

## Creation of a software platform database for process monitoring and diagnosis of wastewater treatment plants

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### ABSTRACT/RESUME

**Abstract:** This paper aims to present a new software platform developed for process monitoring and diagnosis of a domestic wastewater treatment plant. The software platform is a Firebird server installed on a corporate intranet with multi-users having different access rights. The objectives of the development of this platform are to control emissions and protect the environment, as well as to economically manage and optimally operate wastewater treatment plants in a sustainable way by reducing the operating cost and optimizing the operation of treatment plants and pumping stations. The wastewater treatment plant of Chlef was chosen to illustrate the results.

### I. Introduction

The management of wastewater treatment plants through performance, process monitoring, and diagnosis has become crucial [1] [2] [3] [4]. Treatment plants, for example, have to take into account both cost management and government regulations. Furthermore, when treated water is produced, likely variations in water quality must be identified as soon as possible. Also, the vast quantity of measurement data generated means that advanced tools for checking, analysis, and control are necessary. Consequently, it is essential to ensure that a monitoring system is available that can handle all information in a simple, user-friendly, and supple way. Research has been conducted to develop models, tools, and new applications to address these issues. Berthouex [5] for instance emphasized the importance of databases in the operation of wastewater; Serra et al. [6] [7] focused on the development of a real-time expert system, called DEPUR, for the management of wastewater treatment plants. Punal et al. [8] developed an expert system for monitoring and diagnosis of treatment plants (anaerobic), Gibert et al. [9] have developed an intelligent analysis of data for management system knowledge in environmental databases. Different new software tools have been developed such as the ones by Vasiloglou [10] Liukkonen [4] and Kellouche and Abdelbaki [3]. Longnecker [11]

developed databases and tools to facilitate the analysis of large datasets resulting from the study of small molecules, or 'metabolites', that are the end products of biological processes. Current technology and modern techniques allow for storing, archiving, centralizing, and securing access to data.

The aim of the current research was the design of a new software platform called GEXPLOITE for process monitoring and diagnosis of a domestic wastewater treatment plant. the platform has to be accessible from several positions as intranet, internet without posing difficulties, keep traceability and historical events, eliminate redundant data, answer queries with current and future record time and be capable of supporting the new objects that may arise over time. The platform was designed to respond to any request made by any participant a system that is both, centralized, reliable, and powerful is essential.

### II. Presentation of the GEXPLOITE Platform

GEXPLOITE is a developed platform based on daily and monthly operating reports of three units within the National Office for Sanitation of Chlef. The canvas of operation and other information sources connected to the operation as a restricted meaning related to the management and operation of wastewater, therefore it is used for storing various data and thematic information extraction. Figure 1

shows the general architecture of the GEXPLOITE platform. All data are organized and structured based on a theme by theme (i.e. town, center, sewage,

energy, etc.). This organization facilitates the operation of the platform.

