to these constraints. Within this shared space, individuals attribute varying meanings to services and infrastructure, even though they are communal. Certain services and infrastructure, such as water, electricity, and toilets, capture the residents' attention and prompt them to act. However, the issue of greywater disposal and solid waste garnered a far lower level of urgency for action. Silvertown exemplifies the concept of people as infrastructure as discussed by Simone (2004), as people go beyond the provided services and infrastructure to adapt their lives and to adapt the infrastructure to support their livelihoods. Infrastructure plays a critical

role in making Silvertown function, and individuals personalize the importance of services based on their specific needs and circumstances.

Regarding responsibility, once people have acquired housing and access to water and sanitation facilities (especially toilets), they generally feel content. Other activities are considered additional. Some individuals do not even come to the taps to do their washing. They collect water at the taps and take this water to wash at home, only coming to dispose of the greywater at the designated points. Nevertheless, the spaces for water collection and disposal are highly interactive. Water collection fosters community collaboration, where people come together to discuss how to restore services when these services are not functioning correctly. Due to its shared function and immediate necessity, water compels residents to find solutions promptly. Electricity is another service that brings people together. Residents collectively address the issue during power outages caused by load shedding or unauthorized connections. Instead of each community member individually contacting the power utility (Eskom), one elected representative communicates the problem. However, before reporting the issue, residents attempt to identify and resolve the situation themselves.

The lack of shared access to greywater solutions and the impact that the lack of these solutions has on individuals has contributed to the limited sense of responsibility towards greywater in Silvertown. Similarly, how blackwater sanitation has been handled impacts on how new solutions for greywater management will be seen. It is unrealistic to expect people to take responsibility for greywater disposal when there are already challenges regarding blackwater sanitation management. Residents have expressed concerns about the public nature of shared toilets, fearing that if they are publicly available, people will not take responsibility for their upkeep. As a result, residents have taken it upon themselves

to organize how the sharing of toilets takes place, and they enforce locking after use for security and hygiene reasons.

The CWs, since they are infrastructure for water disposal, fall into the services category, requiring more work to organise sharing and responsibility. Despite being close to the water taps, the CWs have received less appreciation from residents than other services like water. The reason is likely due to the perception that the CWs deal with waste removed from people's homes. During data collection, some residents expressed that the CWs were suitable if they were far from their homes. These sentiments relate to concerns about disposal of potential harmful water near their homes and potential leaks which might flood into their homes, which could indicate a lack of responsibility towards public infrastructure and a disregard for waste. However, this perspective contradicts with the idea that most residents wanted services like water to be close to their houses. A question arises as to whether infrastructure would be respected if there was a shift in moral values and a greater sense of responsibility. The idea of "as long as it is away from me, I do not care" regarding waste raises the importance of addressing the underlying moral and responsibility perspectives to foster respect for public infrastructure.

In Silvertown, various services and infrastructure, including houses built by the residents, have fostered a sense of pride within the community. Following the vandalism of CW1 in Phase 1 and its subsequent revamping in Phase 2, it was deemed beneficial to involve the residents more actively in project management. The notion of residents taking pride in their own houses, coupled with the alignment of community works with high-income countries in terms of development, led to the expectation that individuals would demonstrate responsibility towards the CWs, like their approach with their homes and the services they attach to their homes.

The current state of the CWs in Silvertown is significantly impacted by human activities, including littering and the improper disposal of greywater which contains solid waste. This unfortunate reality indicates that the CWs and other infrastructure in Silvertown are integral components of a communal space characterized by extensive interaction and various activities. It is crucial to recognize that in a community like Silvertown, not all initiatives are approached collaboratively, underscoring the intricate and multifaceted dynamics within the community.

5.11. Municipality responsibilities

The responsibility for the lacklustre practical implementation of services and infrastructure in Silvertown lies heavily on the CoJ. The residents' confidence in the CoJ has diminished due to perceived inefficiencies and lack of commitment to the needs of the community, leading them to rely on their own initiatives or external sources to fulfil their needs. The construction of the CWs was initiated to address the requirement for a greywater solution. However, it is worth noting that the residents felt that it was a government responsibility to provide such solutions and there needed to be more supportive policies in this regard. The backlog of essential services and infrastructure provision exacerbates the situation, resulting in heightened anticipation and criticism whenever development projects are introduced in the area. This dynamic creates an ebb and flow in the progression of the projects, as expectations, including job opportunities and additional construction of infrastructure, exert pressure on the implementation process. Criticisms, particularly from individuals who may have yet to participate in workshops or other meetings where suggestions were welcomed to improve the research project, further complicate matters. In the case of the CWs, these criticisms often arose towards the end of the iterative process when it was obvious that the research project was coming towards an end.

On a positive note, the CWs have offered temporary job opportunities, allowing community members to be involved in the development process. Once the construction phase was completed, individuals in Silvertown would approach the researcher to inquire about future construction projects because they needed employment. The challenges caused by backlogs in housing, water, and sanitation; breakdowns in communication and accountability; and issues related to the political-administrative interface and intra- and inter-political party dynamics Masuku et al. (2019) have negatively impacted governance and the provision of essential services in Silvertown.

5.12. System interactions

5.12.1. Multiple interacting service systems at play

This section explores the interactions taking place in Silvertown regarding services and infrastructure, revealing two distinct interconnections. Firstly, we examine the broader interconnection between services and infrastructure, as depicted in Figure 42 below. All the services and infrastructures form interconnected systems arranged based on design, usage, or production. Upon closer examination of the various networks, we observe the extent of interconnection.

In the second part, a specific analysis is conducted to determine which systems are interconnected with the CWs. These interconnections between different systems demonstrate the importance of considering infrastructure configuration in informal settlements, recognising that overlapping elements will influence their operation.

