PAPER 5 B

ASSESSMENT OF THE EFFECTIVENESS OF CONTAINMENT SUMP - SEWER SCREEN TO REDIRECT SEWER AND MICROBES' DOSAGE TO ENHANCED BIOREMEDIATION OF SURFACE WATER POLLUTION CAUSED BY COLLAPSE SEWER LINE, A CASE OF PROTEA SOUTH, COJ, SA.

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ABSTRACT

Bioremediation, a process harnessing natural mechanisms to mitigate environmental pollution, has become imperative in addressing surface water contamination worldwide, particularly by sewage spill/ collapse sewer networks. In Johannesburg water, South Africa, rapid urbanization and industrialization have made worse the problem, posing significant ecological and public health risks. Traditional remediation methods have proven inadequate, prompting exploration into innovative approaches like the use of containment sump with sewer screen and microbial ecology. The use of a containment sump with a sewer screen reduces the amount of sewer solids in water bodies such as rivers and dams, thereby reducing the significant impact on water bodies, while the dosage of microbes (microbial ecology) employs microorganisms to degrade pollutants within the channel and containment sump. This study assesses the effectiveness bioremediation technique using containment sump and microbes' dosage of polluted water before reaches the river bodies located within the City of Johannesburg specifically Johannesburg water, down the gradient of the sewer collapse point. Before the intervention, a significant of solid was observed within the water body down the gradient of the sewer collapse point leading to poor water quality.

During bioremediation using a containment sump channel to redirect sewer from the sewer line and dosage of microbes, lead to a reduction in sewer smell and solid waste into the river and further improved breakdown of pollutants concern before wastewater reaches the river, this has led to improved ecosystem health. Post-bioremediation technique, sustained enhancements in water quality were noted, with increased DO concentrations and decreased E. coli counts, leading to ecosystem health improvement which can sustain most aquatic species within the river. The results underscore the potential of these interventions in mitigating surface water pollution within the City of Johannesburg and South Africa at large, aligning with sustainable environmental management principles. Through interdisciplinary collaboration and demanding monitoring, these innovative strategies offer promising pathways toward safeguarding water resources and fostering ecosystem resilience.

The outfall catchment covers the greater Protea Glen and its various extensions. As a result, sewer is spilling into the stream causing pollution and possible penalties on JW by Department Water Sanitation (DWS).The pipe is located west of the last street in Protea South, namely Wanderers street in the stream (Lower Klipspruit). On the western side of the stream is an open park. South from the spillage is the N12 Moroka Bypass.

A summary of the work scope is as follows:

- Consider the social impact of the project by involving stakeholder engagements for local community participation through smmes ,training of local sand local labourers during the course of the project
- Installation of HDPE Pipes
- Installation and/or repairing of manholes.
- Installation of bioremediation and rehabilitation works along the river and riverbanks
- Stabilizing the Riverbank using gabions, concrete and commercial sources bedding e.g., G5,G2, Flexible bedding etc.
- Sewer diversion by method of dredging bypass the river by the working area
- Sewer bridge repair or replacement below riverbed but will be confirmed after exposing of services

The project was not screened as it was regarded as an emergency project. Section 30A was applied and GDARD gave authorization. Section 30A written was issued.

1. INTRODUCTION

Surface water pollution, particularly due to sewage spills and collapsed sewer networks, poses a significant threat to environmental health and public safety. Worldwide, urbanization and industrial activities have exacerbated the issue, leading to increased contamination of rivers, lakes, and other water bodies (Sarker, et al., 2021). In Johannesburg water, South Africa, the rapid urban expansion has intensified these challenges, necessitating innovative and sustainable solutions to manage and remediate polluted surface waters (Thomas, et al.,2021). Traditional remediation methods, such as chemical treatments and physical removal of contaminants, often fall short in addressing the complexity and scale of pollution, prompting the exploration of more effective and eco-friendly alternatives (Arsenov, et al., 2023).