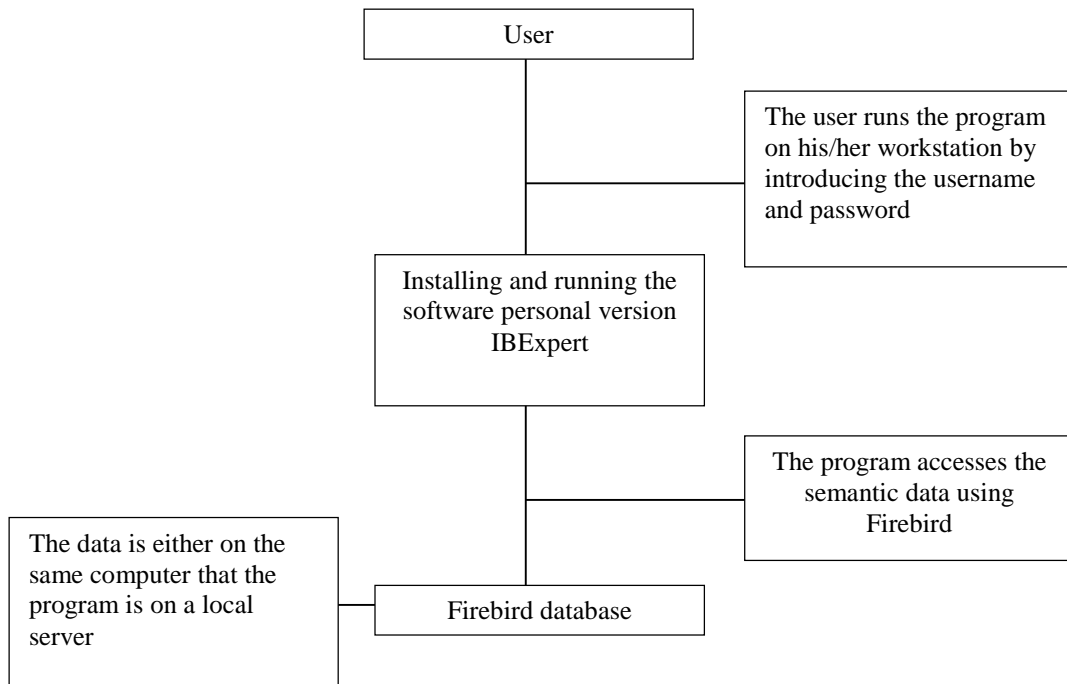


Figure 1. Architecture of the GEXPLOITE platform

### III. Adopted approach for the implementation of the software platform

Modeling requires establishing functional relationships between the data as accurately as possible. Figure 2 shows a conceptual data model that maps the reality, without redundancy, entities to be included in the database, their properties, and their relationships. The conceptual data model to define the types of data items defining the attributes, they made will consolidate the attributes to describe the entities and associations from the real world and possibly the rules to be followed by data during their cycle life. Figure 2 shows the conceptual data model illustrating the relationships between the different classes and the interactions between classes of objects.

The GEXPLOITE platform database is easily accessible, only a name and a password for access are needed. Once connected, the user can do all kinds

of tasks according to the profile that has been provided. Three profiles were defined for access to the operational database. Table 1 shows the information rights of each of the predetermined profiles for the GEXPLOITE database. The operating GEXPLOITE platform database consists of tables, views, and stored procedures (SP). Figure 3 shows the launcher window of the database.

The administration of the platform database is a real protection against any kind of false manipulation. It relates to both the management of objects (tables, views, etc.) and users. The administrator of the database and the sole authority to create or delete objects and users. He also created the role of rights to use the database, ranging from a simple consultation to full control of the database. This procedure protects the GEXPLOITE platform database and makes it inaccessible without predetermined rights by the administrator.