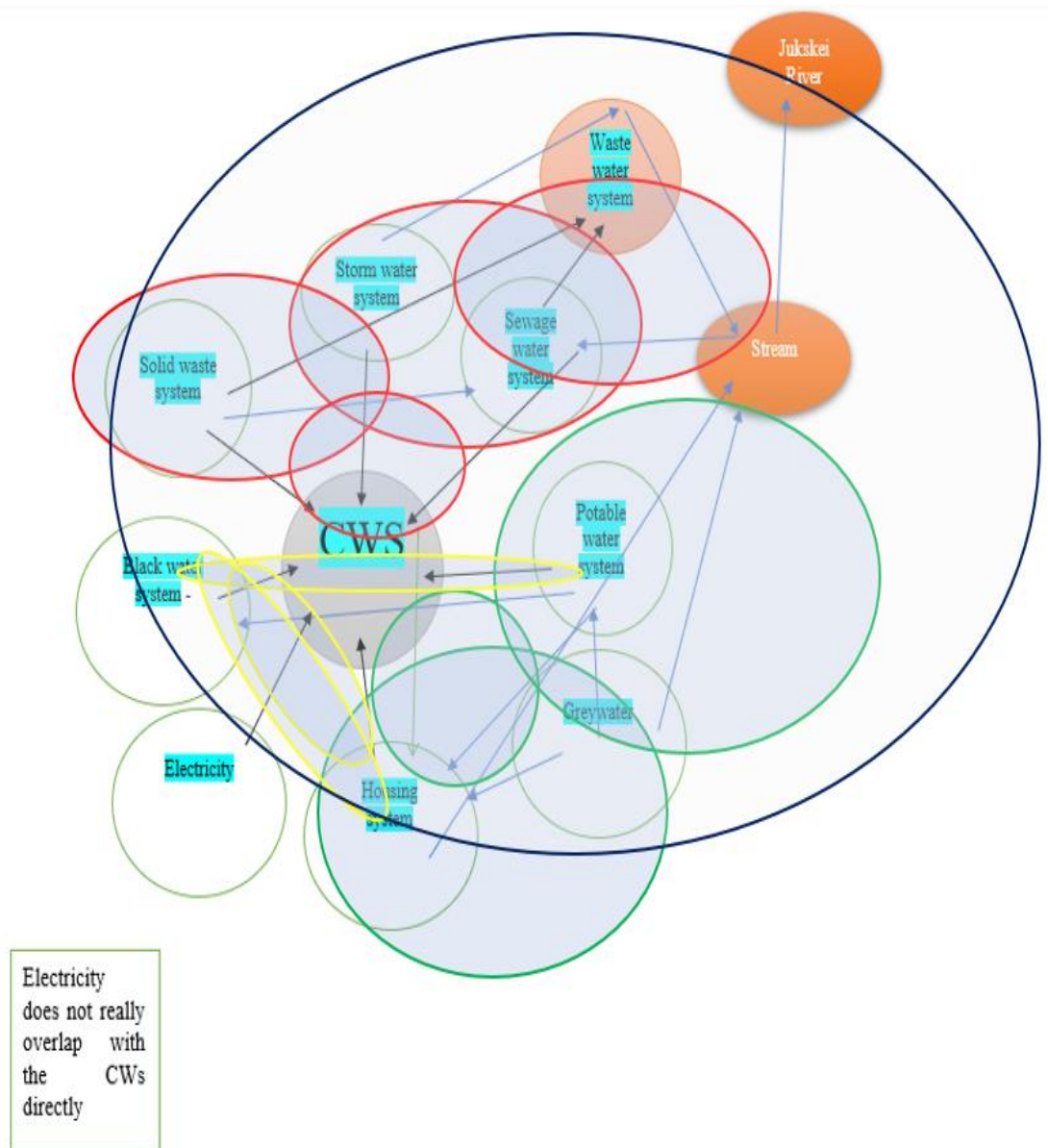


Figure 42: Illustration of related service and infrastructure systems in Silvertown.

Sketch: Motshwaedi Sepeng (researcher)

Silvertown is a system made of the “spread of networked infrastructure”, as mentioned in (Lawhon et al. 2018). Figure 42 was developed to echo what HIC has pointed out about the “spread of networked infrastructure” found in Silvertown and how people connected them to make services and infrastructure systems work for them. In this system illustrated in Figure 42, the circles represent the different systems of services and infrastructures. The CWs as a system or a configuration (grey circle) are directly influenced by the systems (green circles) with arrows pointing to them, like black water, solid waste, stormwater, sewage water, portable water, and the house around it. Electricity is likely to interact with the CWs if the cables fall in the CWs, but that has not happened yet. The red circles highlight the connection of the systems or the linkages of those systems that move through the trenches and gullies (stream) and end up being deposited into the Jukskei River (dark orange circle). Unlike the red circle system, the system of (green circles) goes through the CWs before it is channelled into the stream system and eventually into the Jukskei River. This diagram also has arrows illustrating the immediate interconnections between the system services and infrastructures. A good example illustrated in the diagram is that the solid waste system directly connects to the wastewater system, not the stormwater system. The system of yellow circles highlights the connection of disposal coming from the taps and households that end up in the black water system in the form of toilets. The figure 42 illustrates that Silvertown is strategically positioned within a network of links that benefit the community. Therefore, it does emphasise the complement of the interactive process that embraced these interconnections in Silvertown when altering in phase 2 to make the better version of the CWs in Silvertown.

5.12.2. Interconnections outside of the constructed wetland system

In Silvertown, multiple service and infrastructure systems are interconnected, even if they are not physically linked. The human element often plays a crucial role in these interconnections. Before the introduction of CWs, Silvertown had existing

services and infrastructure with their own interdependencies. This study specifically focused on the water and sanitation systems.

Residents' access fresh and potable water through communal taps. This water is connected to various other systems. Firstly, the potable water system provides water to individuals, and the resulting wastewater eventually moves into gullies and other constructed trenches. It is important to note that this water is collected and taken to homes for household use, including drinking, cleaning, and cooking. Subsequently, the generated wastewater is disposed of into the gully.

Another scenario involves people using water directly at communal taps to wash hands, clothes, shoes, carpets, linen, containers, and utensils. If the water is used within the immediate vicinity of the tap, such as for hand rinsing, the resulting wastewater may enter the CWs. However, activities like washing clothes also occur outside the tap area. In those cases, the wastewater typically flows into the gullies or trenches, eventually leading to the river. These various sources of wastewater collectively constitute what is commonly referred to as greywater, which does not always enter the CWs.

The interconnections among the different service and infrastructure systems in Silvertown illustrate the intricate pathways and destinations of greywater within the community.

Stormwater and sewage (blackwater)

In Silvertown, the greywater wastewater system outside the CWs can also be influenced by stormwater and sewage, including blackwater from overflowing sewers. In this context, sewage from a broken maintenance hole on the road and a

broken sewer adjacent to Silvertown is directed through the gully near CW1 and eventually into the same gully near CW2. This diversion aims to prevent the uncontrolled flow of wastewater through the community. During rainfall, stormwater combines with sewage water, and the resulting mixture becomes part of the outflow into the Jukskei River. Without sufficient protection though, this combination of blackwater and stormwater has the potential to flood the CWs and the community.

Solid waste, including debris and litter, also finds its way into the gully, where it can either be washed away or cause frequent blockages. The simultaneous flow of stormwater and sewage can burden other systems. For instance, between August and December 2021, an unattended sewer spillage was combined with stormwater from summer rains. As the stormwater and sewage entered the gully near CW1, the water volume became excessive, leading to flooding in CW2 and even inside people's homes. The presence of stormwater and sewage in the greywater system and the associated challenges and flooding events highlight the complex dynamics and potential risks the CWs and the wider community face in managing wastewater in Silvertown.

Greywater

Greywater in Silvertown primarily originates from residents' homes. This greywater generally ends up in three locations: on the road or pathways, into the drains of the CWs, or in the gully. Based on the formal observations, the last two destinations are the most common for greywater disposal. Greywater resulting from clothes washing, handwashing, and kitchen cleaning typically finds its way into the drains of the CWs. On the other hand, greywater from households tends to flow into the gully adjacent to the CWs. The interviews shed light on the disposal patterns of greywater, revealing factors such as distance from the CWs, personal habits, and individual preferences. After disposing of the greywater, individuals often rinse

their buckets near the taps where the CWs are situated. The subsequent rinsed water is then typically added to the water that enters the CWs. These disposal practices and rinsing habits demonstrate the various pathways and locations where greywater is directed within the community of Silvertown. Understanding these patterns is essential for assessing the impact on the CWs and effectively managing the overall wastewater system.

The blackwater system

In Silvertown, the blackwater system, which primarily consists of portable chemical toilets, operates as a closed system with limited interconnections to the greywater system. However, multiple blackwater systems exist within the community, each with its characteristics and interconnections. In the first system, many houses in Silvertown lack indoor toilets, leading residents to rely on portable chemical toilets or resort to open defecation if they do not have access to portable chemical toilets. After using the portable chemical toilets, individuals typically use communal taps to wash their hands. They may also rinse their chimbas, which are essentially chamber pots used to collect “night soil” or waste. These activities create interconnections between the blackwater water and greywater systems.

The second system involves formal sewer systems that intersect with Silvertown. Ideally, if the traditional sewer system functions properly, it would be separate from the greywater system. However, due to frequent malfunctions, sewage from burst sewer pipes in Marlboro Gardens often flows along the road and eventually enters Silvertown, leading to the intermingling of greywater and blackwater. Third, some community members have constructed toilets within their homes. However, only a few individuals have access to these toilets. Those with toilets in their yards have connected their household reticulation to artificial underground pipes developed by community members. The wastewater from these households is ultimately discharged into the Jukskei River. A distinct pipeline, located on the south of

Silvertown, plays a role in this blackwater system. These blackwater systems intersect with the housing, potable water, and greywater systems in Silvertown. This interconnection becomes particularly evident when the blackwater system overflows, spilling raw sewage through the community. These dynamics emphasize the challenges and potential risks associated with the management and interplay of blackwater and other systems in Silvertown.

The gully system is another system with many interconnections and multiple methods of interaction. This is where wastewater collects and is eventually transported to the Jukskei River. This is the primary means of greywater disposal. All these wastewaters exited into the Jukskei River through the gully.

