CLEANER TECHNOLOGY OPTIONS FOR IMPROVEMENT OF WATER QUALITY IN SOUTH AFRICA

INCEPTION REPORT

November 2023

water & sanitation
Department:
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DEPARTMENT OF WATER AND SANITATION

CLEANER TECHNOLOGY OPTIONS FOR IMPROVEMENT OF WATER QUALITY IN SOUTH AFRICA

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Disclaimer:

The Department of Water and Sanitation is not in any position to endorse any specific cleaner technologies to water users but only to provide guidance on available cleaner technology options for the improvement of water quality. Thus, this document can only be used as a guide.

APPROVAL

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EXECUTIVE SUMMARY

South Africa is facing multi-faceted water quality challenges which, if not addressed effectively, have the potential to limit the economic growth of the country significantly. It is generally accepted that the long-term approach to curb the deterioration of water quality is to manage pollution at source, rather than mitigating the symptoms by treating an existing pollution plume.

This **Cleaner Technologies Options for Improvement of Water Quality in South Africa** project is a continuation of the **Eutrophication Management Strategy for South Africa (EMSSA)** which intends to explore cleaner technologies for **improvement of water quality** in the country. The project is also giving effect to the Department of Water and Sanitation (DWS) policies and strategies aimed at addressing water quality issues for water resource protection such as the National Water Resource Strategy (NWRS) and Integrated Water Quality Management (IWQM) Policies and Strategies while taking into consideration international obligations such as the Sustainable Development Goals (SDGs).

The project intends to **develop guidelines** on technologies for water use sectors, such as **water services, agriculture, industrial** and **mining**. These sectors are significant water users and subsequently contribute significantly to water quality impacts in South Africa. Therefore, sector-specific guidelines will be designed to guide cleaner technology options for long-term water quality solutions and sustainable water resource management.

The project will consist of four consecutive phases, namely, project planning, inception, situation assessment and ultimately development of cleaner technology options guidelines. Stakeholder engagement will be executed concurrently throughout the project phases.

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CMA	Catchment Management Agency
CP	Cleaner Production
CT	Cleaner Technology
CTO	Cleaner Technology Options
CTOWQ	Cleaner Technology Options for Water Quality
DEAT	Department of Environmental Affairs and Tourism
DWS	Department of Water and Sanitation
EMSIP	Eutrophication Management Strategy into Practice
EMSSA	Eutrophication Management Strategy for South Africa
FSM	Faecal Management Strategy
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
NWA	National Water Act, 1998 (Act 36 of 1998)
NW&SMP	National Water and Sanitation Master Plan
NWRS	National Water Resource Strategy
PMC	Project Management Committee
PSC	Project Steering Committee
RDM	Resource Directed Measures
SDC	Sources Directed Control
SDS	Sources Directed Studies
Sub-TT	Sub Technical Task Team
TTT	Technical Task Team
WDCS	Waste Discharge Charge System
WEM	Water Ecosystems Management
WRC	Water Research Commission

1. BACKGROUND AND INTRODUCTION

1.1 OVERVIEW

Water security has long been an issue of concern in South Africa. It has increasingly become under tremendous threat in recent years due to natural factors (e.g., geohydrology and climate change effects on rainfall patterns, droughts, flooding etc) and different anthropogenic factors related to land management practices such as poor agricultural practices and wastewater facilities which all lead to the deterioration of the quality of water resources. The most notable implication factor on water resources is the degradation of water quality. Deteriorating water quality impacts significantly on the cost of treating water, presenting a major constraint to economic and social development in South Africa (DWS, 2018).

South Africa is facing a multi-faceted water challenge, which, if not addressed effectively, has the potential to significantly limit the economic growth potential of the country. The deterioration of water quality in rivers, streams, dams, wetlands, estuaries, and aquifers impacts on the economy, human health, and the healthy functioning of aquatic ecosystems. It reduces the amount of water available for use as more water must be retained in our river systems to dilute polluted streams to acceptable standards. It increases the costs of doing business as many enterprises are forced to treat water before using it in their industrial processes. Municipalities also incur additional costs as the cost of water treatment also increases.

The deterioration in water quality also impacts human well-being with productivity falling as more workdays are lost due to water-related illnesses, and it threatens economic sectors by impacting crop yields, making crops vulnerable to import restrictions in key trading partner countries. Some of the impacts of water quality deterioration are immediately visible, such as fish kills, with resulting negative impacts on socio-economic development in South Africa; while others are less visible, such as rising water treatment costs for industrial users. Water quality is, therefore, an economic and developmental issue. It is for these reasons that water resources need to be protected and managed efficiently and effectively.

Water quality is the term used to describe the physical, chemical, biological, and aesthetic properties of water that determine its fitness for use and for the protection of the health and integrity of aquatic ecosystems (DWAF, 1996). Managing water quality requires integrating a wide range of knowledge in a structured process that allows co-learning, co-creation, and co-adaptation as our society and economy develop. Whilst the Department of Water and Sanitation (DWS) is mandated to lead the water sector, the challenge of ensuring sustainable water use will require a more holistic response from the Government, the private sector and civil society (DWS, 2016).

It is generally accepted that the long-term approach to curb the deterioration of water quality is to manage pollution at source, rather than mitigating the symptoms by treating an existing pollution plume. Thus, cleaner technologies have been identified as a preventative environmental approach aimed at reducing the generation of waste at the source. According to the National Water Act, 1998 (Act 36 of 1998), **waste includes any solid material or material that is suspended, dissolved, or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition, or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted**.

The National Water Resource Strategy (NWRS) provides the foundation for the water circular economy and for different water use sectors like municipal, agriculture, industry, and mining. In the municipal space the Water Services Act, 1998 (WSA) stipulates that everyone has a right of access to basic water supply and basic sanitation. Thus, the NWRS lays the foundation for the obligation to ensure that all people in South Africa have access to effective, reliable, affordable, and sustainable water and sanitation services (DWS, 2023e).

Cleaner production (CP) has emerged as an industry initiative that is intended to minimize waste and emissions, while maximizing product output and profitability (Trusler and Mzoboshe, 2011). Strategies for reducing source emissions and waste can be developed by examining the flow of materials and energy during industrial manufacturing processes. Improvements of organization and technology help to suggest better choices in the utilization of materials and energy, to avoid waste, wastewater generation, unwanted gaseous emissions, waste heat and noise, as well as more efficient resource use, increased business profitability and competitiveness, and increased production process efficiency. Cleaner production is applicable to all businesses, regardless of size or type. In addition to the Best Practices Guidelines (BPGs) for wastewater treatment and handling, BMPs with guidelines for cleaner production and cleaner technology should also be considered and, if merited, developed (DWS, 2023a).

Importantly, cleaner technology (CT) is vital for promoting sustainable growth, protecting the environment (particularly water resources), and advancing the cause of a sustainable future. Sustainable development necessitates planning, design, and management practices that enable innovative approaches of waste management in the form of reuse, and recycling of waste that cannot be avoided, despite the emphasis on reducing raw material and energy consumption through an integrated approach (Gavrilescu, 2004).

Figure 1 depicts a typical example of the CT integrated approach within the waste management hierarchy. The hierarchy defines waste management objectives and represents a paradigm shift away from focusing on improved waste treatment and disposal systems "*end of pipe"* and towards efforts to reduce waste production and eventually pollution. Historically, environmental compliance efforts have been focused primarily on the treatment of pollution once it has been released from the source "*end-of-pipe*" rather than on preventing or recycling, these two approaches that in many cases offer a lower cost means of attaining compliance (Gavrilescu 2004). Hence, it is critical that the focus for interventions shift to minimising impacts from the source.

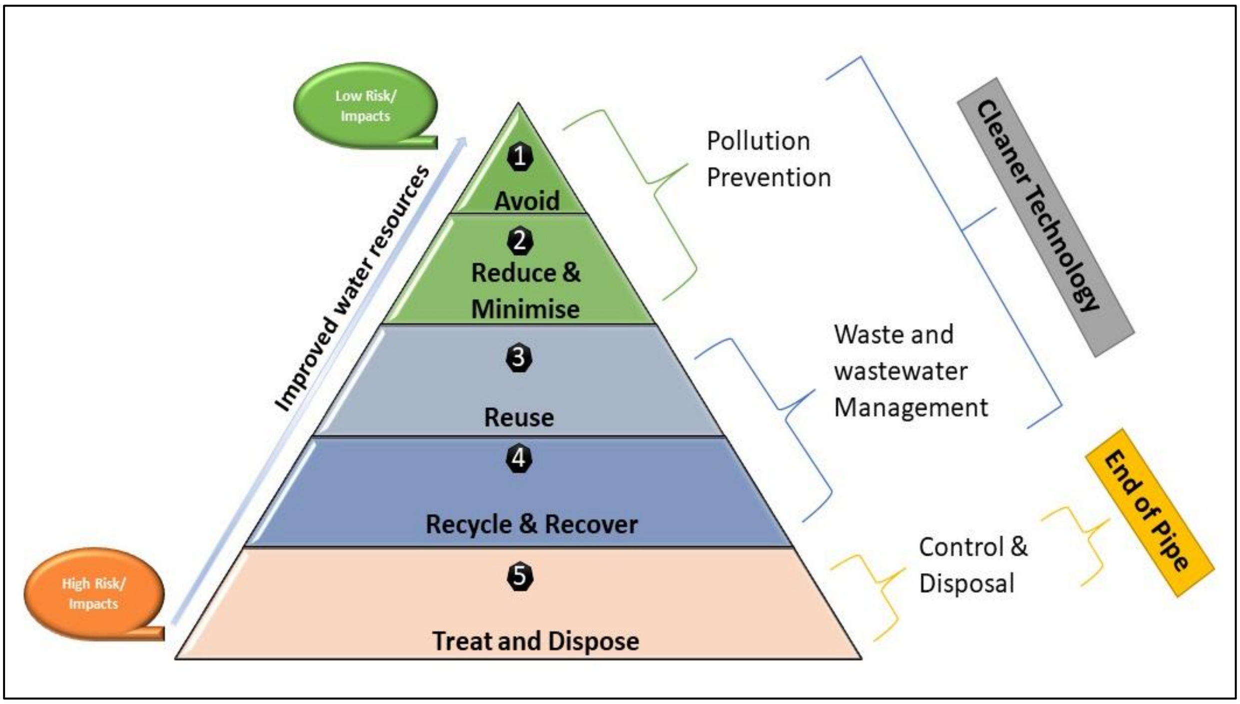

Figure 1: Waste Management Hierarchy for an Integrated Approach for Cleaner Technology (modified from DEAT, 2004)

CT entails the first four strategies of the waste management hierarchy, namely, (1) avoiding the production of waste, (2) reducing and minimising the amounts of waste and impacts of pollution, and (3) reusing or (4) recycling or recovering the waste.

