CReW+

# *Brief analysis on the pollution monitoring process. Based on the comprehensive national Water quality monitoring program and protocol*

*Belize*

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This project builds upon its previous successful phase "The Caribbean Regional Fund for Wastewater Management (CReW)" project (2011-2017). CReW+ is being executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organisation of the American States (OAS) and the Secretariat of the Cartagena Convention (CAR/RCU) on behalf of the IDB and UNEP respectively.

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# Content

# 1 About this document

This document aims to present a brief assessment of the national processes adopted in Belize regarding the monitoring of water point pollution sources within the country. It identifies key factors that may either facilitate or impede the implementation of an Integral System for Water Quality Management and Laboratories (ISWAQ).

The analysis presented in this document primarily relies on two sources obtained from the Department of the Environment (DoE) of Belize:

- The reference document "Final Comprehensive National Water Quality Monitoring Program and Protocol" in its September 2019 version.
- A meeting held on April 4, 2023, between the consulting party and the DoE, which served to address initial questions and clarify aspects of the reference document provided by the department.

As a result, this document provides comments and insights on the main topics identified and discussed during the evaluation process.

# 2 WQMP and Protocol

The document titled "Final Comprehensive National Water Quality Monitoring Program and Protocol" serves two purposes: firstly, it outlines the National Water Quality Monitoring Program (WQMP), which identifies gaps and requirements necessary for implementing a national system; secondly, it introduces a Water Quality Protocol that aims to standardize water quality sampling procedures across Belize.

In order to facilitate the establishment of a national program, the WQMP identifies significant data gaps that could hinder its implementation and proposes potential solutions to address them. These gaps include inadequate selection of sampling locations, limited availability of laboratories and equipment, and the absence of a centralized database to consolidate data.

Regarding the Water Quality Protocol, the document reveals that various protocols and procedures were being used throughout Belize, leading to issues such as improper sample preparation and preservation, inaccurate reporting of analytical statistics, subpar techniques, and challenges related to sample matrix. To tackle these issues, the document proposes a protocol covering five key topics: field sampling, laboratory analysis and procedures, data entry and reporting, mapping, and data sharing.

During the meeting held between the parties, the DoE clarified that regulations and processes related to pollution are still ongoing. Therefore, these issues are still being addressed, and the protocols are still being implemented.

## 2.1 General topics

The document addresses both the monitoring program and the water sampling protocol. It could be beneficial to have a dedicated version specifically for polluters and

labs, a "manual for the collection, preservation, and analysis of water samples" that focuses directly on these specific topics. Many of the issues related to water quality data management stem from inaccurate techniques or records on the part of polluters, which can be significantly reduced with a simplified, straightforward, and well-referenced manual.

In the reference document, the sections pertaining to national management and the polluter are not clearly separated into distinct chapters. For instance, the sample storage procedures, which are relevant to the actions of polluters and laboratories, are presented as a subtopic within Chapter 3, while the Water Sampling Protocol is more prominently addressed starting from Chapter 4.

## 2.2 Challenges to establish the national monitoring program

The document highlights the following as the primary challenges: lack of sampling locations, absence of standardized procedures, limited capacity, equipment, and staff in laboratories, as well as the absence of a centralized database for data sharing and management. In relation to these issues, the following are primarily identified:

- The document includes an annex containing a list of sampling locations and discusses ongoing efforts to update this list through communication with watershed NGOs, universities, and government agencies. Some locations are accompanied by geographic coordinates and are depicted on maps. During the meeting, the DoE clarified that the sampling locations have already been updated, incorporating data from the New River watershed NGOs. It is crucial to continuously maintain an updated network of point polluters.
- Another area of concern is the establishment of a public central laboratory that addresses issues related to space, equipment, and skilled personnel. The