5.12.3. Interconnections with the constructed wetland system

Household water interaction with CWs

Greywater is disposed of at different spots depending on the water produced. As mentioned, wastewater from the house usually goes directly into the gully and water used for cleaning at the tap usually goes into the CWs (before also entering the gully). People often want to avoid putting greywater from the household into the CWs. The thinking here is that if they put dirty household greywater in the CWs, then the CWs would smell. People believed that the CWs improved the quality of the greywater in the systems. The greywater that goes into the CWs is mostly from clothes washing and handwashing water. One person also generates greywater from a washing machine in their home and has a pipe that feeds directly into CW1.

Solid waste (skip bins) interaction with CWs

Some solid waste litter gets disposed directly into the CWs, although this is usually on limited occasions when solid household waste is in greywater that is disposed

directly onto the CWs. Bits of plastic, paper, rice, spinach, and meat bones mixed in with greywater from the household have been observed. This sometimes gets disposed into the CWs, although, more often, it is disposed into the gully. More often, though, when the skip bin is full, litter would get blown into CW1 by the wind. In addition, if the skip bin is full, the litter on the ground can get mixed up with the wastewater from the gully. This is also likely to happen when the skip bin is taken away to be emptied, and the community is left with no means of disposal of their solid waste. There is also solid waste that is thrown away with household wastewater.

Sewage waste (broken sewer) interaction with CWs

During the study, the sewage mainly got into CW2 when the water from the gully overflowed, flooding the CW. The gully parallel to CW1 carries the sewage from Gousblom Crescent Road (through the stormwater drain) that enters Silvertown. The gully takes this sewage water past CW1 until it gets into the gully next to CW2. As the sewage passes along, solid materials in the water (e.g., silt, toilet paper, and faeces) get deposited into the gully, effectively lowering the depth of the gully and eventually leading to flooding in CW2. This also happens when the sewage combines with stormwater.

Stormwater waste interaction with CWs

Like the sewage water, stormwater from the Gousblom Crescent Road enters the entrance of Silvertown through the stormwater drain, which is channelled into the gully next to CW1. This gully eventually transports the stormwater along the gully next to CW2. If the amount of stormwater is excessive, some of this water can get into CW2. In 2020, the rain was so severe that stormwater flooded into the CWs. The walls to the CWs were much lower in Phase 1, which was one of the reasons why alterations were to increase the height of the CWs in Phase 2. In Phase 2, the flooding only happened at CW2 when the gully level had risen due to deposits from

the sewage water. There is also stormwater that flows directly into Silvertown down the road. In this instance, the wall that was constructed usually diverts the water in the direction away from the gully but also away from houses.

Blackwater waste from portable chemical toilets' interaction with CWs

Blackwater waste usually gets disposed into portable chemical toilets. The blackwater containers (i.e., chimbas, or potty loos) are rinsed at the taps connected to the CWs. Based on the observations, the rinsing water does not usually go into the CWs. Instead, after rinsing, the water gets discarded and emptied into the gully. Some people in the community realise that the water from rinsing the chimbas is dirty and cannot end up in the CWs. There have been cases where people have returned to the toilets after collecting water in these containers to dispose of what they are rinsing. In addition, when people come from the toilets, they wash their hands at the tap at CW1, which ends up in the inlet of CW1.

Housing interaction with CWs

Space for housing is vital. Therefore, the introduction of CWs can pose a threat to space availability. If a CW is built next to one's house and they are not happy with that situation, then there are limited options. One option could be to move one's home to a different spot, which is not always feasible because of a lack of space and may be expensive. The CWs were initially built at a distance from the houses to ensure there was no direct impact on the housing infrastructure. However, by the end of the project, there were multiple instances of the housing infrastructure encroaching on the CWs. The CWs were subject to sabotage as part of this encroachment to try and get the CWs to be non-functional. There were also instances where people openly asked the research team to shift (or shorten) the size of CWs so that they did not encroach on space allocated for their housing projects. Other options could be people building on top of the CWs or advocating for the removal of the CWs. This was one of the options considered by the research team

should people be unhappy with the CWs at the end of Phase 2. However, there is also the likelihood that if some people want to remove the CWs to build a house, they may find resistance from the users of the CWs. This was the case as people were asked if they wanted the CWs to be removed. The residents were happy with the CWs, although they wanted alterations.

5.13. People made the infrastructure work.

The systems are interconnected in different ways, some functioning due to the municipality's duty to provide services to the residents. People have usually been the ones to make the infrastructure work to suit their needs. The services and infrastructure come with many obstacles, but the people always seemed to find ways to overcome the obstacles. The fact that the community has their local leadership forums to provide systems of power to deal with the different layers of municipality bodies shows that the people always needed to directly make their voices heard. It is courageous and commendable that the people of Silvertown try to make the backlog of government responsibility work for them. The effective system that allows the community members to communicate with the electricity supply when there are power cuts is testimony to the fact that people take it upon themselves to make this lacklustre service delivery work for them.

Residents felt that they should take power into their own hands. After all, Setswetla informal settlement is only a small part of Ward 109, meaning that their presence in the ward was not always visible. This is not to say that there is the complete gamut of services in Silvertown, but that where there are problems, the community has developed power structures that work more effectively to suit the community's needs. The neglect of these communities within the city has forced the community to develop independent power structures. Without government monitoring and regulation, the community grew to its current size. In some cases, a hierarchical

system of engagement with services and infrastructure has developed to guide how people engage, although these guides remain “unwritten”.

The power hierarchy of Silvertown is that the original “settlers” are the ones with the primary decision-making power when it comes to infrastructure, particularly in the case of the CWs, which were implemented with the full cooperation and support of the Silvertown CLF. The implementation and evaluation of the CWs went through a number of challenges over three years, but they remained because they were perceived to impact the community. Unlike the other examples of HIC that use services that people receive, like water, for survival, the CWs provide a service which was not necessarily survival-dependent but would add to the quality of life. Across the research project, the residents coordinated alliances to make sure that the CWs integrated into the hybrid system of existence. Still, the CW infrastructure created some disconnections. In Phase 1, some people thought the CWs were not easy to use because the only form of use was disposal through a raised inlet. Additionally, those living close to the CWs have complained about problems such as leaks and smells. In the same way that Simone (2004) felt that ignoring the human element of cities was problematic, the residents of Silvertown, by voicing out concerns to ensure that the CWs work for them, have bridged those disconnections.

5.14. URBWAT project development going beyond the research priorities.

5.14.1. Additional infrastructure implementations in Phase 2

The URBWAT project also decided to build walls, gullies, a ramp and a staircase as part of listening to what the community needed. These needs emerged from listening to the community on an ongoing basis, rather than simply asking the community to report and provide suggestions in formal settings. The building of walls, for example, played a significant role in deflecting stormwater. The efforts

of the URBWAT project were responsive and considerate to the issues that were affecting residents' wellbeing. Putting a wall around the points where the CWs were built proved to be an effective way to transition into assisting community residents with problems that extended beyond greywater. In fact, people in other parts of Silvertown have begun to prepare walls that perform similar functions in their own areas. They have seen what has worked for one part of Silvertown and are incorporating this in the design of their own part of Silvertown. Ideally, the roll out of CWs to other parts of Silvertown (and other sections of Setswetla) should happen organically and be driven by community involvement. However, there are other constraints to consider, especially costs and the threat of completely taking over the municipality's responsibility. Even with the wall being built in Silvertown, this still did not mean that water was deflected entirely. The point here is that even though there were additional solutions that were introduced by the URBWAT project, those developments still need to accommodate everyone.

The gully development, especially at CW1, responded to the recurring problems of stormwater and sewage. In particular, the upgrading of the gully has helped disposed water to flow more quickly away from the site of the disposal. Unfortunately, this just means that the wastewater gets to the river quicker, although it does meet the requirement of moving the dirty away from people as quickly as possible. The upgrading of the gully also sent the message that the CWs were complementary to their habitual way of disposing greywater rather than a replacement. This also complimented the HIC framework regarding new opportunities for social organisation, ownership, and power relations inside and outside the State. This supports a framework through which tough, politically charged decisions can be made more intelligently (Lawhon et al., 2018).