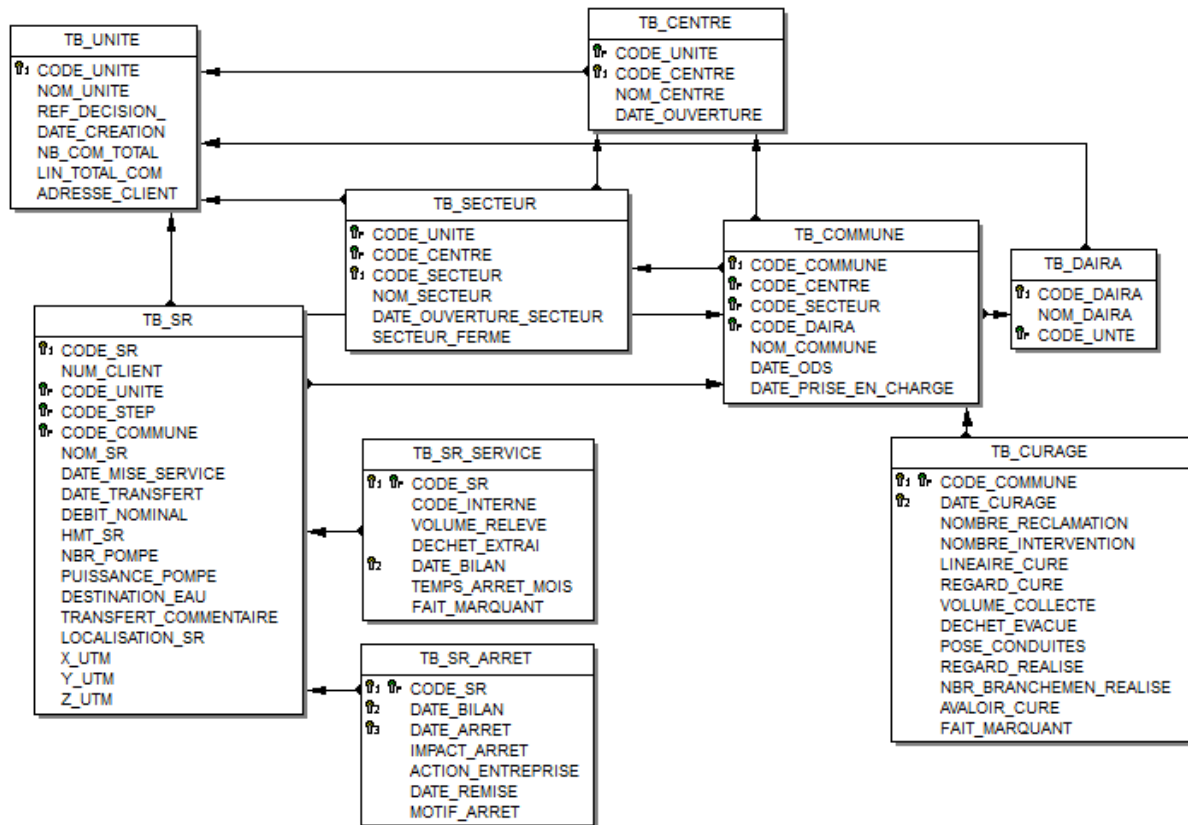


Figure 2. The conceptual data model

Table I. Different access rights

Object \ Profile	Table				View			Stored Procedure		
	Insertion	Modification		Consultation	Modification		Execution	Modification		Execution
		Structure	Data		P <sup>1</sup>	NP <sup>2</sup>		P	NP	
Administrator	*	*	*	*	*	*	*	*	*	*
Update <sup>3</sup>	*		*	*	*		*	*		*
Consultant				*			*			*