Sustainable development in respect of water resource management seeks to ensure that basic water needs, socio-economic development and improved quality of life are met for all; both current and future generations (DWAF, 2006).

The DWS as the custodian of water resources in South Africa is mandated by the National Water Act, 1998 (Act 36 of 1998) (NWA) which provides for the protection, use, conservation, management, and control of water resources in an efficient, sustainable, and equitable manner. The NWA is founded on the principle that the DWS has overall responsibility and authority over water resource management. In that background, the Chief Directorate: Water Ecosystems Management (CD: WEM) is mandated by **Chapter 3** of the NWA. Chapter 3 provides for the protection of water resources through the implementation of Resource Directed Measures (RDMs) and Source Directed Controls (SDCs). To effect and ensure that the water resources are protected, the principles of efficiency, equity and sustainability are applied.

Resource Directed Measures (RDM) comprises the setting of Water Resource Classes, determining the Reserve and setting of Resource Quality Objectives (RQOs). On the other hand, SDCs are measures to protect water resources by preventing and/or minimizing potential polluting activities and limiting impacts to acceptable levels by imposing regulatory controls (*e.g.*, water use authorizations, regulations, best practice guidelines) on water use activities such as abstraction of water and disposal of waste or water containing waste.

To this end, the Directorate Sources Directed Studies (SDS) within CD: WEM is coordinating an in-house project to conduct studies on ***Cleaner Technology Options for the Improvement of Water Quality (CTOWQ) in South Africa***. Therefore, the project gives effect to strategic actions of the Eutrophication Management Strategy for South Africa (EMSSA).

The inclusion of CP-related aspects into national policy and legislation on waste management, pollution control, water management and energy; and the development of DWS Water Conservation and Water Demand Management Strategies as examples of government's move towards CP are some of the significant milestones regarding the introduction of CP in South Africa in recent years (DEAT, 2004). In addition, this current project asserts that CTOs can play a major role in addressing concerns related to water quality issues in the country; and in return alleviating the tensions that result between competing, but essential, water users as they compete for the same scarce, vulnerable resource.

1.2 PROJECT MOTIVATION

Water quality challenges in South Africa are predominantly a result of the challenges the country faces in managing the ever-expanding sources of pollution. These sources of water pollution are contributed to by rapid urbanisation, expansion of the mining industry, increasing use of chemicals in industries, inappropriate practices for surface soil tillage and fertiliser application, and the destruction of our natural/green infrastructure, including wetlands and riparian buffer zones (DWS 2023a). There is a need to increase the sustainability efforts for South African water resources.

In that background, the DWS had revised, updated, and consolidated its policies and strategies and developed the Integrated Water Quality Management (IWQM) Policies and Strategies for South Africa in 2016 and 2017, respectively. The IWQM Strategy emphasised five water quality issues of priority which included eutrophication, salinization, Acid-Mine Drainage (AMD), urban pollution, and sedimentation which require urgent attention. It further sets out the prioritized strategic objectives and actions that need to take place to achieve the vision and mission for water quality management in South Africa (DWS 2017). As a result, ongoing research, innovation, and development are required to ensure that the most effective techniques, technologies, and approaches for managing and regulating water quality are implemented across the country to deal with emerging pollutants and afford current technologies adaptation.

In addition, the EMSSA gave effect to the IWQM policy and strategy. Thus, the new project on "Cleaner Technology Options for Improvement of Water Quality (CTOWQ) in South Africa" is giving effect to the EMSSA Strategic Goals, namely:

- **promote the reduction, recycling and re-use of excessive nutrient-load containing waste and/ or wastewater, and faecal sludge in accordance with relevant geographical water quality management strategies and thematic plans.**
- **promote cleaner production and technologies, specifically to combat anthropogenic eutrophication.**
- **investigate recent innovative treatment technologies to improve water quality.**

The National Water Resources Strategy 3 (NWRS-3) outlines strategic objectives and actions which ought to be carried forward for resourcing and implementation in the National Water and Sanitation Master Plan (NW&SMP), and by addressing challenges identified in the NWRS-2. Some of the challenges related to this project include:

- improving raw water quality and increasingly protecting and restoring ecological infrastructure.
- innovating and implementing new technologies in the sector.
- addressing the long-term water quality situations.

The Cleaner Technology Options (CTO) project intends to address these technology-related challenges identified in draft NWRS-3.

1.3 PROJECT AIM AND OBJECTIVES

The Project aims to develop guidelines on Cleaner Technology Options for the improvement of Water Quality in South Africa for water resources. The Project is in line with the departmental policies and strategies for effective water resource management and sustainable development. In addition, this project intends to assist the water sector and affected parties in providing guidance for CTOs and implementing CTO programmes. The project aims and objectives are depicted in **Figure 2.**

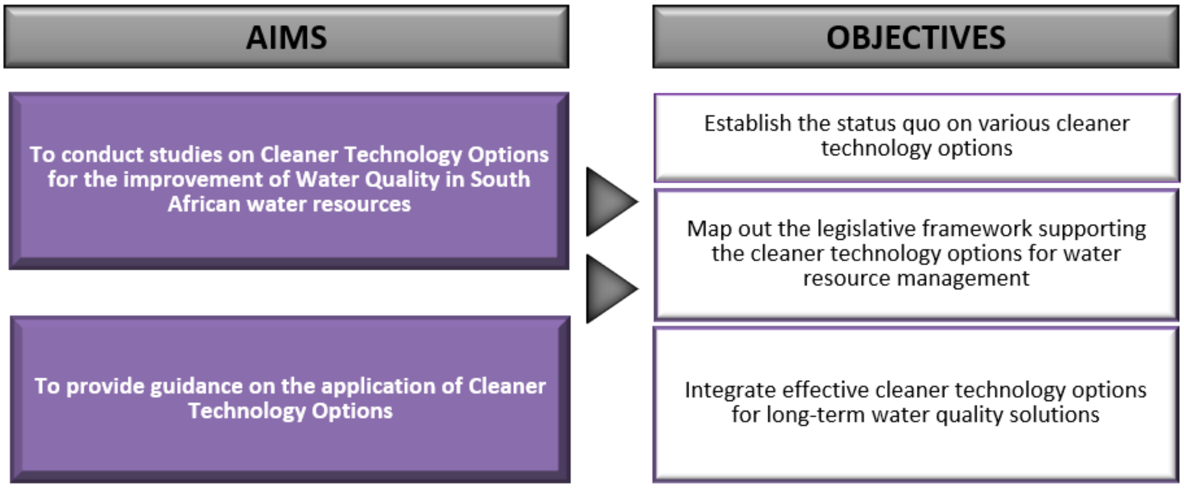

Figure 2: Project Aims and Objectives

Therefore, the project focus will include but not limited to the following:

➢ Point Sources of Pollution

- Industrial wastes (*e.g.*, garage wastes, laundry wastes, putrescible matter from abattoirs, tanneries, food canning industries, wool, and cotton fibres).
- Return flows from mining activities and Acid Mine Drainage (AMD) desalination plants.
- Domestic wastewater [*e.g.*, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nutrients, and pathogenic bacteria].
- Chemicals of Emerging Concerns/ Contaminants of Emerging Concerns (CECs) (*e.g.*, microplastics)
- Solid waste dumps (*e.g.*, faecal sludge, landfills discharge).

➢ Non-Point Sources of Pollution

- Urban run-offs (*i.e.,* heavy metals, bacteriological contamination).
- Stormwater pollution.
- Chemicals of Emerging Concerns/ Contaminants of Emerging Concerns (CECs) (*e.g.*, pharmaceutical product disposal, endocrine disruptors).
- Persistent Organic Pollutants (POPs).

- Other agricultural return flows (fertilizers, insecticides, pesticides).

Figure 3 provides an illustration of the project focus.

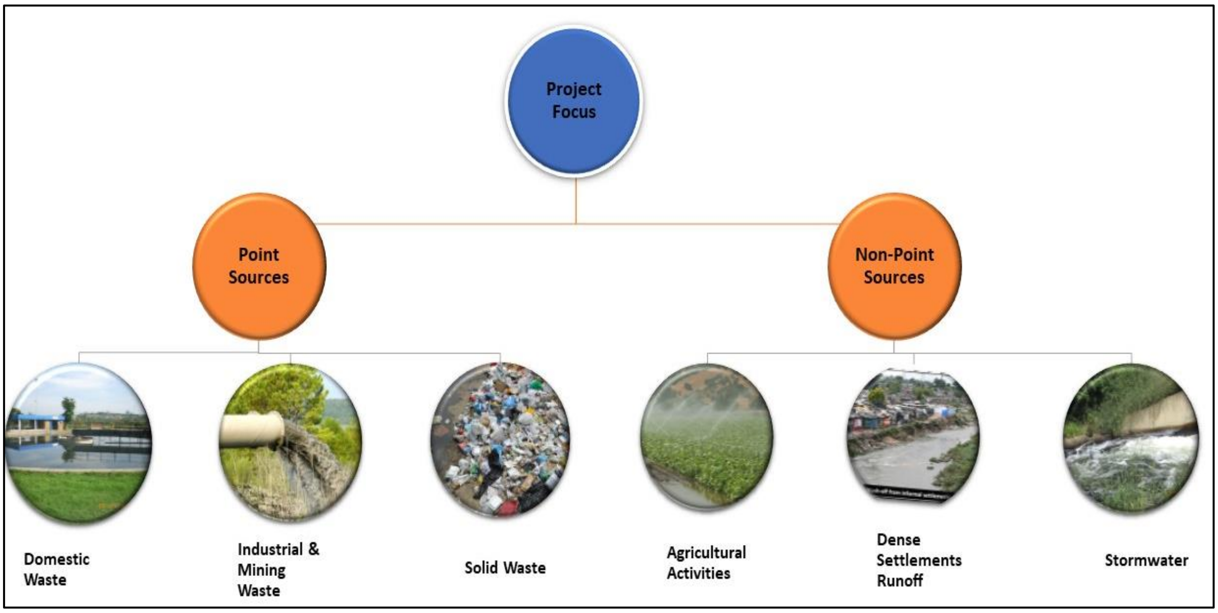

Figure 3: Project Focus

1.4 PROJECT APPROACH

The project intends to **develop guidelines** on technologies for water use sectors, namely, **water services, agriculture, industrial** and **mining**. These sectors are significant water users with notable pollution contributions in South Africa, and thus sector-specific guidelines will be designed to guide on the application of CTs for long-term water quality solutions and sustainable development. Themes identified for the project and examples of project focus per theme are depicted in **Figure 4**.