Even though cleanliness was a problem with how the CWs were maintained, CWs had well-coordinated systems as people tried to use them in distinct sequences. In

discussing this sequence with residents, it made sense that people prioritised putting cleaner greywater in the CWs and the more naturally dirty bath water and night buckets into the gully. While the CWs were intended for all greywater intake, the residents ultimately decided what was good and what was not. A strange paradox emerged here as the residents knew that money had been invested in building the CWs and they want to keep them “clean” (i.e., to mimic their perception of “first-world” infrastructure). The other point to note is that at night, especially for women, it was easier to dispose of wastewater where it was convenient (i.e., anywhere in the CWs or in the gully depending on where they lived in relation to the CWs) because of safety issues.

5.15. Political ecology of greywater management

The inequality of greywater sanitation is a political ecology discourse. Greywater in Silvertown is a problem that has both social and environmental implications. Political ecology is a framework that enables the analysis and interrogation of nature–society relations, particularly looking at the power relations that intersect and affect access to natural resources (de Micheaux et al. 2021). In the case of Silvertown, there is a lack of access and consideration of greywater disposal and the relationships between political, economic, and social factors and the environment. The paucity of greywater sanitation solutions in Silvertown is not by chance but a reflection of the past and current inequalities in South Africa relating to access. Rusca et al. (2017) pointed out that the inequalities of sanitation are embedded in the infrastructural configuration of the network. Silvertown demonstrated this because greywater infrastructure was not considered. It was hypothesized that some of the embedded inequalities result from the power dynamics. Inadequate access to water services, particularly in the less-wealthy world’s megacities, is the prime cause of premature mortality. This human and environmental cost dramatically outweighs global climate change’s predicted negative human consequences (Swyngedouw 2009).

Political ecology focuses on how power structures intersect and influence access to natural resources (Benjaminsen et al. 2021). Political, economic, social, and cultural forces influence and are influenced by ecological and environmental trends, as demonstrated by the setting of Silvertown concerning the CWs (Minch 2011). The nature of the politics involving the informal settlements has affected the access to services in Silvertown. The political (municipality), economic (cost of living), and broad social (housing, poverty) factors have shifted the focus from an emphasis on the management of greywater. The management of greywater must be incorporated into the government's priorities for the supply of sanitation services that have been set per the strategic framework, particularly in vulnerable areas where waterborne sanitation is not provided (Carden et al. 2007). Greywater disposal issues lead to environmental and health problems, especially noticeable in high-density informal settlements like Silvertown. Moving forward, a critical consideration of incorporating greywater management in the policy and implementation could be a step in the right direction.

Inequality of access to greywater sanitation could have dire ramifications for water access in Silvertown. The result showed that the makeshift pipes that the people have used to connect water are very shallow and pose other dangers as some of them are situated close to the illegally connected electricity cables. However, the other risk is that the uncontrolled disposal of greywater near the water pipes can also pose health implications. The CWs were built because of the danger that the CWs pose for children playing near the exposed disposed water. The other implication that has been highlighted is the eventual exposure to the Jukskei River, which gets multiple pollution inputs, including greywater pollution. Alemu et al. (2017) talk about barriers to sanitation because of the lack of access to facilities and appropriate sanitation technology. In political ecology, the discourse on how access in informal settlements is mandated has yet to progress to an extent where there is equality and equity.

One of the problems that places like Silvertown have, is that past governments and the current government have indirectly played a role in the contamination of the environment. The fact that Alexandra was neglected by both the Apartheid governments and the current government has led to consistent negligence of neighbouring informal settlements like Setswetla and Silvertown. The lack of developmental funding has led Silvertown's people to seek alternative means of meeting their needs. The other argument from HIC is that the plan for development in the Global South has yet to live up to the standards of the Global North because the occurrences in the Global South have different dynamics. Regarding the concept of HICs, the CWs in Silvertown formed a critical complementary infrastructure to what the people were using. The CW concept has improved and given awareness to how people think about greywater disposal.

5.16. Did the CWs make a difference in Silvertown?

The CWs made an impact beyond providing a greywater disposal solution, by incorporating other infrastructure. The CWs provided the community with another point of reference for greywater disposal in addition to how they were used to disposing of greywater. The CWs aimed to release cleaner water, but the functionality of the CWs was also interrupted by personal obstacles like vandalism, carelessness, and a highly dynamic environment. These issues also required addressing throughout the URBWAT project. Although the greywater that was released from the CWs was much improved, the same greywater from CWs was released into the gully which was contaminated with other wastewaters coming from the other disposal points as well as wastewaters coming from stormwater and blackwater. The CWs were one of many disposal points in Silvertown. Since there were no official rules on how greywater could be disposed, people continued disposing of greywater in whatever way they saw fit and were able.

Besides their functionality, the CWs provided an arguably more aesthetic alternative. The design and the building process of the CWs also provided hope. Once the CWs were completed, they looked beautiful and provided a better-quality solution than the previous infrastructure. After the CWs were built in Phase 1, a grandmother said that the CWs had brought beauty into the area. In Phase 1, people used the CWs, but several people were not aware about how to use the CWs. Another reason that they were rarely used in Phase 1 was that the tap at CW1 was broken and the water pressure at the CW2 tap was low. In Phase 2, people were more familiar with using the CWs, so there was greater interaction. Slowly but surely, through the interactive process, the CWs became infrastructure that people expected. The design improvements (especially the washing areas and the connection of the washing areas to the CWs) made a difference in allowing people to access and dispose of greywater properly without really having to change their behaviour. This was achieved in terms of the easy use of the infrastructure because the risen platform for water access and greywater disposal provided a simple but effective innovation. However, the CWs were placed at only two tap points in Silvertown, which meant that other tap points in Silvertown needed this infrastructure to get better coverage for a more complete solution. There were also other points where there was direct greywater disposal, like trenches and gullies.

The CWs also taught the URBWAT project team that when such projects are implemented, they do not just serve the primary purpose of a solution for greywater disposal. It also provided improved everyday functions in life. Indirectly, both CWs created pathways for people to walk on, especially when it rains. The most important indirect function that resonated with the people's needs was that the CWs also played a role as barriers for stormwater for the people staying close to the CWs. On the other hand, they also created problems, mainly when tap leakages occurred. In Phase 1, a resident said he wished that CWs would be moved from where they were because it needed to be more practical for him. The CWs were impractical

when it suited them because they connected a pipe from their house to the CWs. In this regard, the CWs helped dispose of greywater in a reticulated, piped system.

On the other hand, the CWs have yet to make that much of a difference for the people staying far from them. Indeed, it only makes sense for someone to carry a 20-litre bucket to a CW that is metres away from them. It is also important to consider that CW1 is built at the entrance, which is steep, but accessible. The passages are narrow to get to CW2, which has been worsened by people building houses on those pathways. Such external factors have also contributed to the usability of the CWs. The fact that the greywater in the gully is not concealed is something that the people of Silvertown have tried to address with their limited resources. At the site of CW1, there was a concrete pipe that was used to transport the wastewater from the tap. A couple of people even said it would be nice if the CWs were designed so that there was a big pipe built that would also allow them to throw away anything.

The problem is that the whole point of the CWs was to ensure that the greywater was treated. Having a wider pipe might increase the number of items (and the volume of items) that could be disposed, but the CW is only designed to treat greywater and no other waste streams that enter the CWs. It was also not possible to create an entirely concealed structure since this would make it impossible for the CW plants to survive. With a concealed option, the function of the CWs will change from a nature-based solution to a gravel filter system. Given the high rates of clogging found with the surface CWs, it is unlikely that a concealed filter system would remain functional for long.

The lack of infrastructure in Silvertown and unemployment demonstrated that the CWs were expensive to build, especially if the residents were expected to do this

themselves. The results of both Phase 1 and Phase 2 have shown that it will also take more work to expect the community to maintain the CWs moving forward. The one positive aspect that both the CWs have brought to the community is the elevated water access and disposal points. This is also part of the design that could help change how the community designs water and disposal points. Many taps, not only in Silvertown but across Setswetla, have low access points. This contributed to people choosing to use the taps where the CWs were because it was easier to access and wash at the taps.