<sup>1</sup>Owner profile creation profile views or stored procedures

<sup>2</sup>Profile non proprietary, unable to make changes

<sup>3</sup>Updating profile

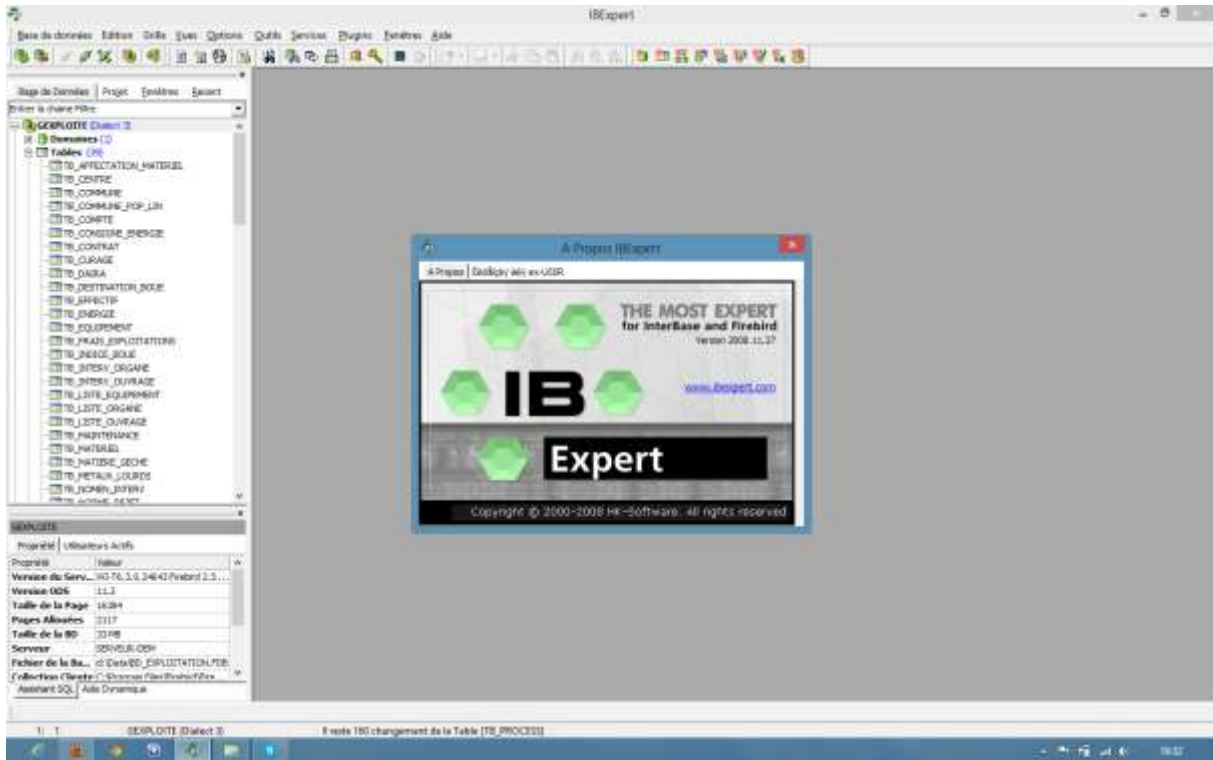


Figure 3. Presentation of the GEXPLOITE platform database

#### IV. Description of the Chlef wastewater treatment plant

Covering an area of approximately 9 ha, the Chlef wastewater treatment plant is located on the north

side of Chlef city (figure 4), it has been functional since 2006.

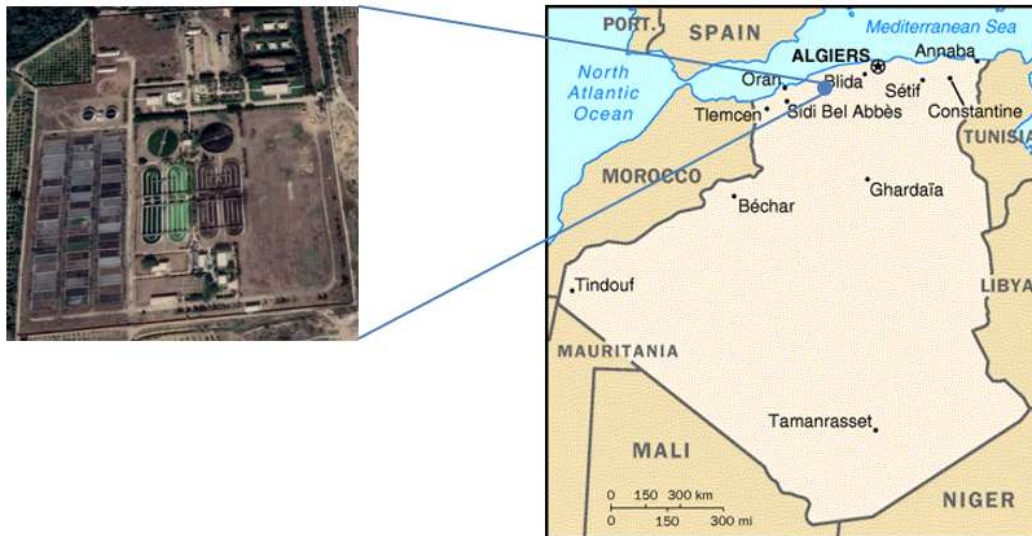


Figure 4. Location of the wastewater treatment plant

The treatment plant was designed to treat the municipal wastewater with a daily volume of 36 405 m<sup>3</sup> of wastewater to domestic dominance by activated sludge process with low load and prolonged aeration.

The wastewater treatment plant consists of preliminary and secondary treatment systems. After a series of pre-treatment, wastewater is admitted directly into the aeration tanks for biological treatment. The operation of an aeration basin is

anaerobic/aerobic. After degradation of the carbonaceous and nitrogenous pollution, wastewater is directed to a clarifier for solid–liquid separation. The clarified water from the clarifier is directly released into the Oued Chellif [12, 13].

### V.Results & discussion

Stored procedures were performed to respond to many types of queries. The procedures were grouped by type of canvas: daily, monthly, quarterly, and annual. Stored procedures to meet monthly canvas are the most common in the GEXPLOITE platform

database. These procedures meet monthly operating data. They can be extracted from one or more tables and behaved nested queries and formulas. Figures 5 and 6 show examples of the stored procedure " **AUTO\_SURVEILLANCE** " of the WWTP of Chlef.