Bioremediation has emerged as a promising approach to tackle surface water pollution, leveraging natural microbial processes to degrade and detoxify contaminants while permanent sewer infrastructure pipe upgrade is ongoing. This method not only reduces the environmental footprint of remediation efforts but also enhances the long-term sustainability of water bodies by promoting the natural breakdown of pollutants. In Johannesburg, the integration of bioremediation techniques, such as the use of containment sumps and microbial dosing, represents a significant advancement in managing sewage-related water pollution (Koren., 2017). These methods aim to intercept and treat pollutants before they reach larger water bodies, thereby mitigating the adverse effects on aquatic ecosystems.

The containment sump with a sewer screen is designed to capture and remove solid sewage materials from contaminated water, preventing their

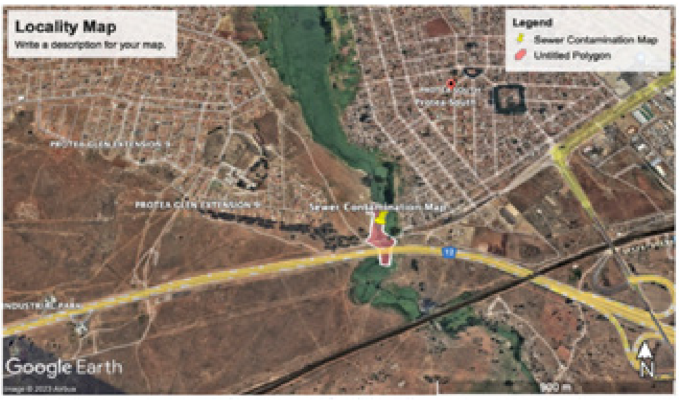

FIGURE 1: *Protea South, Locality Map*

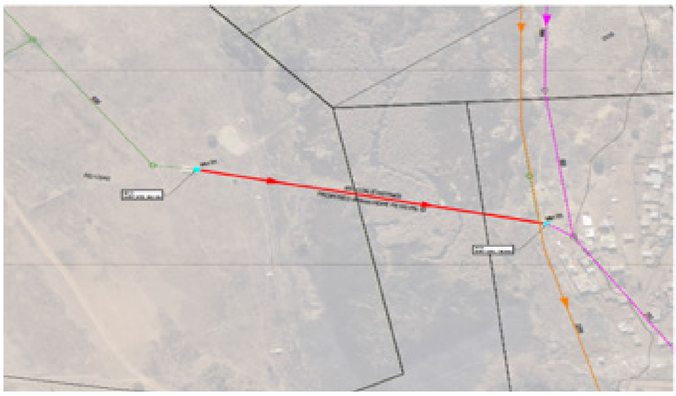

FIGURE 2: *Replaced sewer line at Protea Glen ext.9 region D Ward 10*

entry into rivers and dams. This mechanical intervention is complemented by the strategic introduction of microbial cultures, which are capable of degrading organic pollutants and reducing microbial loads in the water (Yadav, et al., 2021) Together, these bioremediation strategies not only improve water quality but also restore the ecological balance within affected water bodies. The proactive adoption of these techniques reflects a broader commitment to environmental stewardship and public health protection.

This study evaluates the effectiveness of these combined bioremediation and engineering works interventions in Protea South, Johannesburg, where a collapsed sewer line has significantly polluted local water resources. By the implementation of the containment sump and microbial dosing, this research aims to provide evidence of the benefits of reducing the impact on surface water and the challenges associated with these innovative remediation techniques. The findings are expected to offer valuable insights into sustainable water management practices, not only for Johannesburg but also for other urban canters grappling with similar environmental issues globally.

2. PROJECT AREA

The study was conducted in Protea South, a suburb in the City of Johannesburg, South Africa. Geographical locations are (26°17′07″ S 27°50′29″ E). The area is characterized by rapid urbanization and currently sewer line collapses, leading to significant surface water pollution. The existing sewer infrastructure 650mm concrete-steel pipe. The operations department tried to maintain the system, however the section operations did not have resources and the site was not inaccessible thus need for emergency construction. Figure 1 presents the location of the contaminant sump in Protea South.

3. MATERIAL AND METHODOLOGY

This chapter details the materials and methodology used to assess the effectiveness of the containment sump with a sewer screen and microbial dosage in enhancing bioremediation and engineering works of surface water pollution caused by a collapsed sewer line in Protea South, City of Johannesburg, South Africa. The study focuses on removing suspended rags, permanent pipeline sewer pipeline and pollutants to improve water quality and ecosystem health.