5.17. Limitations

The design of the study had elements that affected or influenced how the results were interpreted. The design and building of the CWs in the two designated areas were appropriate due to the presence of vacant land, a feature lacking in the other places within Setswetla. In addition, the project's outcome could be different if CWs were established in an informal settlement with more open space to build more CWs. The CWs in Silvertown were constructed only on the outskirts Silvertown because the interior of Silvertown was too tight to allow for any building. The research project could have also had interesting and diverse results if it had been based on an even bigger informal settlement. The data collection for this project only looked at the upper slope of Silvertown rather than the lower slope closer to the Jukskei River. The gully passing by CW2 collects and eventually deposits the waste into the more downward slope of Silvertown and eventually into the Jukskei River. If the extension of the CWs went further in the direction towards the river, then it would be interesting to see if the flooding that affected the CW2 would have affected another CW built closer to the river. The failure of CW2 due to flooding needs to be reiterated. It is difficult to know what solutions to suggest that would address the problem of flooding when a contributing factor was poor infrastructure maintenance on the part of the municipality e.g., taking months to fix a broken sewer that was releasing sewage in large quantities into a major river. This resulted in fewer activities at CW2 and no direct treatment of greywater because the CW

was completely inactive. Silvertown was also chosen because there was a relatively shallow, but consistent, gradient from the entrance to the river. This enable the CWs to operate using gravity. It is probably not possible to implement similar systems in locations which do not have a gradient.

The social dynamics of Silvertown are such that there was a social “structure” in place where the original members of Silvertown who came in 2006 oversaw the social functioning of the settlement. This also played a role in establishing the CWs because most people having a leading role in the project were these original members. In other informal settlements where this community base is absent, the social dynamics might produce different outcomes, especially in terms of getting community buy-in, for the design, building, and use of interventions. On the other hand, the dominance of these original members could have influenced how the community expressed their needs during the project’s design stage. The dominant characters’ might has influenced how the infrastructure was developed and how it was used.

The data collection plan was that evaluations would happen three months after building the Phase 1 CWs. COVID-19 rendered this data collection plan impossible because it prevented the researcher from going into the field to evaluate how people used CWs. Face-to-face interviews were impossible, and feedback was limited to people who had mobile phones, data, and a willingness to provide information. Unstructured interviews were not possible at all. Aside from the COVID-19 restrictions which prevented data collection, the researcher could not be always present in Silvertown. Due to safety and security concerns, it was impossible for the researcher to collect data in the evening and in the early mornings.

5.18. Recommendations for Further Research

Future studies could also evaluate CWs in an area with conditions that are better than those found in Silvertown. There was a problem of stormwater and wastewater impacting on the effectiveness of the CW2. Therefore, it was challenging to do a proper comparative study of the two CWs built because CW2 was not functioning towards the end of the project. The challenges faced by CW1 were manageable. For example, the leakage of the taps and the lack of water pressure were things which were fixed during the project. As a result, after a year or two of the existence of the CWs, a study could be conducted to investigate the state of the CWs. One of the biggest problems affecting CW1 was litter, and the presence of the skip bin close to the CW1 did not help. The other problem was the clogging and blocking of the CWs, especially if people were disposing of the wrong materials in the system. Such a study could also look to see the best solution for revitalising the CWs when blocking and clogging of the systems happens. One solution would be to partner with the local municipality to find options for cleaning the CWs. There is already a service company that cleans the portable chemical toilets. The CWs will need to be cleaned regularly to enable them to function. Therefore, another study on the evaluation of the clogging could focus solely on the periods that the CWs need to be revitalised and those factors affecting the clogging process to see how regularly the CWs need to be cleaned.

It would be worthwhile exploring the reasons why CW1 was more successful than CW2. What are the factors that enabled CW1 to continue while CW2 collapsed? It would be interesting to see what dynamics would arise if a CW was to be installed elsewhere in Silvertown if suitable space could be found. The URBWAT project team had planned a CW3 on another tap site, but this was yet to be constructed at the time this research project ended.

5.19. Chapter Conclusion

The research aimed to assess the HIC of greywater disposal in utilising CWs in an informal settlement. The results showed dynamism and heterogeneity when documenting the design, building, and use of the CWs in Silvertown. Data obtained throughout Phases 1 and 2 of planning, building, and operating these CWs aided in understanding how they functioned as emerging HICs in an existing heterogeneous society. The case study of Silvertown might have been different from the other cases of HIC because unlike the other cases, the greywater disposal solution was not the service that was considered by people and the government. The CWs brought awareness of the importance of such a service because even governmental authorities were aware of the great strides which were done in Silvertown. The success of Phase 1 and the re-evaluation in Phase 2 were brought by the iterative design process as this refined the effectiveness of the CWs to serve people accordingly. This then played a pivotal role in recommending the additional infrastructure like the wall, staircases, ramp, and gully. All this was indirectly fulfilling the gaps which were identified by HIC. Silvertown has showed the fluidity of infrastructure that not only relate to greywater disposal, but also to the other underserved services in general. Therefore, there are clear signs that HIC was continuous in the community therefore in future developments such a realisation needs to be considered when moving forward.

Chapter 6. Conclusion

This research highlighted the greywater disposal situation in Silvertown, an informal settlement. This provided a different HIC case study that was analysed on a longitudinal basis. The study looked at a service that was not considered essential either by the local Council and even by residents, and therefore the necessary infrastructure was not provided by service providers. The study also added value by showing how new infrastructure must integrate with the existing heterogeneous infrastructure that the people of Silvertown have been engaged in developing and using. It is important to note that it was not that there were no measures applied to dealing with greywater disposal (especially in other parts of the larger Setswetla informal settlement), but rather that the implementation of the CWs brought a structured intervention into an existing heterogeneous infrastructure environment. Prior to the CW implementation there were ad-hoc existing interventions that had emerged to deal with greywater disposal (for example, digging channels and building channels for greywater disposal). The idea of the CWs was co-developed with residents to ensure that the existing configuration can deal with the insertion of a new “technology” that might help take greywater disposal to another level. This thesis critically examined the implementation of the co-developed CW intervention and how this changed the methods of greywater disposal and how the CWs integrated with existing heterogeneous infrastructure over time. In doing this, this research was a longitudinal study of how heterogeneity evolves as part of a deliberate intervention to deal with a previously unprovided service.

In conclusion, the study’s main contribution has been looking at how the heterogeneity evolves in Silvertown over time. Another contribution was the finding that the residents are constantly looking to improve their current circumstances and to live their best possible life. This aligns with the work of Simone (2004) who described “people as infrastructure”, which was also noted by Lawhon et al. (2018) in explaining HIC. Lefebvre’s concept of “the production of

space” was also applied to provide enlightenment about the exploitation of people experiencing poverty and how they engage with the space they occupy. These concepts help explain that while services have been lacking in such communities, they have still been able to provide themselves with mechanisms and processes to cope with the lack of services. HIC scholars have argued that with these predicaments, there is a need for change in the way development happens. This study spent three years watching the implementation process unfold in a situation where a service was identified that was not formally provided. Once the new infrastructure was inserted into this context, this PhD looked at how the infrastructure had to integrate with the existing heterogeneity. For effective integration in an informal environment like Silvertown, it was shown that there needs to be a careful look at what heterogeneity exists and how the new infrastructure will integrate with what is there (and specifically, what needs to take place for the connections to be made).

Previous research examined services and infrastructure case studies in isolation without considering their interconnectedness. Simultaneously, this study demonstrated that HIC also has favourable characteristics that enable an examination of the longitudinal emergence of configurations even when an iterative process, with socially laden decisions related to social or technological interventions (Lawhon et al., 2018; Sseviiri et al., 2020). Lawhon et al. (2018) proposed the need for more investigations into the many risks, redundancies, and tactics users employ in such arrangements. By examining the diversity of people and infrastructure in Silvertown and considering the implementation of the CWs, this research has embraced and utilised the concept of complementarities and fluidity to mitigate risk in uncertain circumstances. In the end, the focus was not just on the CWs but the need for additional infrastructures of influence (such as a staircase and a ramp for better access, walls to limit flooding from a leaking sewage pipe and from stormwater, building gullies to enhance the trenches formed and to assist with wastewater flow) to help with the integration of the CWs with existing infrastructure.