#### Example 1: SP\_AUTO\_SURVEILLANCE

The purpose of this procedure is the determination the parameters of monitoring in the WWTP. To be performed, it needs three parameters (Figure 5); the name of the WWTP, the start date, and the end date of the reporting period.

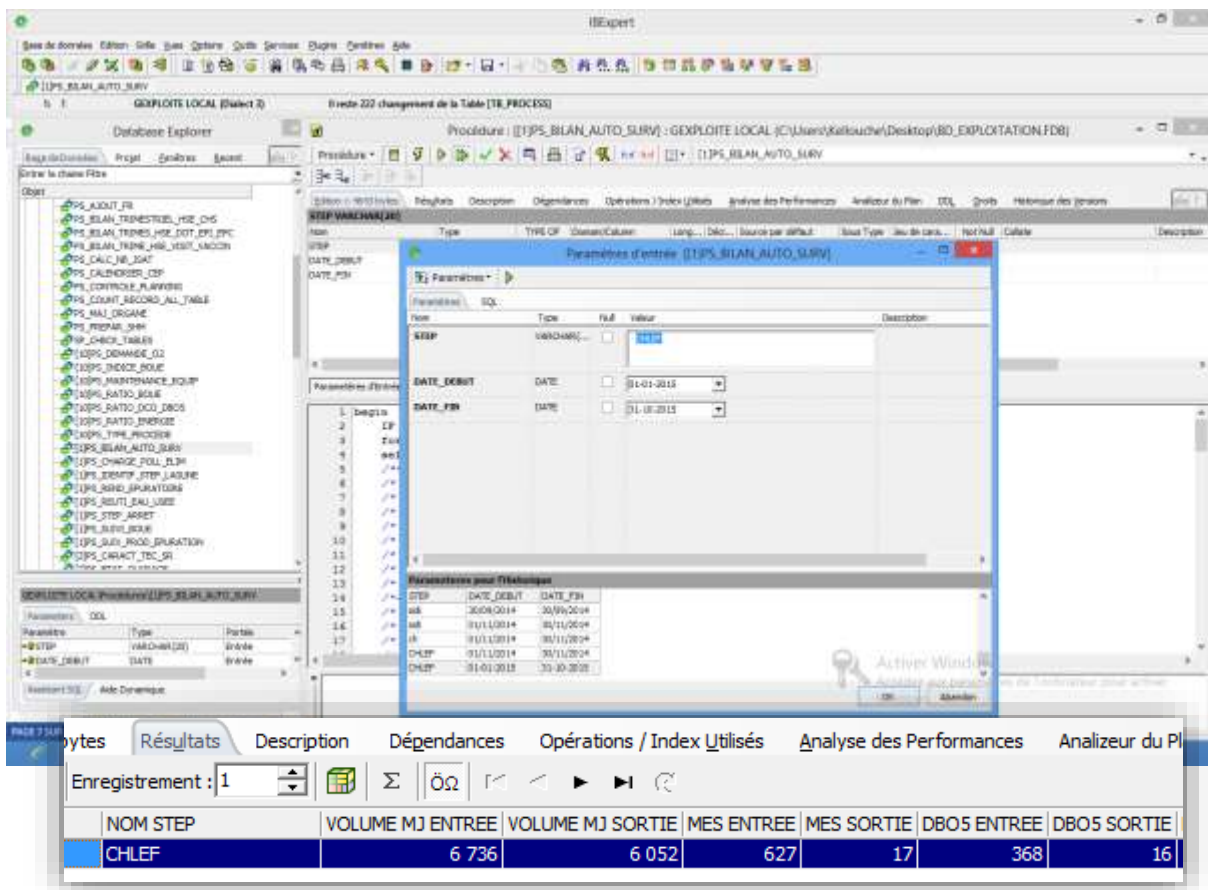


Figure 5. SP\_AUTO\_SURVEILLANCE-Data entry



Figure 6 shows an example of monitoring parameters of the WWTP of Chlef.