- **Experimental Design**

The experimental design included pre-intervention, intervention, and post-intervention phases to evaluate the effectiveness of the containment sump with a sewer screen and microbial dosage.

- **Materials**

See Table 1.

- **Methodology**

i. Installation of Containment Sump and Sewer Screen

A containment sump and temporary bypass was constructed at a strategic point downstream of the sewer collapse to collect and contain sewage before it reached the river. A sewer screen was installed at the inlet of the sump to filter out large solids such as nappies, condoms, and other rags.

ii. Containment Sump Construction:

Excavation was done at the selected site adjacent to the collapsed sewer pipeline to accommodate the sump and installation of a plastic sump structure to prevent the infiltration of the wastewater into the ground. Connect the sump to the existing sewer line by creating a channel to allow the wastewater/sewer to flow from the sewer pipeline towards the containment sump.

iii. Sewer Screen Installation:

Placement of a stainless-steel screen at the sump outlet towards the channel that takes the wastewater from the sump to the river. The installation was

TABLE 1: *Materials Used in the Study*

Material	Function	Advantages	Disadvantages
Containment Sump	To collect and contain sewage, preventing it from reaching open water bodies.	Efficient in controlling large volumes of sewage; prevents immediate environmental contamination.	Requires regular maintenance and cleaning.
Sewer Screen	To filter out suspended rags such as nappies, condoms, and other debris.	Reduces solid waste in water bodies; prevents blockages in bioremediation systems.	Can become clogged and requires frequent m aintenance.
Microbial Consortia	To enhance the breakdown of pollutants through bioremediation.	Effective in degrading organic pollutants; adaptable to different contaminants.	Requires careful monitoring to maintain optimal conditions.
800mm HDPE Pipe	Permanent solution sewer flow	Permanent solution for sewer outflow no more contamination of river	Requires regular maintenance and cleaning of outfall

done strategically to filter out suspended rags and ensure the screen was securely fixed to prevent bypassing of solids.

iv. Application of Microbial Consortia

Microbial consortia were selected based on their efficacy in degrading common sewage pollutants. The microbes were introduced into the containment sump and the surrounding water body through controlled dosing. Suitable microbial strains were selected based on existing bioremediation studies, The HP-RPe-3 compound microbial agent is a kind of indigenous microorganism agent that is composed of bacillus, micrococcus, photosynthetic bacteria, nitrifying bacteria, denitrifying bacteria, lactic acid bacteria, yeasts, enzymes, bacterium pseudoarthrosis, actinomycetes, acetobacter, and other 100 kinds of microorganisms which are all selected from nature and are prepared by domestication technology and unique enzyme treatment technology in the laboratory (Gao et al. 2018). Microbes were highly dosed at the outlet of the contaminant sump to allow wastewater leaving the contaminant sump to flow into the river with microbial consortia to reduce the impact of sewer water on the quality of the river downstream.

4. RESULTS AND DISCUSSION

The utilization of a containment sump with a sewer screen significantly mitigates the impact of sewer collapses on surface water bodies. By filtering out large solids such as nappies, condoms, and other debris, the sewer screen effectively reduces the load of suspended solids entering the water bodies. This physical barrier is crucial as it prevents the immediate contamination of rivers and streams, which has been shown to significantly degrade water quality and disrupt aquatic ecosystems (Bashir et al., 2020). The containment of these solids within the sump minimizes the direct discharge of harmful materials, thus protecting the downstream aquatic environment.

Furthermore, the introduction of microbial consortia into the containment sump enhances the bioremediation process by accelerating the breakdown of organic pollutants. These microbes, selected for their efficacy in degrading common sewage pollutants, help reduce the concentration of harmful substances before the water reaches natural water bodies (Gao et al., 2018). The microbial activity leads to a reduction in organic matter and pathogenic microorganisms, thereby improving water quality and reducing health risks associated with contaminated water (Rajput et al., 2022).