This concept of reconfiguring has been acknowledged in research conducted by Rutherford et al. (2015) on HIC. Their study emphasised that infrastructure was intrinsically dynamic and undergoes continuous modifications in construction, assembly, repair, and maintenance (Geels, 2002). Notably, the realisation that Silvertown was a complicated environment and was made more complex because services were provided in an unstructured way. Therefore, this study demonstrated the need to consider the diversity and lack of formality while studying informal settlements, as the concept of HIC is still evolving. In other words, this research project showed that the construction of infrastructure in these kinds of areas is a continuously unfolding process. In this study, it was necessary to learn from the mistakes in Phase1 and to embrace the dynamic nature of these environments by engaging in the iterative process of design, building, and use to make sure that desired outcomes are achieved.

Chapter 7. References

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Chapter 8. Appendices

8.1 Appendix A: Unstructured interviews records

Phase 1 Unstructured interviews

Days when data was collected	Number of people interviewed	Unstructured interviews in a (Group) or (Alone)	Gender of the people interviewed
January 2020			
Saturday, 18 January 2020	2	2 (Alone)	F/F
Tuesday, 21 January 2020	3	2 (Group)+ 1 (Alone)	M/F/M
Friday, 24 January 2020	1	1 (Alone)	F
Sunday, 26 January 2020	2	2 (Alone)	F/F
Tuesday, 28 January 2020	3	3 (Group)	M/M/M
Thursday, 30 January 2020	5	2 (Group)+ 3 (Alone)	M/M/F/F/F
Friday, 31 January 2020	4	2 (Group)+ 2 (Alone)	M/M/M/F
February 2020			
Thursday, 06 February 2020	3	2 (Group)+ 1 (Alone)	F/F/M
Saturday, 08 February 2020	6	4 (Group) +2 (Alone)	F/F/F/F/F/M
Monday, 10 February 2020	1	1 (Alone)	M
Tuesday, 11 February 2020	1	1 (Alone)	F
Wednesday, 12 February 2020	2	2 (Alone)	M/M
Saturday, 15 February 2020	2	2 (Alone)	F/F/M
Monday, 17 February 2020	3	2 (Group)+ 1 (Alone)	F/F/F
Tuesday, 18 February 2020	1	1 (Alone)	M
Wednesday, 19 February 2020	1	1 (Alone)	M
Thursday, 20 February 2020	4	2 (Group)+ 2 (Alone)	F/M/M/M

Friday, 21 February 2020	1	1 (Alone)	F
Saturday, 22 February 2020	1	1 (Alone)	F
Sunday, 23 February 2020	2	2 (Group)	F/F
Monday, 24 February 2020	2	2 (Alone)	F/F
Tuesday, 25 February 2020	2	2 (Alone)	M/M
Wednesday, 26 February 2020	2	2 (Alone)	F/F
March 2020			
Sunday, 01 March 2020	3	3 (Alone)	F/F/F
Thursday, 05 March 2020	5	3 (Group)+ 2 (Alone)	F/F/F/M/M
Friday, 06 March 2020	4	4 (Group)	M/M/M/M
Saturday, 07 March 2020	2	2 (Alone)	M/M
Monday, 09 March 2020	6	3 (Group)+ 3 (Alone)	F/F/F/M/M
Tuesday, 10 March 2020	5	2 (Group)+ 3 (Alone)	F/F/F/M/M
Thursday, 12 March 2020	1	1 (Alone)	M
Saturday, 14 March 2020	5	4 (Group)+ 1 (Alone)	M/M/M/F/M
Sunday, 15 March 2020	2	1 (Group)+ 1 (Alone)	F
Tuesday, 17 March 2020	6	4 (Group)+ 2 (Alone)	F/F/F/M
Wednesday, 18 March 2020	4	4 (Alone)	M/M/F/F
Friday, 20 March 2020	3	3 (Alone)	F/F/F
Saturday, 21 March 2020	5	5 (Group)	F/F/F/F/M
Sunday, 22 March 2020	1	1 (Alone)	M
Monday, 23 March 2020	6	2 (Group)+ 4 (Alone)	F/F/F/F/F
November 2020			
Thursday, 05 November 2020	2	2 (Alone)	F/F
Sunday, 08 November 2020	3	2 (Group)+ 1 (Alone)	M/F/M/

Tuesday, 10 November 2020	1	1 (Alone)	F
Wednesday, 11 November 2020	2	2 (Alone)	F/F
Friday, 13 November 2020	3	3 (Group)	M/M/M
Thursday, 19 November 2020	5	2 (Group)+ 3 (Alone)	M/M/F/F/F
Sunday, 22 November 2020	4	4 (Alone)	M/M/M/F
Thursday, 26 November 2020	4	2 (Group)+ 2 (Alone)	F/F/F/F
Saturday, 28 November 2020	5	4 (Group)+ 1 (Alone)	M/F/M/F
December 2020			
Thursday, 03 December 2020	2	2 (Alone)	F/F
Wednesday, 09 December 2020	2	2 (Alone)	F/F
Saturday, 12 December 2020	6	4 (Group) +2 (Alone)	F/F/F/F/F/M
Tuesday, 15 December 2020	4	4 (Alone)	M/M/F/F
Friday, 18 December 2020	3	2 (Group)+ 1 (Alone)	F/F/M
Monday, 28 December 2020	2	2 (Alone)	F/F
January 2021			
Friday, 08 January 2021	2	2 (Alone)	F/F
Sunday, 10 January 2021	4	2 (Group) +2 (Alone)	M/M/M/F
Wednesday, 13 January 2021	2	2 (Alone)	M/M
Saturday, 16 January 2021	1	1 (Alone)	M
Friday, 22 January 2021	5	3 (Group)+ 2 (Alone)	F/F/F/F/F
February 2021			
Tuesday, 09 February 2021	3	3 (Group)	F/F/F
Thursday, 11 February 2021	4	3 (Group) +1 (Alone)	F/F/F/F
Saturday, 13 February 2021	1	1 (Alone)	M
Tuesday, 16 February 2021	2	2 (Alone)	F/M
Friday, 19 February 2021	2	2 (Alone)	M/M

Sunday, 21 February 2021	3	2 (Group)+ 1(Alonge)	F/F/F
March 2021			
Tuesday, 09 March 2021	1	1 (Alone)	M
Friday, 19 March 2021	3	2(Group) +1 (Alone)	F/F/F
Wednesday, 24 March 2021	1	1 (Alone)	F
Sunday, 28 March 2021	2	2(Group)	F
Saturday, 13 March 2021	4	3 (Group)+ 1(Alonge)	M/M/M/M
April 2021			
Tuesday, 06 April 2021	5	4 (Group)+ 1(Alonge)	M/M/M/M
Saturday, 10 April 2021	1	1 (Alone)	M
Wednesday, 14 April 2021	1	1 (Alone)	F
Friday, 16 April 2021	4	2 (Group)+ 2(Alonge)	F/F/F/F
Sunday, 18 April 2021	1	1 (Alone)	F
Monday, 19 April 2021	3	2(Group) +1 (Alone)	F/F/M
May 2021			
Thursday, 06 May 2021	2	2(Alonge)	F/F
Friday, 07 May 2021	3	3 (Group)	M/M/M
Thursday, 20 May 2021	5	2 (Group)+ 3(Alonge)	F/F/M/F/M
Sunday, 23 May 2021	2	2 (Alone)	F/F
Total	227		

Phase 2 Unstructured interviews

Days when data was collected	Number of people interviewed	Unstructured interviews in a (Group) or (Alone)	The gender of the people interviewed
August 2021			
Monday, 16 August 2021	2	2 (Alone)	F/M
Wednesday, 18 August 2021	2	2 (Alone)	F/M
Friday, 20 August 2021	3	2 (Group)+ 1(Alone)	F/F/F
Sunday, 22 August 2021	2	2 (Alone)	F/F
Tuesday, 24 August 2021	5	5 (Group)	M/M/M/M/M
Thursday, 26 August 2021	2	2 (Group)	M/M
Saturday, 28 August 2021	1	1 (Alone)	F
Monday, 30 August 2021	5	4 (Group)+ 1(Alone)	M/M/M/M/M
September 2021			
Thursday, 02 September 2021	5	2 (Group)+ 3 (Alone)	F/F/F/F/F
Saturday, 04 September 2021	3	3 (Group)	M/M/M
Wednesday, 08 September 2021	7	4 (Group)+ 3 (Alone)	F/F/F/F/M/M/F
Friday, 10 September 2021	5	3 (Group)+ 2 (Alone)	M/M/M/F/F
Monday, 13 September 2021	1	1 (Alone)	F
Tuesday, 14 September 2021	3	3 (Group)	F/F/F
Monday, 20 September 2021	1	1 (Alone)	M
Tuesday, 21 September 2021	2	2 (Alone)	F/F
Friday, 24 September 2021	4	3 (Group)+ 1 (Alone)	F/M/M/M
Sunday, 26 September 2021	2	2 (Group)	M/M
November 2021			
Wednesday, 10 November 2021	5	4 (Group)+ 1 (Alone)	F/F/F/F/M