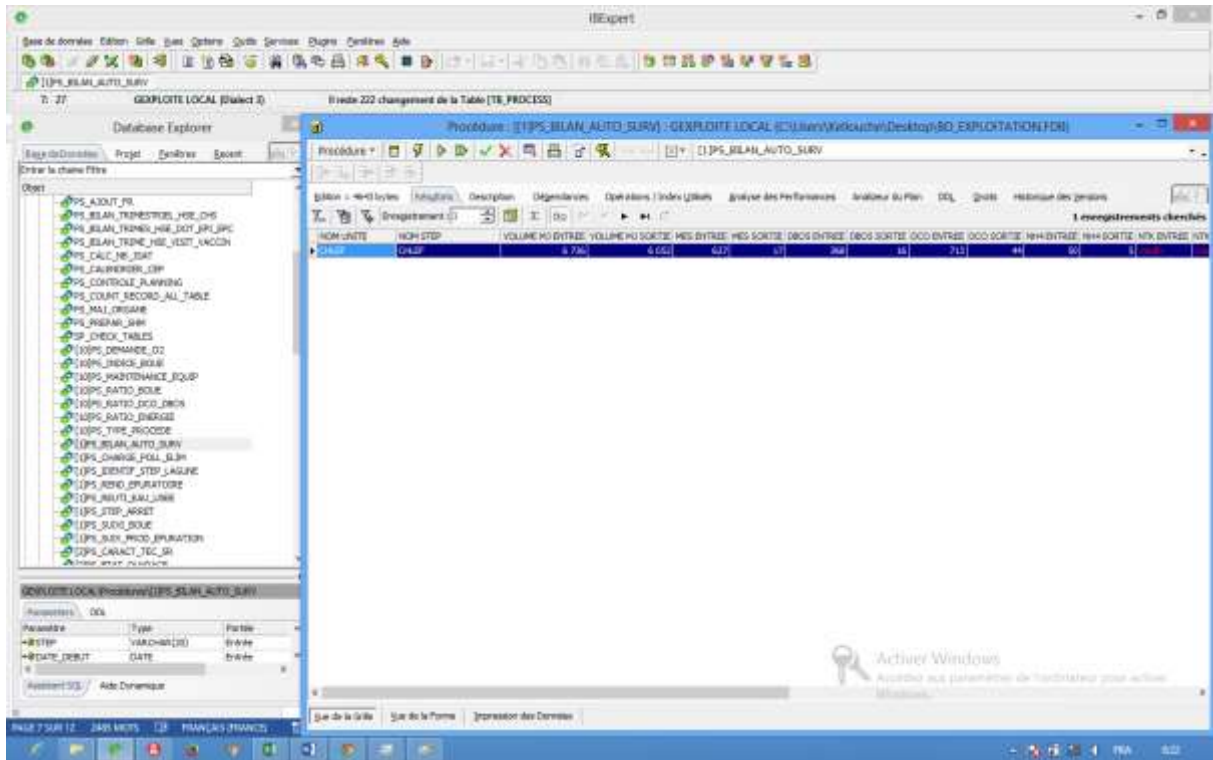


Figure 6. Monitoring Parameters of the Chlef WWTP

**Example 2: SP\_RENDEMENT\_EPURATOIRE**  
 The purpose of this stored procedure is to calculate purification yields for the WWTP. For the execution of this stored procedure, the name of the

WWTP, the start date, and the end date of the reporting period are introduced. The example taken is the month of October 2015 (Figure 7).