document proposes a solution by highlighting the ongoing preparations at the University of Belize laboratory to meet this demand. In the meeting with the DoE, it was clarified that a movement is underway to utilize three national-level laboratories, each specializing in specific areas: the DoE laboratory for regulatory purposes, the University of Belize laboratory for research, and the Ministry of Health and Wellness laboratory for potable water analysis. The consultants emphasized the importance of having national infrastructure capable of conducting heavy metal, persistent organic pollutants, and pesticides analyses, which are currently outsourced to other countries. The DoE responded by stating that progress is being made in this regard, as the regulatory laboratory activities were initiated in 2017 with a primary focus on effluent discharge from commercial and industrial activities to ensure compliance with effluent regulations. Furthermore, it is essential to ensure that the regulatory laboratory is equipped with all the necessary instruments and equipment to conduct the required analyses.

## 2.3 Field sampling

For field sampling, the document presents the sampling protocol and highlights the key aspects that should be taken into consideration for quality assurance.

- The document outlines a protocol for sample collection in various water bodies. While it acknowledges the significance of utilizing bottle blanks to identify contaminations, it does not provide a comprehensive procedure for washing and sterilizing bottles and other containers employed for sample collection. These steps are crucial, particularly for biological parameters (which are more sensitive to microbiological contaminations) or phosphate analyses (which are sensitive to contamination from phosphate-based detergents). As a result, it is advisable to include specific information on this topic in a dedicated manual for polluters

and laboratories in the future.

- The discussion regarding sample preservation should ideally be included within the sampling section; however, it is currently addressed in another chapter. Specifically for this topic, it is recommended to ensure that Table 3.20, which provides information on storage preservation, is consistently updated. The table currently references information from 1995 to 2017, but there are more recent references available, such as ISO 5667, that offer valuable insights for wastewater samples. For the measurement of dissolved parameters (such as ammonia, nitrate, nitrite, and orthophosphate), it is currently advised to filter the samples before acidification. This procedure can make a significant difference for samples that still contain solids. Acidifying samples with a substantial presence of solids can enhance the concentration of dissolved parameters by inducing chemical digestion of the non-dissolved substances.