Before bioremediation or the introduction of these technical measures, the collapse of the sewer pipe posed a significant threat to surface water quality, which posed serious ecological and public health concerns. During the bioremediation phase, the use of containment sump and sewer screens demonstrated a notable reduction in the presence of these contaminants. Post-bioremediation observation showed a marked decrease in levels of suspended solids and pathogenic bacteria, which aligns with the findings of similar studies (Mulligan et al., 2001). These improvements are critical for sustaining aquatic life and enhancing the overall health of the ecosystem. Sustained enhancements in the reduction of the impact on surface water quality post-bioremediation underscore the effectiveness of this bioremediation technique indicating healthier water conditions that can support diverse aquatic species (Pillay et al., 2016). The implementation of this method has demonstrated that, with regular maintenance and monitoring, the containment sump and microbial dosage can provide a sustainable solution for managing sewage spills and improving surface water quality.

In conclusion, the combination of containment sump with sewer screens and microbial consortia presents a practicable and effective strategy for addressing surface water pollution caused by sewer collapses. This approach not only reduces the immediate impact of contaminants on water bodies but also enhances the natural bioremediation processes, leading to long-term improvements in water quality. The success observed in Protea South, Johannesburg water, serves as a promising model for other urban areas facing similar challenges. Future research should focus on optimizing microbial consortia and exploring the long-term sustainability of these interventions under varying environmental conditions (Giri et al., 2020)

5. PHOTOGRAPHIC EVIDENCE

Protea South Field Activity

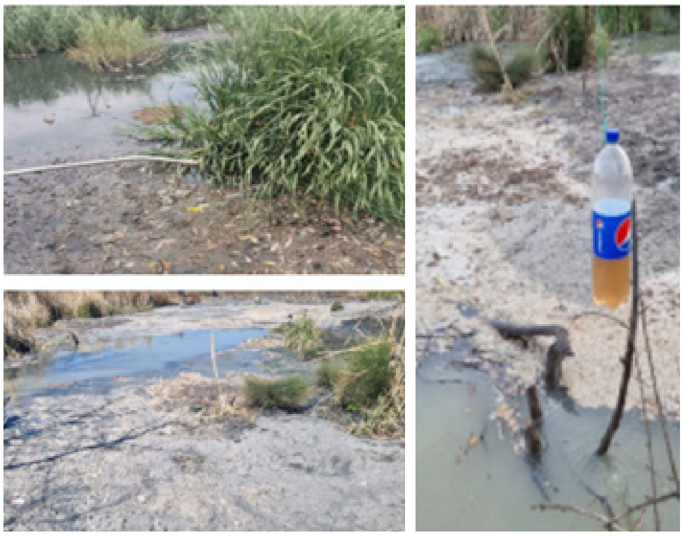

FIGURE 3: *Showing raw sewer spill impcted area taken before construction and bioremediation.*

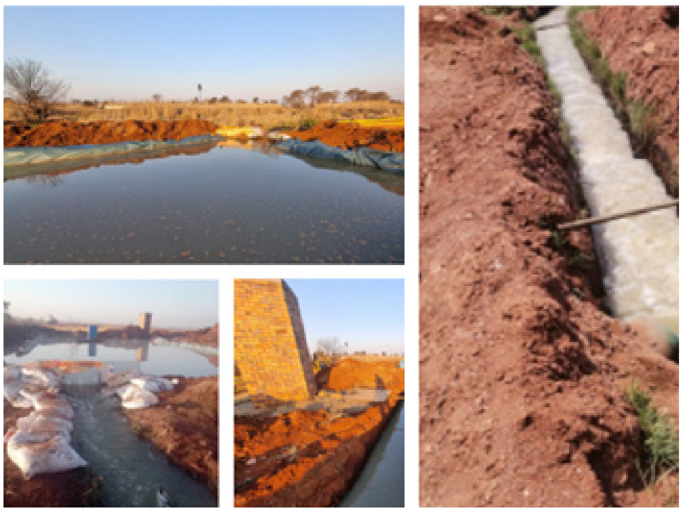

FIGURE 4: *Showing constructed channel to direct wastewater to sump and from sump to river*