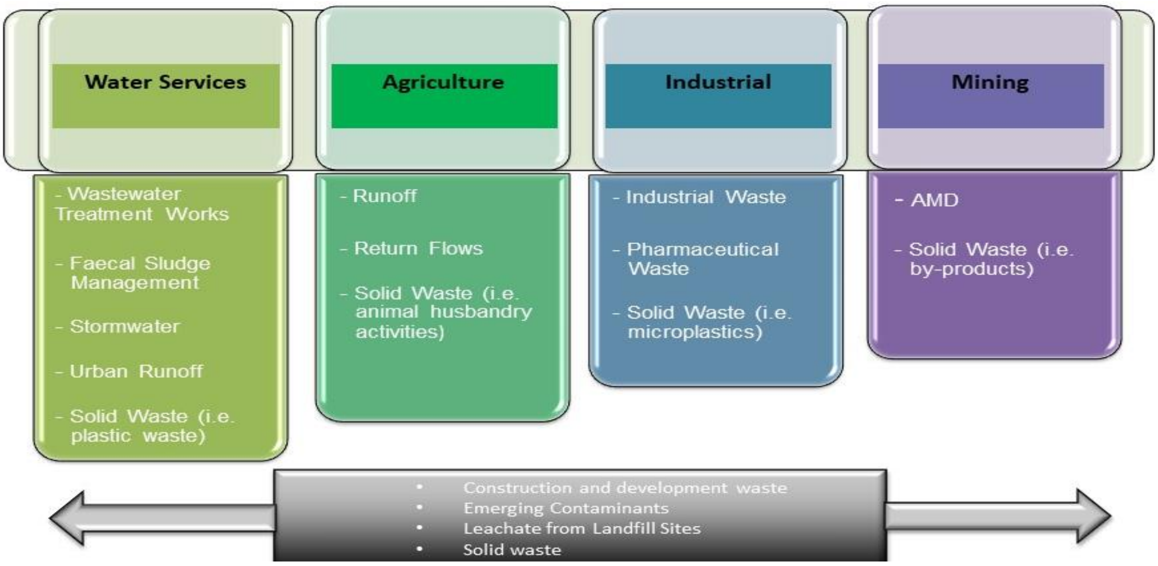

Figure 4: Project Themes

2. PURPOSE AND REPORT LAYOUT

2.1 PURPOSE OF THE REPORT

The purpose of this Inception Report is to:

- define the scope of the project;
- review available information to establish the status quo with regards to available CTOs; and
- confirm the proposed project approaches, programme, deliverables, timelines, and budget.

2.2 REPORT LAYOUT

The layout of the report is as follows:

- **Sections 1 – 2** provide the background and introduction as well as the layout of this report.
- **Section 3** presents the legal framework pertaining to the project.
- **Section 4** presents the preliminary contextualization of the available literature.
- **Section 5** details the scope of work and project approach based on the preliminary assessment on the available literature.
- **Sections 6 – 8** present the stakeholder engagement plan, project management team, project plan, milestones, timeframes, and the indication of the project's budget.
- **Sections 9 – 10** provides direction on the reporting lines for the project and conclusions.

A preliminary contextualization of the available literature and information has been completed in Section 4 as part of this Inception Report, succinctly taking stock on the progress made to date with regards to CTOs. Information was sourced and collated from reports, previous studies, ongoing water resource management and protection initiatives and programmes. This information builds up to the next project phase which is the Situation Assessment Phase.

3. LEGAL FRAMEWORK

3.1 INTERNATIONAL OBLIGATION

South Africa is a member state of the United Nations and has committed to the achievement of Sustainable Development Goals (SDG). SDG 6 focuses on clean water and sanitation and must ensure availability and sustainable management of water and sanitation for all. SDG 6 was unpacked into six SDG targets and two additional supporting SDG targets (**Table 1)**.

Table 1: SDG 6 targets and indicators with direct relevance to cleaner technologies

SDG 6:	**Ensure availability and sustainable management of water and sanitation for all.**
SDG TARGET 6.2:	**SANITATION AND HYGIENE**
By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.	
Indicator 6.2.1:	Proportion of population using safely managed sanitation services, including a handwashing facility with soap and water.
SDG TARGET 6.3:	**WATER QUALITY AND WASTEWATER**
By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	
Indicator 6.3.1D:	Proportion of water containing waste lawfully discharged.
Indicator 6.3.2D:	Proportion of bodies of water that complies with water quality objectives.
Indicator 6.3.3A:	Proportion of water containing waste recycled or reused.
Indicator 6.3.4A:	Proportion of waste lawfully disposed of.
Indicator 6.3.5A:	Proportion of waste recycled or reused.
SDG TARGET 6.5:	**WATER RESOURCES MANAGEMENT**
By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.	
Indicator 6.5.1:	Degree of integrated water resources management implementation (0 - 100).
SDG TARGET 6.6:	**WATER-RELATED ECOSYSTEMS**
By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.	
Indicator 6.6.1D(1):	Change in the spatial extent of water-related ecosystems over time, including wetlands, reservoirs, lakes, and estuaries as a percentage of total land area.
Indicator 6.6.1D(2):	Number of systems affected by high trophic and turbidity states.
Indicator 6.6.1D(3):	Change in the national discharge of rivers and estuaries over time.
Indicator 6.6.1A(1):	Change in the ecological condition of rivers, estuaries, lakes, and wetlands.

3.2 NATIONAL OBLIGATIONS ON CLEANER TECHNOLOGY

Not only does poor water quality impact on the ***right to an environment that is not harmful to health or well-being,*** but it carries significant economic costs through lost productivity, escalated water treatment costs, and high health costs (DWS, 2017)***.*** Therefore, the implementation of CTs by water users reduces environmental impact and leads towards sustainable development. Consequently, CT promotes reduction of pollution at source strategy, reducing water consumption, and toxicity of effluent discharged at source (Barclays, 2011). Therefore, this section provides the overarching legislation which is the Constitution of the Republic of South Africa and scale down to the strategic initiatives done which are in line with the current project.

Whilst there are no specific legislative instruments directly enforcing CTOs in South Africa at present, there are numerous policy initiatives which are likely to be incorporated into legislation in the near future (Hanks and Janisch, 2003; Chewe 2007). However, the Bill of Rights in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) enshrines the concept of sustainability, specifying rights regarding the environment, water, access to information, and just administrative action. These rights and other requirements are further legislated through the National Water Act, 1998 (Act 36 of 1998) (NWA).

The NWA provides the legal basis for water management in South Africa by ensuring ecological integrity, economic growth, sustainability, and social equity when managing and using water (DWA, 2008). Furthermore, NWA introduced the concept of Integrated Water Resource Management (IWRM) comprising all aspects of the water resource, including water quality, quantity, and the aquatic ecosystem (*i.e.*, quality of the aquatic biota and in-stream and riparian habitat) (DWA, 2008). The IWRM is a concept that is meant to foster effective water resource management in a sustainable manner. The consideration of sustainability, as a main part of IWRM, is not only restricted to ecological sustainability for protecting the natural system, but it also covers aspects of financial and economic sustainability (Meran, et al., 2021).

The current project will be informed and aligned with the various existing policies and strategies, and International Treaties, such as the:

- Sustainable Development Goals;
- Ramsar Convention;
- Global Plastic Pollution Treaty negotiations;
- National Water Act, 1998 (Act 36 of 1998);
- National Water Resource Strategy version 3 (NWRS – 3);
- Integrated Water Quality Management (IWQM) Policies and Strategies for South Africa;
- National Water & Sanitation Master Plan (NW&SMP);
- Eutrophication Management Strategy for South Africa (EMSSA);
- Eutrophication Management Strategy into Practice (EMSIP);
- Draft National Faecal Sludge Management Strategy for Onsite Sanitation System.

3.3 STRATEGIC ALIGNMENT

This sub-section provides a summary of the most prominent policies and strategies that give direction to the Cleaner Technology Options for water quality in South Africa and highlights the important aspects for alignment with the current project.

1. National Water Resource Strategy (Edition 3) (DWS, 2023e)

The NWRS calls for the development of government policies and strategies for proactive measures to mitigate water resource quality degradation and address legacy deterioration; while maintaining healthy water ecosystems (rivers, wetlands, estuaries, lakes, dams, and groundwater) to ensure their continued provision of ecosystem services.

- **Chapter 8: Regulating Water and Sanitation Sector -** Regulation of the water and sanitation sector is a critical element of effective, equitable and sustainable water and sanitation management of water resources and the delivery of sustainable and appropriate water and sanitation services. Regulation aims to change the behaviour of water users and water and sanitation institutions to ensure the sustainable and equitable use, protection, conservation, and development of the nation's water resources and sustainable, equitable and appropriate delivery of water and sanitation services.
- **Chapter 12: Protecting and Restoring Ecological Infrastructure - Principle 8: Recognising the scarcity of good quality water**: How sanitation services are provided must reflect the growing scarcity of good water quality in South Africa in a manner which reflects their value and does not undermine long term sustainability of water resource and economic growth. The ecosystem, public and economic benefits of improved sanitation must be recognised and valued. The economic value of sanitation by-products should be recognized, and the reuse of these products should be encouraged, particularly as a resource in energy generation. The economic value of sanitation is recognised concurrently with recognition of the social value of sanitation.
- **Chapter 17: Enhancing Research, Development, and Innovation** - Research and innovation is a major contributor to meeting the ever-increasing demands for and challenges in water and sanitation in South Africa. The development of skills in the water sector and high-level knowledge about water and sanitation is still a priority for rapid progress to be made in ensuring that equity in water use and sanitation services is achieved.