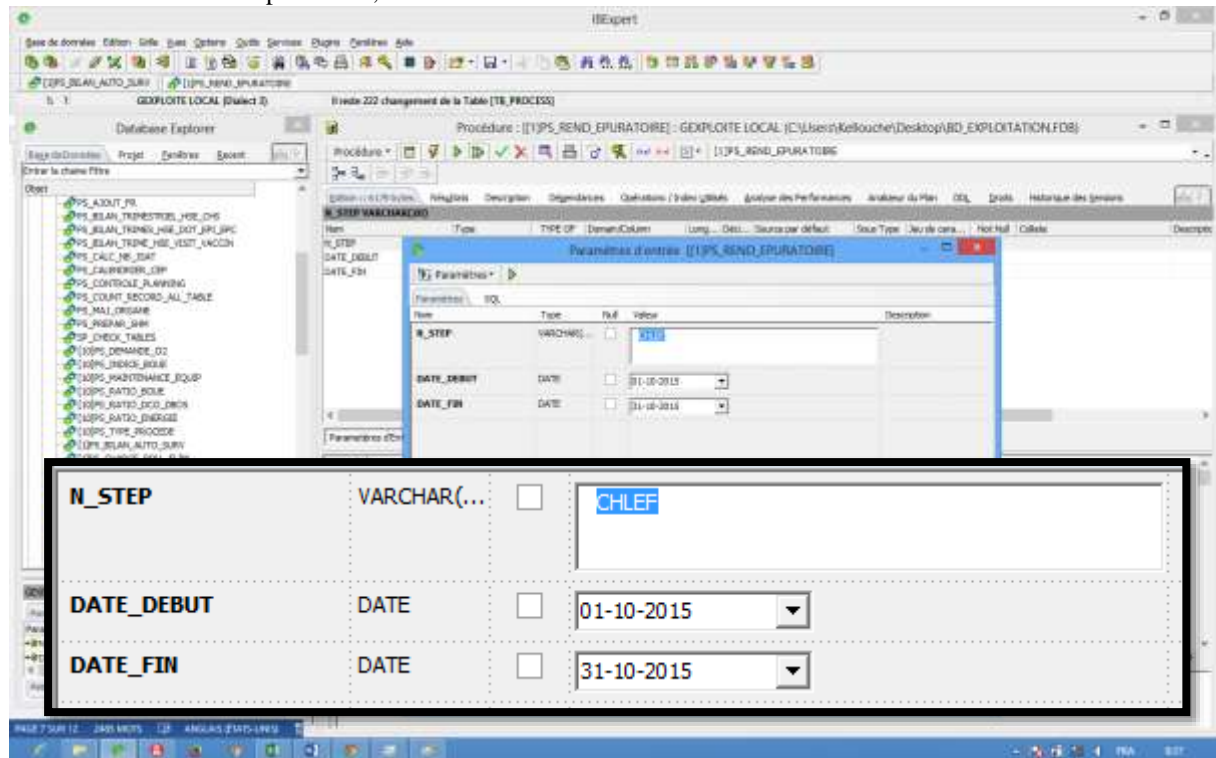


Figure 7. SP\_RENDEMENT\_EPURATOIRE-Data entry

Figure 8 shows the output results for treatment efficiency of wastewater treatment plant for the month of October 2015.