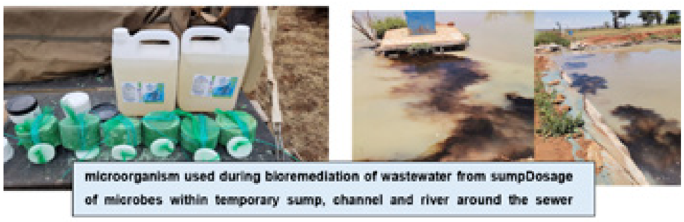

FIGURE 5: *Showing microbes used at the containment sump and strategic point of the impacted river*

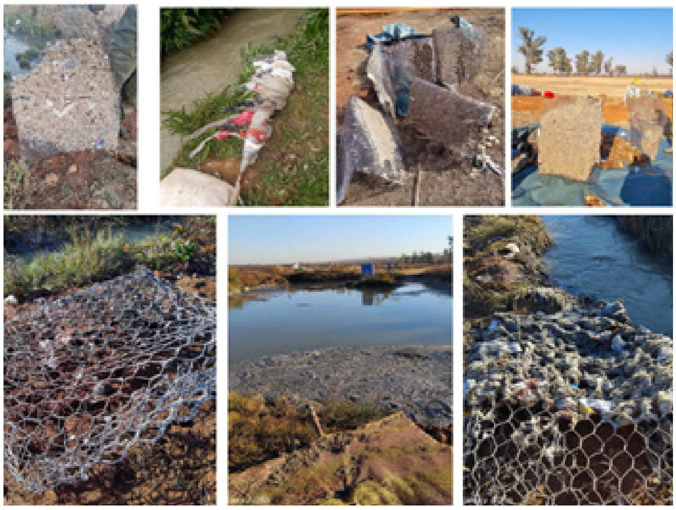

FIGURE 6: *Showing waste water screens installed within the channel to trap solids before reaching the river*

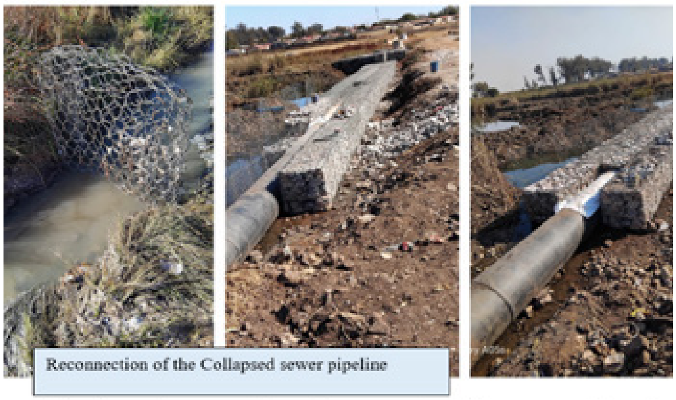

FIGURE 7: *Showing newly constructed sewer line protected by gabions to prevent future damage*

6. CONCLUSION

The implementation of a permanent sewer upgrade, containment sump with a sewer screen, combined with microbial dosage, proved to be a highly effective bioremediation technique for mitigating surface water pollution caused by a collapsed sewer line in Protea South, Johannesburg water infrastructure. This approach significantly reduced the presence of suspended rags as well involving the community in the process through stakeholder engagements assisted and improved water quality by decreasing pollutant levels before the wastewater reached the river. The intervention led to enhancing ecosystem health, training and empowerment of local SMME and labourers and supporting the aquatic life. The study underscores the potential of integrating civil, mechanical filtration and biological treatment to address urban water pollution challenges during pipe breakdown and overflow of sewer lines.

7. RECOMMENDATION

Based on the successful outcomes observed in Protea South, it is recommended that similar bioremediation strategies be adopted in other urban areas facing sewer line collapse and surface water pollution and involve the local community in the activities for empowerment. Continuous monitoring and maintenance of the containment sump and sewer screen are essential to ensure sustained efficacy. Furthermore, expanding research on microbial consortia tailored to local environmental conditions can optimize pollutant degradation. Collaborative efforts between municipal authorities, environmental agencies, and the scientific community will be crucial to scaling these interventions, fostering sustainable water management, and protecting public health and ecosystems. The rehabilitation of the contaminant sump is required to ensure mitigation of soil contamination in the surrounding environment.

8. REFERENCES

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