2. National Water and Sanitation Master Plan (DWS, 2018b)

The NW&SMP forms part of a suite of initiatives led by the DWS in conjunction with other government departments and agencies, the private sector and civil society to ensure that the country avoids a water crisis, and to aim, instead, for a water-secure future with reliable water and sanitation services for all, and that these contribute towards meeting national development objectives. NW&SMP advocates for the application of smart and water-efficient technology systems.

Volume 2, Action 2.3.7 provides for the continuation of developing high-end skills (post-graduate) to ensure a future science, technology, and innovation capability in South Africa**.**

3. Eutrophication Management Strategy for South Africa (DWS, 2023a)

The Eutrophication Management Strategy for South Africa (EMSSA) was developed as a tool to address issues related to the degradation of water resources due to excessive nutrient enrichment. The EMSSA identified several policies and strategies for eutrophication management and water quality in general. Whereas Eutrophication Management Strategy into Practice (EMSIP) supports the Eutrophication Management Strategy by providing guidance for the effective implementation of the Strategy.

EMSSA advocates for the development of Best Management Practices (BMPs) for cleaner production and cleaner technology in addition to Best Practice Guidelines (BPGs) for wastewater treatment and handling.

4. Integrated Water Quality Management Policies (IWQM) Policies and Strategies for South Africa (DWS, 2016)

Strategic Issue 9 provides for clean technology supported by green economy initiatives and the financing mechanism provides targeted ways of reducing pollution at source.

In addition, **Principle. 10** provides for the Promotion of green/ecological infrastructure restoration and rehabilitation.

5. Draft National Faecal Sludge Management Strategy (DWS, 2023c)

In South Africa, there is no water services authority that is 100% sewered (DWS, 2023c). The National Faecal Sludge Management Strategy is developed to guide the sector on the safe management of faecal sludge from all onsite sanitation systems to prevent groundwater contamination, safeguard public health and protect the environment from pollution throughout the sanitation service chain.

SDG target 6.2 is one of the international initiatives that accelerated actions towards faecal sludge management to ensure safely managed sanitation (**Table 1)**.

6. Water Conservation and Water Demand Management Strategy (DWAF, 2004; DWS, 2023d)

Water Conservation and Water Demand Management Strategy (WC/WDM) developed by the DWS in 2004 and updated in 2023, promotes efficient use of water and encourages demand side management of water. WC/WDM is concerned not only with reducing water usage and water wastage but also safeguarding the quality and quantity of water resources.

The relevance of this Strategy is the promotion of reduction in water use, and water reuse and recycling (DWS, 2023d).

- **Objective 5:** to support innovation and the use of technology.

4. CONCEPTS AND DEFINITIONS

4.1 CONCEPT OF CLEANER TECHNOLOGY OPTIONS FOR WATER RESOURCE PROTECTION

Cleaner technology is often used interchangeably with cleaner production or green technology, or sustainable technology. It is a broader term that refers to various environmentally friendly practices. Thus, cleaner technology is a term that describes a **preventative environmental approach, aimed at increasing resource efficiency and reducing the generation of waste at source, rather than addressing and mitigating the symptoms by technically treating an existing pollution problem** (Trusler and Mzoboshe, 2011). Furthermore, this approach embraces the '*cradle-to-grave'* principle, the *'precautionary principle*' and the '*preventive principle'*. Because Cleaner Production addresses the problem at several levels at once, it is a holistic integrated preventive approach to environmental protection (DEAT, 2004).

In essence, Cleaner Technology/Production is about (DEAT, 2004):

- Preventing waste and pollution at source;
- Improving water and energy efficiency;
- Minimizing the use of hazardous raw materials;
- Reducing risks to human health;
- Saving money;
- Improving efficient management practices;
- Promoting sustainable development.

These technologies provide a practical way of moving towards sustainable development by allowing the producers of goods and providers of services to produce more with less – less water, less raw material, less energy, less waste, less pollution and thus less environmental impact and greater sustainability (UNEP, 2000). In simple terms, this refer to technologies which are efficient enough to minimize pollution while being eco-friendly in terms of environmental impacts. For the purpose of this project and in alignment with the DWS mandate of water resource protection, **CTOs refer to eco-friendly technologies that are effective and efficient in reducing the impacts of pollution on water resources and promoting the water use efficiency**.

Cleaner production has emerged as an industry initiative that is intended to minimize waste impacts while maximising product output and profitability. By analysing the flow of materials and energy in industrial production processes, options to minimize waste impacts can be identified, and industry source reduction strategies can be established.

Improvements in organization and technology help to suggest better choices in the utilisation of materials and energy, to avoid waste, pollution, wastewater generation, unwanted gaseous emissions, waste heat and noise, as well as more efficient resource use, increased business profitability and competitiveness, and increased production process efficiency (El-Haggar, 2007). The concept of cleaner technology is summarized in **Figure 5**.

Cleaner technologies can be beneficial to developing countries such as South Africa and those undergoing economic transition through planning, design and management practices that facilitate innovative approaches to the reuse, remanufacturing, and recycling of the limited amounts of waste that cannot be avoided (Gavrilescu, 2004).

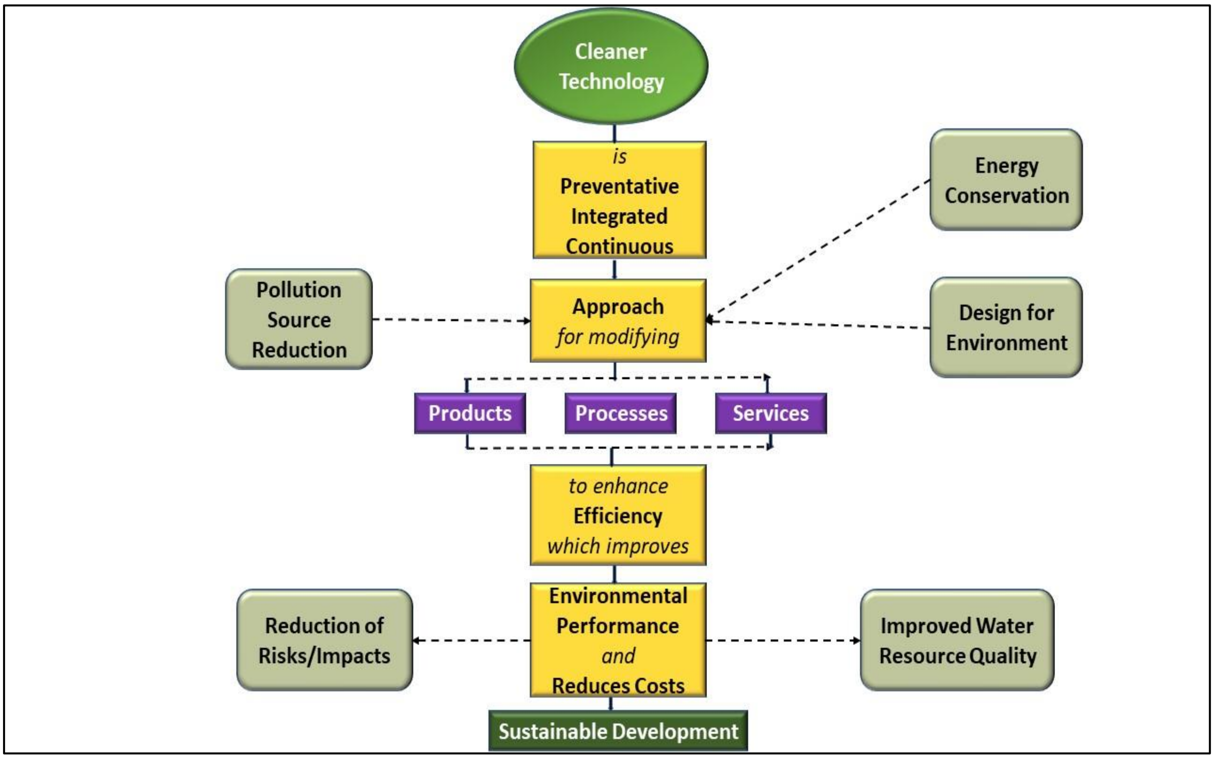

Figure 5: Concept of Cleaner Technology (Modified from Chewe, 2007)

Cleaner Technology approach follows the waste management hierarchy and involves taking a pro-active approach such that the production of waste is minimized at source (**Figure 6**) (Barclay et al., 2011).

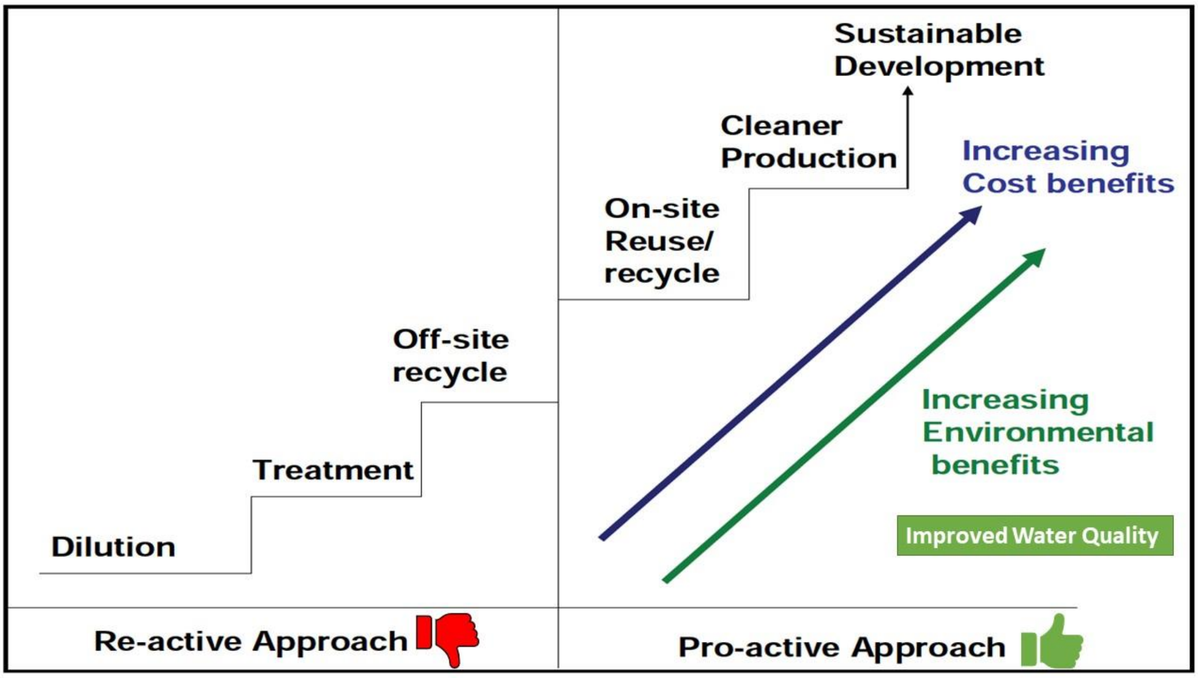

Figure 6: Waste Management in relation to CT (modified from Barclay *et al.,* 2011)

Table 2 provides a list of some of the benefits associated with CTOs.