## 2.4 Laboratory Analysis and procedures

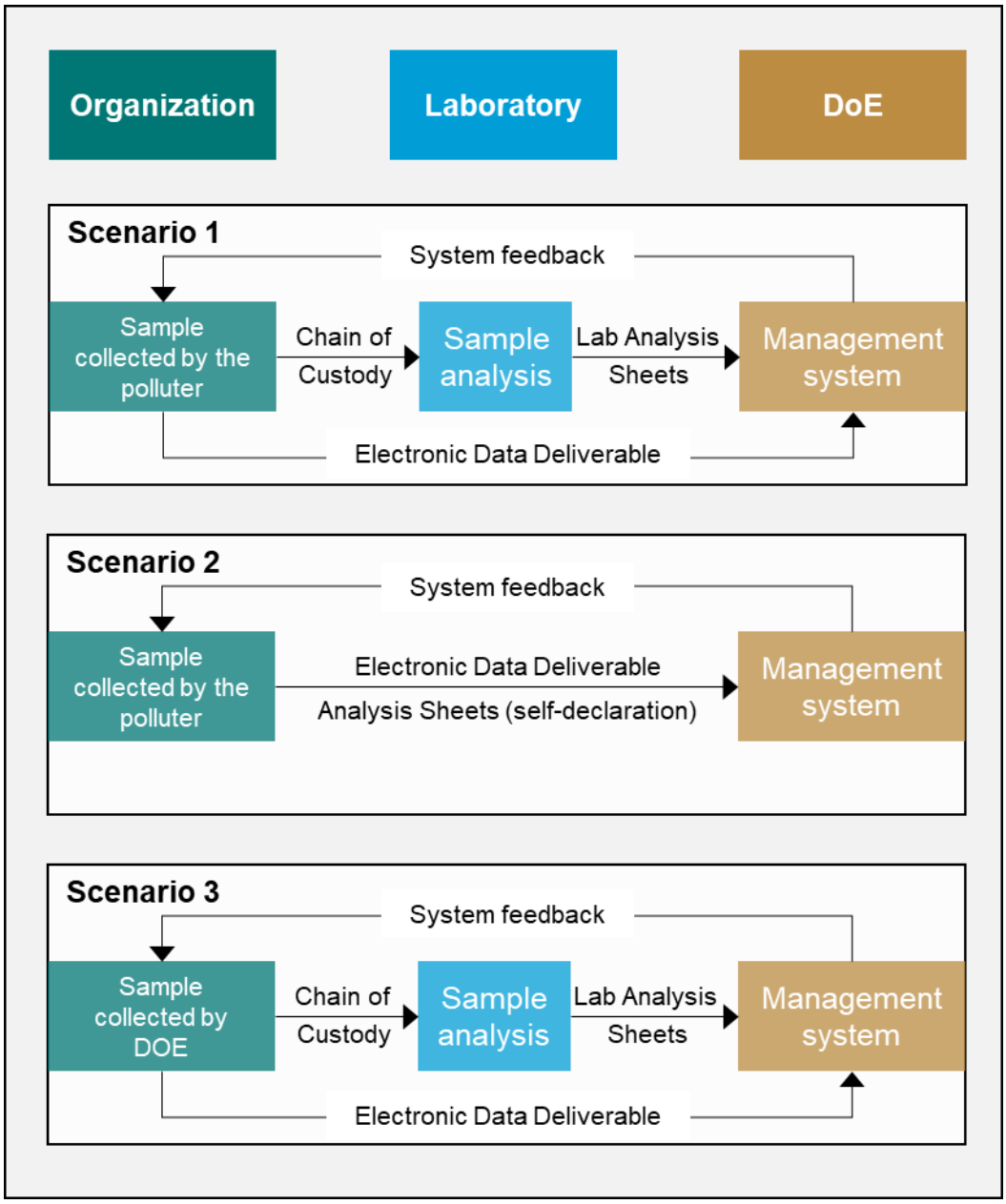
In relation to this topic, the reference document primarily focuses on quality control procedures, such as the importance of utilizing duplicates. However, it does not provide specific indications regarding which analysis methods to employ or which bibliographic references to follow. While the absence of these indications may not necessarily be problematic, it is valuable for the regulatory body to have a reference regarding the methods utilized by the laboratory, whether they are based on the "Standard Methods for the Examination of Water and Wastewater" (APHA, 2023) or on technological procedures developed by companies, such as the use of probes. In some countries, this control is achieved through authorizations granted to laboratories for the use of specific methods. Nonetheless, it is emphasized that, at the very least, the analysis method employed should be documented in the report provided by the laboratory, which is subsequently submitted to the DoE.

## 2.5 Data entry and report

In this section, the reference document discusses the fundamental aspects of ensuring the quality and reliability of the elements involved in the process of reporting information, starting from field data to the submission of results to the DoE.

Figure 1 has been adapted from Figure 6.1 of the reference document, taking into consideration the discussions held during the meeting with the DoE. It illustrates three scenarios that depict the data flow and the implemented procedures aimed at ensuring quality and reliability.

**Figure 1 - Data collection, management, and submission to the DoE.**




In the first scenario, the organization (whether it is an industry or a municipal WWTP) collects samples and requests analysis from a laboratory through a chain of custody. Upon receiving the analysis results, the organization is required to input them into the Water Quality Management System in a standardized format for integration. For quality control purposes, either the laboratory or the polluter itself could submit an Analysis

Sheet to the DoE for documentation. **In the current development version of the management tool, it is considered that the polluter is responsible for both inputting the results (Electronic Data Deliverable) and the lab analysis sheets**.

In the second scenario, the organization (whether it is an industry or a municipal WWTP) conducts the sampling and analysis of its own samples, providing the standardized results and analysis sheet to the Water Quality Management System.

The third scenario pertains to regulatory purposes, wherein the DoE performs the sampling and laboratory analysis in its own laboratory, documenting all procedures within the system.