Friday, 12 November 2021	1	1 (Alone)	M
Saturday, 13 November 2021	2	2 (Alone)	F/F
Tuesday, 16 November 2021	4	2 (Alone)	M/M/M/M
Wednesday, 17 November 2021	3	2 (Group)+ 1 (Alone)	M/M/M
Thursday, 18 November 2021	4	3 (Group)+ 1 (Alone)	F/F/F/M
Friday, 19 November 2021	1	1 (Alone)	M
Sunday, 21 November 2021	5	2 (Group)+ 3 (Alone)	M/M/M/M/M
February 2022			
Tuesday, 22 February 2022	2	2 (Group)	M/M
Thursday, 24 February 2022	1	1 (Alone)	M
Saturday, 26 February 2022	6	4 (Group)+ 2 (Alone)	M/M/M/M/F/M
Monday, 28 February 2022	2	2 (Group)	F/F
March 2022			
Monday, 07 March 2022	2	2 (Alone)	F/F
Tuesday, 08 March 2022	6	4 (Group)+ 2 (Alone)	M/M/M/M/F/M
Wednesday, 09 March 2022	1	1 (Alone)	M
Monday, 28 March 2022	1	1 (Alone)	F
Tuesday, 29 March 2022	3	3 (Group)	M/M/M
Wednesday, 30 March 2022	5	2 (Group)+ 3 (Alone)	F/F/M/M/M
Thursday, 31 March 2022	1	1 (Alone)	M
Friday, 01 April 2022	4	3 (Group)+ 1 (Alone)	F/F/F/F
Saturday, 02 April 2022	3	2 (Group)+ 1 (Alone)	M/F/M/
Friday, 01 April 2022	2	2 (Group)	F/F
May 2022			
Monday, 09 May 2022	1	1 (Alone)	M
Tuesday, 10 May 2022	2	2 (Group)	F/F

Wednesday, 11 May 2022	1	1 (Alone)	F
Thursday, 12 May 2022	6	4 (Group) +2 (Alone)	M/F/M/F/F/F
Friday, 13 May 2022	1	1 (Alone)	M
June 2022			
Monday, 20 June 2022	5	3 (Group)+ 2 (Alone)	F/F/M/M/M
Tuesday, 21 June 2022	3	3 (Alone)	M/M/M
Wednesday, 22 June 2022	2	2 (Alone)	F/F
Thursday, 23 June 2022	4	3 (Group)+ 1 (Alone)	F/F/F/M
Friday, 24 June 2022	2	2 (Alone)	F/F
Sunday, 26 June 2022	3	3 (Group)	M/M/M
August 2022			
Monday, 01 August 2022	2	2 (Alone)	M/M/
Tuesday, 02 August 2022	2	2 (Group)	M/M
Wednesday, 03 August 2022	2	2 (Alone)	M/M
Thursday, 04 August 2022	4	2(Group) +2 (Alone)	F/F/F/F
Friday, 05 August 2022	3	3 (Group)	M/F/F
Monday, 08 August 2022	2	2 (Alone)	M/M
Tuesday, 09 August 2022	1	1 (Alone)	F
Thursday, 11 August 2022	3	2 (Group)+ 1(Alone)	F/F/F
September 2022			
Monday, 12 September 2022	2	2 (Group)	M/M
Tuesday, 13 September 2022	3	3 (Group)	F/F/F
Wednesday, 14 September 2022	5	3 (Group)+ 2 (Alone)	F/F/F/M/M
Thursday, 15 September 2022	2	2 (Alone)	M/F
Friday, 16 September 2022	3	3 (Group)	F/F/F
Thursday, 22 September 2022	5	5 (Group)	M/M/M/M/M
October 2022			
Monday, 17 October 2022	5	3 (Group)+ 2 (Alone)	M/M/M/M/M

Tuesday, 18 October 2022	3	2 (Group)+ 1(Along)	F/F/M
Wednesday, 19 October 2022	4	2(Group) +2 (Along)	F/F/F/F
Thursday, 20 October 2022	2	2 (Along)	F/F
Friday, 21 October 2022	2	2 (Along)	M/M
Saturday, 22 October 2022	4	4 (Group)	F/F/F/F
Sunday, 23 October 2022	1	1 (Along)	M
Monday, 24 October 2022	8	5 (Group)+ 3 (Along)	M/M/M/M/M/M/F/M
Tuesday, 25 October 2022	3	3 (Group)	F/F/M
Wednesday, 26 October 2022	1	1 (Along)	F
Thursday, 27 October 2022	2	2 (Group)	F/F
Thursday, 27 October 2022	3	3 (Group)	F/F/M
Total	226		

8.2 Appendix B: Data collection instruments for Silvertown participants

School of Geography, Archaeology and Environmental Studies

Private Bag 3, Wits 2050, South Africa Enquiries: GEOGRAPHY: TEL: +27 11 717-6503 • FAX: +27 086 651 6366
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<http://www.wits.ac.za/geography/>



Participant Information sheet for the residents of Silvertown

Good day

My name is Motshwaedi Sepeng, a PhD geography student from the University of the Witwatersrand. For my degree I am undertaking a research study to understand the factors that shape residents of Silvertown's relationships with the constructed wetlands (CWs). Therefore, I will need to document how you relate to the CWs.

As a Silvertown resident, you are invited to participate in the study. Participation in the study will consist of an interview. The interview will take approximately 30 minutes. You will be asked questions on how you relate to the CWs.

You will be asked if I can audio record the interview as this will help me to capture all the given information. The given information and the audio recording might not be deleted as I might want to listen to the tone and variations of the interview when analysing the data. Neither your name nor any other personally identifying information about you will be recorded. If you feel uncomfortable with being recorded, then your responses will only be handwritten and not recorded. There will be no personal costs for your participation in this study. You will be participating in the research study voluntarily. There are no anticipated risks or benefits for your participation in the study, and you have the right to withdraw from the study without any penalty at any point. You can answer any or all the questions you want. You also have the right to ask questions about the research and have them answered to your satisfaction. As a precaution adhering to the Covid-19 regulations, the interview will be conducted with both you and the researcher wearing masks and standing at one or two metres distance in between.

The final report will not directly relate any personal information such as your name and address to protect your identity. The collected information will be kept confidential, whereby it cannot be directly traced back to you. After the research is completed, the collected information will be kept in the password-protected cloud storage as the information could be useful to the researcher's future studies in the field of urban infrastructure development. Should you wish to receive the report's summary, I can organise that to get to you. The final study will be available in the Wits library and on the online thesis repository. I may also share the research findings at a conference or in an academic article.

Should you have any concerns or complaints concerning the ethical processes of this study, you can contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Yours sincerely
Motshwaedi Sepeng

Researcher contact: Motshwaedi Sepeng, 0724384916, 419847@students.wits.ac.za

Supervisors' contacts: Prof Andrew Thatcher: 0117174533, Andrew.Thatcher@wits.ac.za and Dr Melanie Samson: 0117176515, Melanie.Samson@wits.ac.za

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Consent Form for the Silvertown

Title of project:

Constructed wetlands and conflictual social relations in Silvertown, Alexandra Township, Johannesburg

Name of researcher: Motshwaedi Sepeng

I, agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my participation will remain anonymous

YES NO

I agree that the researcher may use anonymous quotes in his / her research report

YES NO

I agree that the interview may be audio recorded

YES NO

I agree that the researcher will not delete the collected data as it could be used for future research provided the data is kept confidential

YES NO

..... (signature)

..... (name of participant)

..... (date)

..... (signature)

..... (name of person seeking consent)

..... (date)

Phase 1 Silvertown Interview Schedule

1. What area do you reside in? (e.g., Silvertown)
2. Did you go to any of the design workshops?
 - a. If not, why did you not attend?
 - b. If so, was it useful?
3. Did you go to the handover meeting where we explained how to use the constructed wetlands?
 - a. If not, why did you not attend?
 - b. If you did attend, was it useful?
4. Did someone else explain to you how to use the constructed wetland?
5. Do you know why the wetlands have been built?
6. Do you know how to use the wetlands? (if yes, ask them to explain)
7. Are you using the wetlands?