Table 2: Benefits associated with application of Cleaner Technologies

REASONS	ACTIONS
Reducing environmental degradation	- Promotes pollution prevention and brings about more efficient use of resources. - Improves water quality because of the reduction of pollutants discharged into water resources. - Conservation of land from the contaminants which may potentially leak from waste generation, transportation, storage, and disposal activities. - Conserving endangered species
Improving quality of life	- Better health, safety, and morale of employees - Improved safe and healthy conditions for communities and consumers
Economic benefits: reduction of operating costs	- Savings in raw material and energy. - Reduced costs of end-of-pipe-solutions. - Reduced environmental degradation costs by the enterprise.
Other benefits	- Reduced liability connected with treatment, storage, and disposal of hazardous wastes. - Reduced concerns over environmental legislation.

4.2 GLOBAL CONTEXT OF CLEANER TECHNOLOGIES AND CLEANER PRODUCTION

Increased awareness of the inefficient and overall ineffective nature of pollution control technologies, and their incompatibility with the increasing emphasis on sustainable development, resulted in the emergence of pollution prevention practices which led to the introduction of the concept of CP/ CTOs. The concept of cleaner production was introduced by the United Nations Environmental Programme in 1989 as a new and innovative approach to resource conservation and environmental management as well as to respond to the question of how to produce in sustainable development (UNEP 2001).

Cleaner Technologies are acknowledged worldwide as essential tools for the sustainable development of countries through maintaining high rates of economic growth, expanding environmental protection activities, and as a fundamental point, achieving social equity (Hicks and Dietmar, 2007). However, there are challenges associated with the adoption of these tools in different countries such as insufficient focus on CT in environmental, technology, trade and industrial development policies and strategies; absence of sound operational basis; and immaturity of the environmental policy framework (including the lack of enforcement and low prices for natural resources such as water, and energy, etc (UNEP, 2000).

4.3 STATUS QUO OF CLEANER TECHNOLOGY OPTIONS IN SOUTH AFRICA

This section of the report aims to provide an account on the various water resources cleaner technologies related studies, programmes and initiatives that have been undertaken with specific reference to improving water resources quality in South Africa. The focus is on preliminary information gathering to identify and highlight progress made to date in terms of the CTOs. Previous and existing research results and other related information were relied upon to support the information needs and refine the project scope.

The information gathering, and review in **Table 3** has been initiated as part of this Inception Report and will be expanded during the Situation Assessment Phase of the project. **Therefore, at this stage, available information is not considered to be exhaustive as the literature review exercise is ongoing**.

Table 3: Summary of findings on the status quo in relation to CTOs and CPs in South Africa

WATER USE SECTORS	IMPACTS ON WATER RESOURCES	STUDIES, PROGRAMMES, INITIATIVES	SUMMARY OF FINDINGS, INTERVENTIONS AND BEST MANAGEMENT PRACTICES IMPLEMENTED
Water Services	- Over abstraction for water users including Domestic Water Use - High volumes of wastewater and sewage discharge largely affect the oxygen balance, nitrogen, and phosphate concentration in the waters of the receiving bodies.	**Water Quality Guidelines** (DWAF, 1996); and **Water Use Authorisation (WUA) conditions**	The rationale for developing the South African Water Quality Guidelines was to develop a criterion that was appropriate for South Africa based on a consensus of experts and the role players in water quality and fitness for use. The undesirable effects of water quality on its fitness for a specific use can often be prevented or mitigated through management interventions during use or at the point of use. Thus, CTOs can play a crucial role in ensuring that the water quality standards stipulated in these guidelines are met by various users for specific water uses.

WATER USE SECTORS	IMPACTS ON WATER RESOURCES	STUDIES, PROGRAMMES, INITIATIVES	SUMMARY OF FINDINGS, INTERVENTIONS AND BEST MANAGEMENT PRACTICES IMPLEMENTED
	- Urban runoff is a pathway for sedimentation, nutrients, solid waste and heavy metals from illegal discharges of industries in urban areas. - Stormwater runoff events can drive the transport of pathogens from urban sources (faecal waste from humans, domestic animals, or wildlife) to waterbodies, potentially leading to microbial water quality impairment	**Resource Quality Objectives** (RQOs)	The Act states that the purpose of Resource Quality Objectives (RQOs) is to establish clear goals relating to the quality of the relevant water resources. It also stipulates that in determining RQOs, a balance must be sought between the need to protect and sustain water resources and the need to use them. RQOs are numerical and/or narrative descriptors of conditions that need to be met to achieve the required management scenario as provided during the water resource classification. Such descriptors relate to the (DWS, 2022): a) Water quantity, pattern, timing, water level, and assurance of instream flow; b) Water quality, including the physical, chemical, and biological characteristics of the water; c) Character and condition of the instream and riparian habitat; and d) Characteristics, condition, and distribution of the aquatic biota.
		Draft National Faecal Sludge Management Strategy (DWS, 2023c)	FSM calls for the **Development of a framework for Faecal Sludge Management (FSM) technology options across the service chain, with attached promotional materials.** This will require DWS to review legislation, regulations and guidelines and include amendments for new technology.
		Water Conservation and Water Demand Management Strategy for Water Services Sector (DWS, 2004)	The management of water resources and the provision of water services in South Africa calls for a new approach in which WC/WDM is expected to play a crucial role in ensuring environmental sustainability, social equity, and economic development. The Water Services sector is expected to play a greater role in water conservation and water demand management.
Agriculture	- Farms discharge large quantities of agrochemicals, organic matter, drug residues, sediments, and saline drainage into waterbodies. - Excessive nutrients (*i.e.*, phosphorus) load into water bodies resulting in eutrophication. - Contamination of surface water with	**Water Conservation and Water Demand Management Strategy for Agriculture Sector** (DWS, 2004)	The strategy promotes the equitable and efficient use of water to increase productivity and reduce past inequities in the sector, especially regarding new entrants. It also endeavours to provide a supportive and enabling framework to improve irrigation efficiency.
		Applying Life Cycle Assessment for the mitigation of environmental impacts of South African agri-food products" (Harro	The project contributed to the important global question of how to reduce environmental impacts from food production, with a focus on South African food value chains.

WATER USE SECTORS	IMPACTS ON WATER RESOURCES	STUDIES, PROGRAMMES, INITIATIVES	SUMMARY OF FINDINGS, INTERVENTIONS AND BEST MANAGEMENT PRACTICES IMPLEMENTED
	pathogens (*i.e.*, bacteria, virus, etc.) leading to chronic public health problems - Potential leaching of nitrogen, etc. to groundwater - Destruction of riverine habitat in riparian habitat and infilling of wetlands by agriculture activities leads to erosion and sedimentation of water resources - Afforestation – Alien Invasive Plants species	von Blottnitz, 2014 – 2017)	This project produced various publications on the application of cleaner technologies with a focus on the agriculture sector. More information on this study is accessible at this link: https://www.zhaw.ch/en/research/research-database/project-detailview/projektid/2130/
Industry	- Acidic atmospheric deposits - pollution loading into water resources. - Changes in stream regimens (can affect fish, plants, and wildlife by changing stream levels, flow patterns, and temperature)	**A Pilot Study into Available Upstream Cleaner Production Technologies for the Petroleum Refining Industry to Meet the Requirements of the Waste Discharge Charge System** WRC Project by (Mazema et al., 2008)	The project aimed to produce a prioritized list of upstream technologies for the petroleum refining industry; quantify the financial implications of meeting the requirements of the Waste Discharge Charge System (WDCS); and provide a summary of the international standards used for effluent quality discharged from petroleum refineries. It was evident from the survey conducted on international standards for effluent quality discharge limits for the petroleum refining industries, that most countries list pH, BOD, COD, ammonia (total N as a nutrient), oils and greases, volatile organic compounds (VOCs) and heavy metals as the main contaminants.
Mining	- Contamination of surface water by spills from treatment and processing facilities - Contamination of surface or groundwater by sediment, mobilisation of salt, release of toxic elements from overburden, tailings or wastes, or spills of oil, chemicals or fuel as surface	**Cleaner Production: A Guidance Document for the Mining Industry** WRC Project by (Barclay et al., 2011)	The aim of the Guidance Document is to assist the mining industry and its regulators, in determining the benefits of implementing cleaner production and the methodology involved. Case studies and examples are incorporated to demonstrate how cleaner production has been implemented successfully in mining companies, both locally and internationally, and checklists are used to guide the user through each stage of the cleaner production process.
		The introduction of Cleaning Production Technologies in the	The overall objective of this project was to introduce CP technologies in the mining industry.