For all cases, the system will automatically check if the received results meet the maximum limits allowed by operating licenses and Belizean Guidelines, and **feedback will be given to the organization to make the necessary changes to adjust their treatment**. To ensure that the organization can provide a prompt and efficient operational response, the entire process from sample collection to system feedback to the organization **should be completed within a maximum of three weeks**.

### 2.5.1 Chain of Custody

The Chain of Custody refers to a documented process that tracks the control and responsibility of a sample from collection to laboratory analysis. It is an important tool for maintaining sample integrity and providing confidence in the results of laboratory analysis. It could also be required by DoE to ensure the quality and traceability of data generated during the analysis process.

In the reference document, the template for this documented process is provided in Annex G. The following suggestions are made regarding the presented template:

- The "Sample Information" field should be transformed into specific columns for each sample ID. This is necessary because an organization may collect multiple

samples from different locations. Also, for the same sample, different parameters may require different preservation methods. Therefore, it is suggested to remove the "Sample Information" field and add the following columns after the "Type of Water" column: "Preservation Method," "Temperature (Field)," and "Temperature (Received by Lab)". The "Preservation Method" column can replace the existing column "Field Filtered and Preserved (Y/N)?" and is more informative as it allows for better specification of the preservation method used (e.g., field filtered and acidification, acidification, freezing, refrigeration, alkalization, etc.).

- Additionally, it is recommended to add a column called "Acid/Alkaline Verification" after the suggested new column "Temperature (Received by Lab)". In the case of acid or alkaline preservation, it is essential for the laboratory to record whether the sample was received under the correct conditions (acidic: <2.0 or alkaline: >12.0).
- It is also recommended to add a column called "Weather Conditions" after the "Time Sampled" column. This record is important as rainfall periods can increase parameter concentrations in raw sewage during the phenomenon known as "first flush" or decrease them after a few hours of rain.
- Since Belizean Guidelines require pH conditions for the treated effluent, it would be advantageous to include a "pH (field)" column. Incorporating this field measurement into the laboratory report would be beneficial.

### 2.5.2 Electronic Data Deliverable

The Electronic Data Deliverable (EDD) is the standard format required for organizations to input their analysis results into the Water Quality Management System. In the reference document, this format is presented in Appendix H. The format provided in the Appendix contains a significant amount of essential information. However, for process optimization, the following suggestions are proposed:

- Split the date column into separate columns for collection date and laboratory analysis date.
- Include an additional column to identify the responsible laboratory.
- Add a column to include the flow rate measured at the time of sampling (L/s).
- Incorporate a column to record the prevailing weather conditions.
- Ensure that the Sample ID matches the identifier provided by the laboratory performing the analysis in their laboratory analysis sheet. This is particularly important in cases where it is necessary to associate the information from the EDD with additional data from the sheet provided by the laboratory, such as the analysis method, for data quality purposes.

### 2.5.3 Laboratory Analysis Sheet

According to the reference document and the meeting with the DoE, the laboratory analysis sheet is a document that the laboratory or the polluter input into the Water Quality Management System. It serves as a quality control check for the EDD and can also provide additional information, such as the analysis method used by the laboratory.

The DoE does not provide a specific template for this document, as it typically follows the standards established by each laboratory. However, for public laboratories and as a recommended reference, it is suggested that the following information be included, at a minimum:

- Client (organization) details.
- Sample information: Sample ID; Water body type; Sampling point; Geographic location; Person responsible for collection; Date and time of collection; Weather conditions; Date and time of sample receipt by the laboratory.
- Analysis results with clearly specified units.
- Supplementary data: LOQ (Limit of quantification); U95% (Uncertainty at 95% confidence level); Analysis method; Date of analysis.
- Identification and signature of the responsible technician.

# 3 References

APHA - American Public Health Association. American Water Works Association, Water Environment Federation. Lipps WC, Braun-Howland EB, Baxter TE, eds. *Standard Methods for the Examination of Water and Wastewater*. 24th ed. Washington DC: APHA Press; 2023.

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