If yes,

 - a. Which of the two wetlands are you using, and why are you not using the other one?
 - b. What do you use the wetlands for? (e.g. throwing away greywater, throwing away other things?)
 - c. How often do you use them?

If no,

 - a. Why do you not use them?
8. Who looks after the wetlands in the community?
9. Do you think the wetlands are the right structures for their purpose?
10. Are you happy with the presence of the wetlands in your community?
11. Are you happy with the position where the wetlands are currently situated and if not, where would you situate them?
12. Do you think other people use the wetlands and if not, why are they not using them?
13. What could encourage other people to use the wetlands?

Phase 2 Silvertown Interview Schedule

1. How did you dispose your greywater before the building of the constructed wetlands (CWs)?

.....

a. Were you happy with your disposal methods before CWs?

.....

b. What problems did they encounter if any with your previous manner of greywater disposal?

.....

2. How do residents of Silvertown use the CWs?

.....

a. What do you use CWs for, and is this how they supposed to be used?

.....

b. Does the old manner of water disposal influence how you use CWs?

.....

3. Why do some residents not use the CWs?

.....

a. What are the difficulties related to the CWs that limits using them?

.....

4. How do the CWs officially integrate with existing greywater removal mechanisms?

.....

a. Do you feel that CWs are an addition to greywater disposal or a revival to the older manners?

.....

- b. Are CWs a good fit for existing infrastructure to help with the disposal of greywater?

.....

- c. What has the inclusion of CWs meant for the previously used manners of disposal?

.....

5. What power relations and norms affect how residents and use the CWs and how do they do so?

- a. Is the use of the CWs get influenced by,

Your own freewill ☐ the research team or ☐ community leaders ☐

- b. How does that influence your use of the CWs?

.....

- c. Do norms play a role on your relationship to the usability of the CWs?

.....

8.3. Appendix C: Ethics approval documents

UNIVERSITY OF THE
WITWATERSRAND
(JOHANNESBURG)

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/09 Sepeng

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: H210848**

PROJECT TITLE Constructed wetlands and conflictual social relations in
Sesuvella, Alexandra Township, Johannesburg

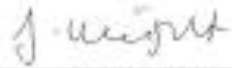
INVESTIGATOR(S) Mr M Sepeng

SCHOOL/DEPARTMENT Geography, Archaeology and Environmental Studies

DATE CONSIDERED 21 May 2021

DECISION OF THE COMMITTEE Approved
Risk Level: Minimal

EXPIRY DATE 19 July 2024

DATE 20 July 2021 **CHAIRPERSON** 
(Professor J Knight)

cc: Supervisor: Dr M Samson, Prof A Thatcher and Dr G Nelken

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 19th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.

Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

8.4. Appendix D: Millennium Development Goals, Targets and Indicators

Millennium Development Goals, Targets and Indicators

Goals	Targets	Indicators
1. Eradicate extreme poverty & hunger	A. Halve between 1990 and 2015, the proportion of people whose income is less than one dollar a day. B. Halve between 1990 and 2015 the proportion of people who suffer from hunger.	1. Proportion of people below \$1 a day. 2. Poverty gap ratio (incidence x depth of poverty). 3. Share of poorest quintile in national consumption. 4. Prevalence of underweight children (under 5 years of age). 5. Proportion of population below minimum level of dietary energy consumption.
2. Achieve universal primary education.	A. Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.	6. Net enrolment ratio in primary education. 7. Proportion of pupils starting grade 1 who reach grade 5. 8. Literacy rate of 15-24 year olds.

3. Promote gender equality and empower women.	A. Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015.	9. Ratio of girls to boys in primary, secondary and tertiary education. 10. Ratio of literate females to males of 15-24 year olds. 11. Share of women in wage employment in the non-agricultural sector. 12. Proportion of seats held by women in the national parliament.
4. Reduce child mortality.	A. Reduce by two thirds, between 1990 and 2015, the under five mortality rate.	13. Under five mortality rate. 14. Infant mortality rate. 15. Proportion of 1 year old children immunised against measles.
5. Improve maternal health.	A. Reduce by three quarters between 1990 and 2015, the maternal mortality ratio.	16. Maternal mortality ratio. 17. Proportion of births attended by skilled health personnel.
6. Combat HIV/Aids, malaria and other diseases.	A. Have halted by 2015 and begin to reverse the spread of HIV/Aids. B. Have halted by 2015 and begun to reverse the incidence of malaria and other diseases.	18. HIV prevalence among 15-24 year old pregnant women. 19. Contraceptive prevalence rate. 20. Number of children orphaned by HIV/Aids. 20. Prevalence and death rates associated with malaria. 22. Proportion of population in malaria risk areas using effective malaria prevention and treatment measures.

		23. Prevalence and death rates associated with TB. 24. Proportion of TB cases detected and cured under directly observed treatment (short-course).
7. Ensure environmental sustainability.	A. Integrate the principles of sustainable development into country policies and programmes and reverse the losses of environmental resources. B. Halve by 2015 the proportion of people without sustainable access to safe drinking water	25. Proportion of land area covered by forest 26. Ratio of area protected to maintain biological diversity to surface area 27. Energy use (kilograms of oil equivalent) per \$1 GDP (PPP) 28. Carbon dioxide emissions (per capita) and consumption of ozone-depleting chlorofluorocarbons (ODP tons) 29. Proportion of population using solid fuels* 30. Proportion of population with sustainable access to an improved water source,
	and basic sanitation. C. Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers.	urban and rural 31. Proportion of population with access to improved sanitation, urban and rural 32. Proportion of households with access to secure tenure
	and basic sanitation. D. Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers.	

8. Develop a global partnership for development.	A. Develop further an open, rule-based, predictable non-discriminatory trading and financial system. B. Address the special needs of the LDCs – includes tariffs and quota free access for LDC exports; enhanced programme of debt relief for HIPC and cancellation official bilateral debt; more generous ODA for countries committed to poverty reduction. C. Address the special needs of land-locked countries and small island developing states (through the programme of action on sustainable development of small island developing states and the outcome of the 22nd Special Session of the General Assembly).	Official development assistance 33. Net ODA total and to the least developed countries, as a percentage of OECD/DAC donors' gross national income. 34. Proportion of bilateral, sector-allocable ODA of OECD/DAC donors for basic social services (basic education, primary health care, nutrition, safe water, and sanitation). 35. Proportion of bilateral official development assistance ODA of OECD/DAC donors that is untied. 36. ODA received in landlocked countries as proportion of their gross national incomes. 37. ODA received in small island developing states as proportion of their gross national incomes. Market access 38. Proportion of total developed country imports (by value and excluding arms) from developing countries and from least developed countries, admitted free of duty.
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	D. Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long-term. E. In cooperation with developing countries, develop and implement strategies for decent and productive work for youth. F. In cooperation with pharmaceutical companies provide access to affordable drugs for developing countries. G. In cooperation with the private sector, make available the benefits of new technologies, especially information and communications.	39. Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries 40. Agricultural support estimate for OECD countries as a percentage of their gross domestic product 41. Proportion of ODA provided to help build trade capacity Debt sustainability 42. Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative) 43. Debt relief committed under HIPC initiative 44. Debt service as a percentage of exports of goods and services Other 45. Unemployment rate of 15- to 24-year-olds, male and female and total e 46. Proportion of population with access to affordable, essential drugs on a sustainable basis f 47. Telephone lines and cellular subscribers per 100 population 48a. Personal computers in use per 100 population 48b. Internet users per 100 population
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(Nunn et al. 2005)