WATER USE SECTORS	IMPACTS ON WATER RESOURCES	STUDIES, PROGRAMMES, INITIATIVES	SUMMARY OF FINDINGS, INTERVENTIONS AND BEST MANAGEMENT PRACTICES IMPLEMENTED
	runoff or as underground seepage - Dewatering of aquifers - Long-term contamination of runoff from stockpiles, rock dumps, tailings facilities - Destruction of wetlands and peat layers by coal-mining activities, especially opencast method.	**South African Mining Industry** WRC project by (Trusler and Mzoboshe, 2011).	The main findings from this study included the following: - The South African mining industry is improving its practices and taking the environmental impacts into consideration in project decisions and operations. - The industry is willing to adopt CP initiatives and realize the benefits of implementing CP technologies. - Distinct differences in approach were noted between big and small companies. These are: - With the larger companies, the awareness is being driven mainly by the company's policies and the practices of their competitor. The environmental policies of the larger companies contain CP principles, and this was used as a route to encourage cleaner technology in these companies.

4.4 FINDINGS FROM LITERATURE AND AVAILABLE INFORMATION

Available literature and information were reviewed in **Section 4.3** above to obtain a preliminary status quo on practices relating to CTOs and interventions on water resources in South Africa. According to the literature most of the research efforts to address water and waste management, particularly in the mining industry, have been devoted to minimizing the impact of waste and pollution on the environment and improving the ability to predict and quantify effects as well as to develop technologies to treat polluted water resources. Thus, the cleaner technologies projects/initiatives done in South Africa have been found to be more sector-specific rather than focusing on improving water quality in water resources. Hence, a need to conduct studies on cleaner technology options to improve water quality. Impacts of water abstraction, water quality deterioration, effect of power usage and land use changes need to be dealt with in a proactive manner (Trusler and Mzoboshe, 2011) rather than dealing with the aftermath. The following are some of the challenges that need to be addressed by adopting and implementing effective and efficient CTOs:

➢ Water Services Sector

Water and wastewater treatment systems require upgrading and modification to deal with the range of pollutants in raw water. Thus, a major concern that needs to be addressed is the ageing and leaking urban reticulation systems (DWS, 2017).

Currently, the capacity of insufficient WWTWs to cope with increasing wastewater loads due to an increase in population numbers is among the technical, social, economic, and environmental challenges facing South African government (Oberholster et. al., 2021). In addition, the management of faecal sludge in South Africa is one of the challenging issues that need to be addressed. FSM Strategy (DWS, 2023c) listed the following as the current challenges relating to the treatment of faecal sludge in the country:

- There are no dedicated FSTPs in South Africa.
- Most WWTWs are not adapted or equipped for receiving and treating faecal sludge.
- Some rural settlements are far away from WWTWs, so faecal sludge transport costs make their use uneconomic and unaffordable.
- Poor operation of WWTWs due to lack of relevant personnel – lack of capacity
- Lack of WWTWs maintenance leads to dysfunctional and inability to effectively treat faecal sludge/wastewater.
- Energy crisis contributes to plant failures.
- Management and capacity at WWTW often are insufficient.
- Faecal sludge from dry on-site sanitation systems is being disposed of at WWTW which is not designed to accept and treat faecal sludge.

In addition, Urban stormwater runoff from dense settlements and overloaded sewage systems is the major source of deteriorating water quality, it is also a major source of suspended sediment as well as heavy metals such as cadmium, chromium, manganese, and iron, some of which are often particle bound. Urban runoff further contributes to litter and solid waste, which includes micro-plastic from clothing washing, in water resources (DWS, 2017).

- **Agricultural Sector**

Agriculture sector (including afforestation and livestock watering) is the largest water user in South Africa, with a demand of more than 66% of total water use (DWS, 2018). Conversely, agriculture continues to be under pressure due to its negative impacts on water resources resulting from poor agricultural activities and return flows. Therefore, these dependencies force agriculture to improve its production and become cleaner and sustainable by using fewer resources and causing fewer emissions.

The use of CT has become a more popular and useful tool in different sectors including agriculture. For example, integrated pest management is a cleaner production technology developed for pollution prevention and control in agriculture in the 1970s (Robertson and Swinton, 2005; Veisi, 2012). Since then, its usefulness has been demonstrated in most countries including South Africa (Urquhart, 1999; Scharfy et al., 2017). Another popular example of the CTO in the agriculture sector is agricultural biogas. Biogas production from agricultural waste (*e.g.*, animal manure, harvest residues, or slaughter waste) combines treatment with energy production which makes it very attractive for agricultural processes (Scharfy et al., 2017).

The CTOs in agriculture focus mainly on cleaner energy use and production or on climate change and tend to focus on one dimension of sustainability instead of the integrated approach (Scharfy et al., 2017). Therefore, Cleaner technologies for the improvement of water resources should be analyzed for sustainability from an environmental point of view.

- **Industrial, and Mining Sectors**

A key challenge is to cope with variations in pollution loads caused by uncontrolled discharges into the sewage network (*e.g.*, industrial discharge). Industrial activities impact severely on water quality through pollution. Thus, pollution abatement techniques can be used in the sector by adopting modern technology (DWAF, 2003).

5. SCOPE OF WORK

5.1 PROJECT PLANNING

The project commenced with the Project Planning phase which consisted of the project proposal, and the establishment of DWS working committees, namely, Technical Task Team (TTT) and Project Management Committee (PMC). The main aim of this phase was to motivate for the undertaking of the Project as well as to get the support and buy-in from the DWS Branches (*i.e.*, Water Resource Management, Regulation, Compliance and Enforcement, Water and Sanitation Services Management, Corporate Support Services and Provincial and Entity Coordination and International Cooperation).

5.2 PROJECT INCEPTION

The inception phase of the project serves as a roadmap for the project to be undertaken. The purpose of this component is to define the specific project scope to ensure alignment between the project objectives and expected final deliverables to be produced. Moreover, the existing literature will be reviewed and assessed as part of the report to obtain status quo on CTOs. This phase will confirm approaches to be followed, project plan, deliverables, and the study budget.

- **Deliverables**

The inception phase tasks include but are not limited to:

- the definition of project scope.
- identification of the role-players.
- outlining the project deliverables.
- outlining the project budget.
- the development of a stakeholder engagement plan; and
- Project timeline/road map.

5.3 SITUATION ASSESSMENT AND GAP ANALYSIS

The primary objective of this component is to conduct a comprehensive review of a collection of existing studies, publications, reports, projects, programmes, and initiatives that are specific to South African water resources and have been proven to be effective and efficient for the improvement of water resource quality. This component will identify current as well as emerging CTOs, and integrate problems and challenges associated with these CTOs.

Data and information gaps will be identified and measures to address the gaps will be explained. The report will categorise the identified information based on components such as point and non-point sources of pollution. In the case where CTO guidelines, manuals or best practices are readily available for improvement of water quality, work will not be duplicated; instead, efforts will be put into reviewing and integrating the existing work across various disciplines, government, and non-government departments as well as institutions to ensure the harmonization and centralisation of the existing work to date. Where there is no other previously related work done on the CTOs, further investigations will be conducted to assist in identifying gaps that will inform the approach of the project.

This component will run concurrently with the inception phase as the outcome of the gap analysis will guide the rest of the project programme. This component will include the following:

- Information on the current and emerging CTO trends, approaches, challenges faced and possible solutions.
- Review and outline of the legislative framework governing CTO processes with the aim to align it to policies and strategies within various departments and water resource management institutions.
- Further assessment and identification of key local impacts on water resources.
- Assessment of previous and current work done to identify gaps, parameters and avoid duplication of efforts and wasteful expenditure.

- Establishing linkages on cooperative governance, stakeholder engagement and relevant partnerships to formulate a plan for the creation of structures with practical linkages and integration of relevant programmes, initiatives, and processes.
- Standardisation of the CTOs-related terminology to be used during the project.

In addition, this component should further consult and assess international and national policies, strategies, practices, approaches, concepts, and other related information to formulate the standing of the CTOs in the South African context. The outcome of this situation assessment will guide the rest of the project programme.

➢ **Deliverables**

The main deliverable for this component will be a Situation Assessment Report and a database covering the components listed in **Section 4**.

- Literature on international, national and any other applicable policies, strategies, practices, approaches, concepts, and other related information.
- A Glossary of related terminology should be produced.
- Historical trends of Water Quality in South Africa.
- Historical trends of CTs.
- Cost and Benefit Analysis associated with CTOs.
- Status quo on CTs – previous and current initiatives.

5.4 CLEANER TECHNOLOGY OPTIONS FOR WATER QUALITY IN SOUTH AFRICA

Conducting Studies on the Cleaner Technology for improvement of water quality is the main component of the project. It will entail collation of information obtained in the Inception and Situation Assessment phases *i.e.*, standardized glossary or terminology, status of CTO activities and recent trends in its development and application, available work done and legislative framework relating to the CTOs. The project's development process will be systematically approached per water sector categorizes and the impacts on water resources, ultimately producing four separate technical reports for Water Services, Agriculture, Industrial and Mining.

The following are aspects envisaged to be covered in the CTO reports for each theme:

- Overview and description of the key water resource impacts that gives rise to water resource degradation to better understand the problem and subsequently establishing effective CTOs;
- Applicable legislative framework supporting the CTOs on a local, provincial and national level;
- Alignment with relevant policies and strategies; and

- Integration of effective CTOs for sustainability long-term water quality solutions.

➢ **Deliverables**

Deliverables for this component will be CT Guidelines per water use sector.

5.5 STAKEHOLDER ENGAGEMENT PLAN

The Cleaner Technology Option project will be strengthened by a strong stakeholder engagement process as required by Batho Pele Principles *i.e.*, consultation, openness, transparency, and access to information. The project process will therefore entail consultation and engagement with all three spheres of government, civil society, private sector, and participation of the entire water sector stakeholders to ensure appropriateness and acceptability of the project by different sectors responsible for implementation and monitoring thereof. This section of the report outlines the stakeholder engagement plan and structures.

A database of all stakeholders that need to be consulted will be compiled and updated throughout the project life cycle. All the inputs and comments received during the project process will be documented in the Issues and Response Register (IRR). Throughout the project, stakeholders will be involved for ensuring oversight authority, guidance, and review in the development of the rehabilitation management guidelines for water resources. Whilst the stakeholder representation will be from directly involved sectors and stakeholders in the water sector such as the three spheres of government (national, provincial, and local government), industry, mining, agriculture and civil society, the meetings will be facilitated and chaired by the DWS, Chief Directorate: Water Ecosystems Management.

Internal consultations of the project will be undertaken through the Sub-Technical Task Team (Sub-TT), Technical Task Team (TTT), and Project Management Committee (PMC) groups. The Sub-TT committee will be used as an immediate working group responsible for the perusal of inputs from authorship and providing technical guidance before technical reports are consulted with the TTT and PMC committees. Conversely, the PMC will be responsible for signing off reports before being consulted with the Project Steering Committee (PSC).

➢ **Stakeholder Engagement Deliverables**

Deliverables for this component include the following:

- A stakeholder engagement and communication plan (outlined in this Inception Report);

- DWS: SDS Website page will be periodically updated and utilized by the departmental administrator to upload project information for access throughout the project period;
- An Issues and Responses Register (IRR) to detail stakeholder engagement input received during meetings, via email communication during the lifespan of project needs to be maintained;
- A Document Change Log (DCL) compiled for each technical report to detail all technical inputs and comments received on project reports;
- Detailed stakeholder database and records of stakeholder engagement meetings (meeting minutes with details such as date of meeting, purpose, number of attendees, summary of proceedings etc.);
- A Newsletter and/or Background Information Document for PSC meetings and Public Workshops to communicate study information, milestones and progress to stakeholders;
- A public “communication event”, with accompanying event documentation (invitations, programme, presentation catalogue and summary of key outcomes);
- PowerPoint presentations on project progress and technical presentations; and
- Project deliverables in Reports.

6. PROJECT MANAGEMENT TEAM AND ADMINISTRATION

6.1. FORMULATION OF DWS WORKING COMMITTEES

This project draws on activities performed in different Branches within the Department, Provincial offices, and the Proto/ Catchment Management Agencies (Proto/ CMA), together with other institutions within the water sector. Internal DWS members with water quality expertise will be identified and nominated through their relevant unit Directors/Chief Directors/Provincial Heads. These members will be formally appointed through nomination letters endorsed by the DWS Deputy Director-General of Water Resource Management (DDG: WRM) and Internal Memos signed by other Branches: **Regulation, Compliance, and Enforcement, Corporate Support Services, Water Services Management** and **Provincial and Entity Coordination and International Cooperation**. The said members will form part of the project working groups and will be recognized in the acknowledgement list in the opening section of the document.

DWS (Internal) working groups will comprise of the following groups:

- **Technical Task Team (TTT) Group**

Internal DWS members with water quality expertise were identified and nominated by their relevant unit heads. Representation recommendations were also sought from the unit heads through one-on-

one requests for nominations. These members were formally appointed through nomination letters signed by the DDG: WRM. All members have been recognised in the acknowledgement list at the beginning of the document.

➢ **Sub Technical Task Team (Sub-TT) Group**

Once DWS members were appointed into the TTT committee that will participate in the project running on a day-to-day basis were, thereafter, Sub-TT members will be selected from the TTT pool. All members will be recognised in the acknowledgement list at the beginning of each technical document.

➢ **Project Management Committee (PMC) groups**

The PMC is responsible for signing off reports before they are consulted with the Project Steering Committee (PSC). This committee will comprise of internal DWS members inclusive of TTT, DWS Provincial Officials, and additional DWS Officials with water quality expertise who are will not be part of the TTT group.

At least one **DWS Provincial Champion** will be nominated per DWS Provincial Office to bridge the gap between the Head Office and Provincial Offices functions. The Provincial Champions will be sourced through the DDG: WRM through the internal Memo signed by the DDG: Provincial and Entity Coordination and International Cooperation which will then be sent to Provincial Heads or/and respective Directors to request nominations for suitable candidates to represent their respective Provinces. These champions will be responsible for sharing information pertaining to the CTO Project in their respective provinces and soliciting inputs from their regions into the CTO process, including disseminating information regarding the development process and project progress in their respective Catchment Management Fora. (CMFs).

6.2. EXTERNAL STAKEHOLDER

External stakeholder consultation will be undertaken with relevant water sector stakeholders to solicit inputs and partnerships to achieve the project's objectives. External consultations of the project will be undertaken through the PSC led by DWS with the aim of providing the project team with strategic and technically sound guidance to ensure that the intended outcome of the project is achieved. The PSC group will consist of DWS and external members from the water sector and the private sector.

Stakeholders will be selected based on their expertise and bear great responsibility to provide strategic management support as well as much needed technical guidance through the project lifespan. The main activities executed by the PSC are to review, monitor progress in project execution, provide strategic guidance, and to support communication and dissemination of project outcomes. The role of the PSC will be to guide the project in all stages as it unfolds and to provide inputs on behalf of the sectors they represent.

The specific objectives of the PSC for this project are therefore to:

- Provide direction and oversight in the development and implementation of project deliverables;
- Guide the technical task team on the desired state of water resources in South Africa;
- Provide technical input, support and information to the process where available; and
- Serve as representatives of the stakeholder bodies and organizations and report back to them on an ongoing basis regarding project development
- Provide executive support, guidance and commitment to the direction and outcomes of the project;
- Assist DWS in ensuring that the objectives of the project are achieved;
- Review study outputs and give comments on them within a reasonable timeframe;
- Share resources, information and data or facilitate sharing where possible; and
- Act as advocates for issues and recommendations that may arise from the project.

In addition, the project is also advocating public participation through engagement with catchment management committees such as CMFs and Regional Water Monitoring Committees which is in line with the spirit of cooperative governance and citizen science.

Project Steering Committee (PSC):	responsible for indicating overall direction and sanctioning of all project deliverables prior to departmental endorsement; and
External stakeholder group/ public:	responsible for wider stakeholder input and public participation.

External stakeholders to be identified will include, but not limited to:

- Water Research Commission (WRC)
- Council for Scientific and Industrial Research (CSIR)
- Department of Economic Development, Tourism and Environmental Affairs (EDTEA)
- Department of Forestry, Fisheries, and the Environment (DFFE)
- Department of Mineral Resources and Energy (DMRE)
- Department of Cooperative Governance and Traditional Affairs (COGTA)

- South African Local Government Association (SALGA)
- Water Services Authorities (including Local Government and Water Boards)
- South African National Biodiversity Institute (SANBI)
- Mining sector (Minerals Council of South Africa)
- Council for Geoscience
- Agricultural sector
- Agricultural Research Council (ARC)
- Industrial sector
- Ecological sector (*e.g.*, SANParks)
- Catchment Management Agencies (CMAs)
- Public members/NGOs
- Research Institutions (Universities and Academic Institutions)

Figure 7 illustrates the composition of the different levels of stakeholder engagement (TTT, Sub-TT, PMC, PSC, and public meetings) and frequency of expected engagements.

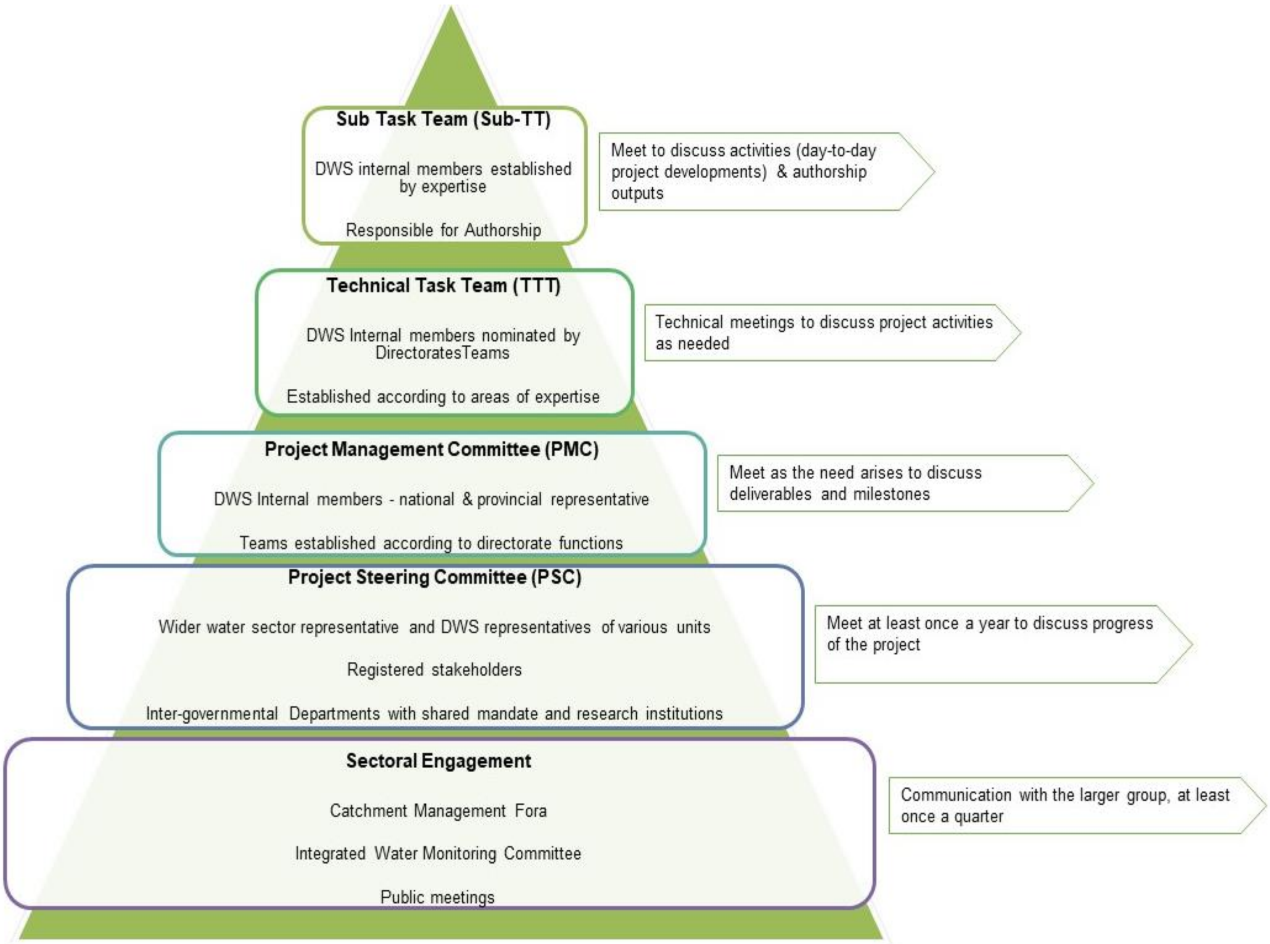

Figure 7: Project Committees and frequency of stakeholder engagement

6.3. DWS CAPACITY BUILDING PROGRAMME

The scope of the capacity building will be limited to the content directly related to the project with specific focus on CTOs in relation to improvement of water quality of water resources. In order to ensure skills, transfer within the DWS, capacity building will be offered at three different levels, namely:

- Mentorship programme and/or engagement of identified staff members on the process of development;
- Capacity building workshops; and
- Stakeholder empowerment sessions if a need arises.

The mentorship programmes for the identified mentees will be aligned to their respective skills and developmental needs as per their Personal Development Plans (PDPs) for water resources management and protection. The mentorship programmes will be designed in a manner that will allow the mentee/trainee to have technical tasks and responsibilities whose output will feed into the overall technical milestones/deliverables of the project.

Technical personnel (*e.g.*, Scientists and Engineers) within the department are required to be exposed to technical work, trainings, workshops, seminars, and conferences to enable them to accumulate sufficient Continuing Professional Development (CPD) points for registration with the respective Professional Registration Bodies such as South African Council for Natural Scientific Professions (SACNASP) and Engineering Council of South Africa (ECSA). This is a similar case with the Graduate Trainees within the department who are required to be exposed to technical work to assist them obtain their professional registration with SACNASP and ECSA.

The capacity-building will be enhanced by the active participation of candidates in Departmental stakeholder engagement platforms (*i.e.*, meetings, workshops, forums, etc.) which include a wider water resource management group consisting of DWS (Head and Provincial offices) and the Catchment Management Agencies (CMAs). The workshops will provide an overview of the project and the topics to be covered for such workshops will be finalised by the TTT/PMC. The participation of relevant DWS officials will ensure the active sharing of ideas and contribute to the broadening of the Chief Directorate: Water Ecosystems Management skills base by being intensively involved in the day-to-day running of the project. Provision will also be made for external stakeholder empowerment sessions (*i.e.*, CMFs) if the need arises in order to capacitate stakeholders so that they can fruitfully participate in the project and in other stakeholder engagement platforms such as the PSC and Public meetings.

6.4. PROJECT CLOSURE

Project Leader will ensure that all the deliverables stated, including meeting records, databases, presentation materials are in place and submitted through the Departmental reporting structures throughout the project life cycle. A Project Closure Report will be the main deliverable for this component.

7. PROJECT PLAN AND MILESTONES

7.1. PROJECT TIMELINE

The Project will be initiated during the 2023/2024-2025/2026 financial year and it is envisaged to be concluded within 36 months from the date of initiation. The first major milestone will be the draft **Inception Report** followed by the **Situation Assessment Report** which will be completed within the first financial year, and the draft **Cleaner Technology Options for Improvement of Water Quality** guidelines, which are envisaged to be completed in the second financial year. Project progress development and status is depicted in **Figure 8** and further unpacked in **Table 4.**

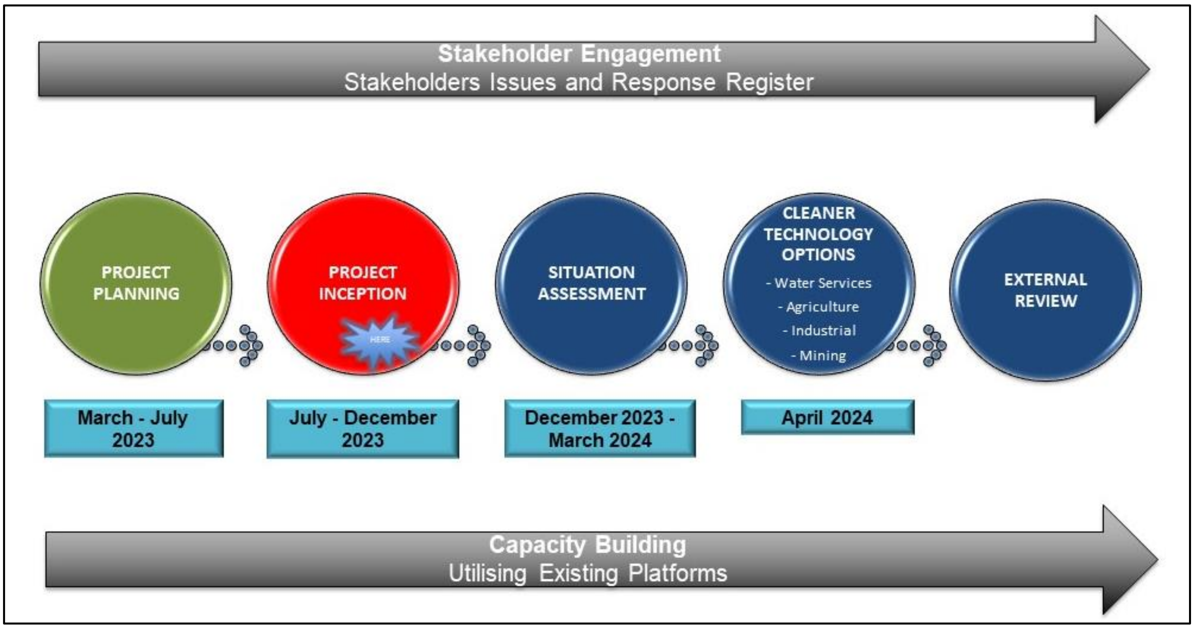

Figure 8: Project Development and status

7.2. PROJECT PROGRAMME

Table 4 provides a proposed deliverables/milestone for the project. All the deliverables are expected to be conducted in-house. Experts to assist with the project will be identified during the project planning and initiation phases of the project. It must be noted that the proposed timelines are in-line with the draft SDS Operational Plan for the 2023/2024 financial year.

Table 4: Project Milestones/Deliverables

<table>
<tr><th>Component</th><th>Deliverables</th><th>Estimated Timeframe</th></tr>
<tr><td rowspan="2">Project Planning</td><td>- Project Proposal (Including, Project motivation, Information and Gap Analysis)
- Draft Project Plan</td><td>March 2023</td></tr>
<tr><td>- Identification of internal Stakeholders (Internal database)
- Nomination of working groups (Sub-Technical Task Team, Technical Task Team, and Project Management Committee)
- Project Plan (Final)
- Identification of External Stakeholders</td><td>April – July 2023</td></tr>
<tr><td rowspan="2">Project Inception</td><td>Updating of Stakeholder Database (both internal and external)</td><td>July – September 2023</td></tr>
<tr><td>Project Inception Report</td><td>October – December 2023</td></tr>
<tr><td rowspan="2">Situation Assessment</td><td>Draft Situation Assessment Report</td><td>December 2023 – March 2024</td></tr>
<tr><td>Final Situation Assessment Report</td><td>April 2024</td></tr>
<tr><td rowspan="4">Development of the Cleaner Technology Options to Improve Water Quality for South African Water Resources</td><td>Cleaner Technologies for Water Services Sector
These CTOs will focus on the following:
- wastewater treatment facilities Water Quality Impacts (including cleaner technologies for faecal management in the sanitation service chain)
- Stormwater Water Quality Impacts (such as plastic waste ‘macroplastics and microplastics’ pollution, CEC, sedimentation and erosion, nutrient ingress, etc.)</td><td>April – June 2024</td></tr>
<tr><td>Cleaner Technologies for Agricultural Sector</td><td>July – September 2024</td></tr>
<tr><td>Cleaner Technologies for the Industrial sector</td><td>October – December 2024</td></tr>
<tr><td>Cleaner Technologies for Mining sector</td><td>January – March 2025</td></tr>
<tr><td>Cleaner Technology Options to Improve Water Quality for South African Water Resources</td><td>Finalization of the Technical Reports</td><td>April 2025 – March 2026</td></tr>
<tr><td>Capacity Building</td><td>Capacity Building Report</td><td>Throughout the project life-cycle</td></tr>
<tr><td>Stakeholder Consultation and Communication</td><td>- Stakeholder engagement in existing Departmental structures (i.e., Catchment Management Forums)
- Information exchange with partner countries that are advanced in the application of appropriate technologies (lessons learnt from other countries).
- Issues and Response Register (IRR)</td><td>Throughout the project life-cycle</td></tr>
<tr><td>External Review</td><td>- Summary Report
- Project Close-Out Report</td><td>March 2026</td></tr>
</table>

8. INDICATIVE BUDGET

The CTO project is conducted in-house; thus, the project is executed through expertise and financial resources will be incurred indirectly through compensation of staff members involved in the project as part of their performance areas.

9. REPORTING

The Project Administrators will report on the project management outputs as follows:

- Reporting through established project management structures (*i.e.*, project progress, feedback, and technical reporting in Sub-TT, TTT, PMC & PSC meetings); and
- Project deliverables submitted for internal Departmental reporting.

10. CONCLUSION

This project is a continuation of the EMSSA completed in 2023, intending to implement some of the actions related to the green technology options for improvement of sources of pollution. Thus, the project aims to conduct studies on Cleaner Technology Options and integrate various outputs already produced by both the sector and international developments regarding cleaner technology options for the improvement of water quality. Therefore, SDS liaised with other Directorates in the Head Office and provincial offices (who play a crucial role in the implementation processes of the Department) regarding the finalization of the Project Plan and inputs on the topics to be covered in this Project.

Due to the important roles of the public and private sectors, as well as civil society in corporative governance, a Stakeholder Consultation and Communication plan is being developed and has been included in this report to inform; consult; involve; collaborate with; and, where possible, empower relevant key role-players to take part in the departmental processes. In addition, it is envisaged that the Stakeholder Consultation and Communication will establish ownership of and buy-in to both the project process and outcomes, and information sharing will take place throughout the project duration to ensure robust debate and scientific rigour. Thus, the project consists of five consecutive phases which will be complemented and supported by the **Capacity Building** and **Stakeholder Engagement** at multiple levels.

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