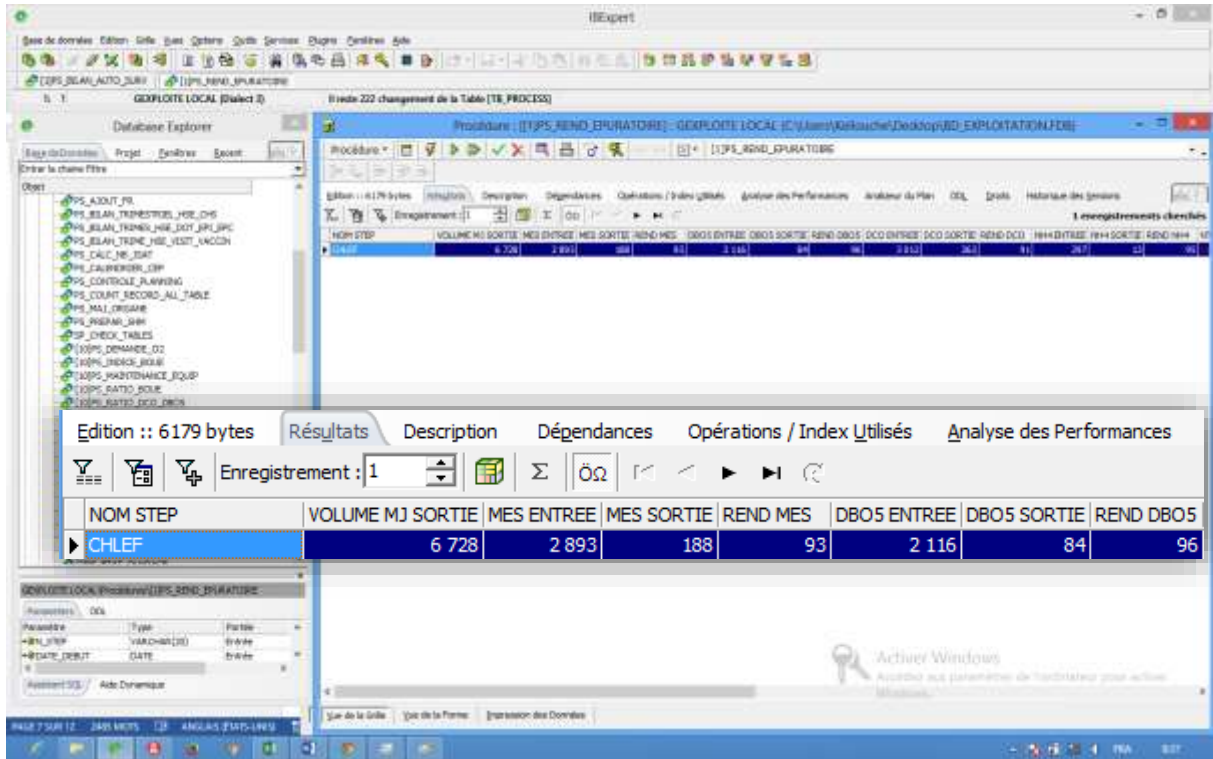


Figure 8. Display of treatment efficiency- Output Results

**Example 3: SP\_RAT\_RESEAU**

This stored procedure allows for data relating to the operation of sewerage systems per unit. For the

execution of this stored procedure, the details needed are: the start date and the date of the end of the reporting period (Figure 9).

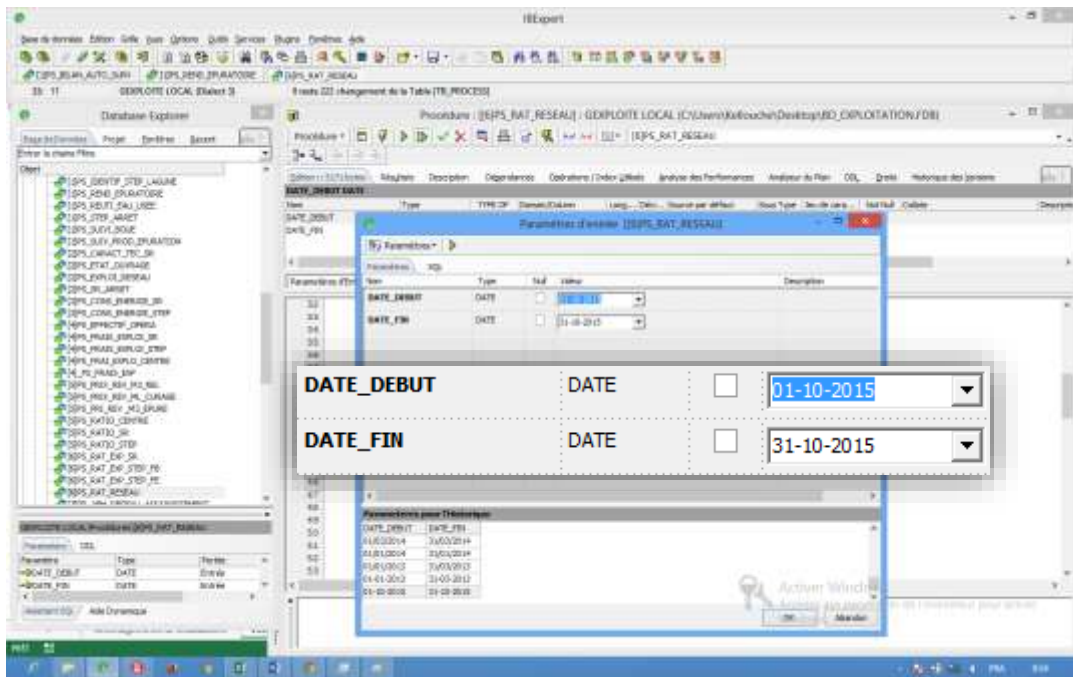


Figure 9. Data Entry SP\_RAT\_RESEAU

Figure 10 shows the operating parameters for sanitation networks operated by the National

Sanitation Office, Chlef area for the month of October 2015.

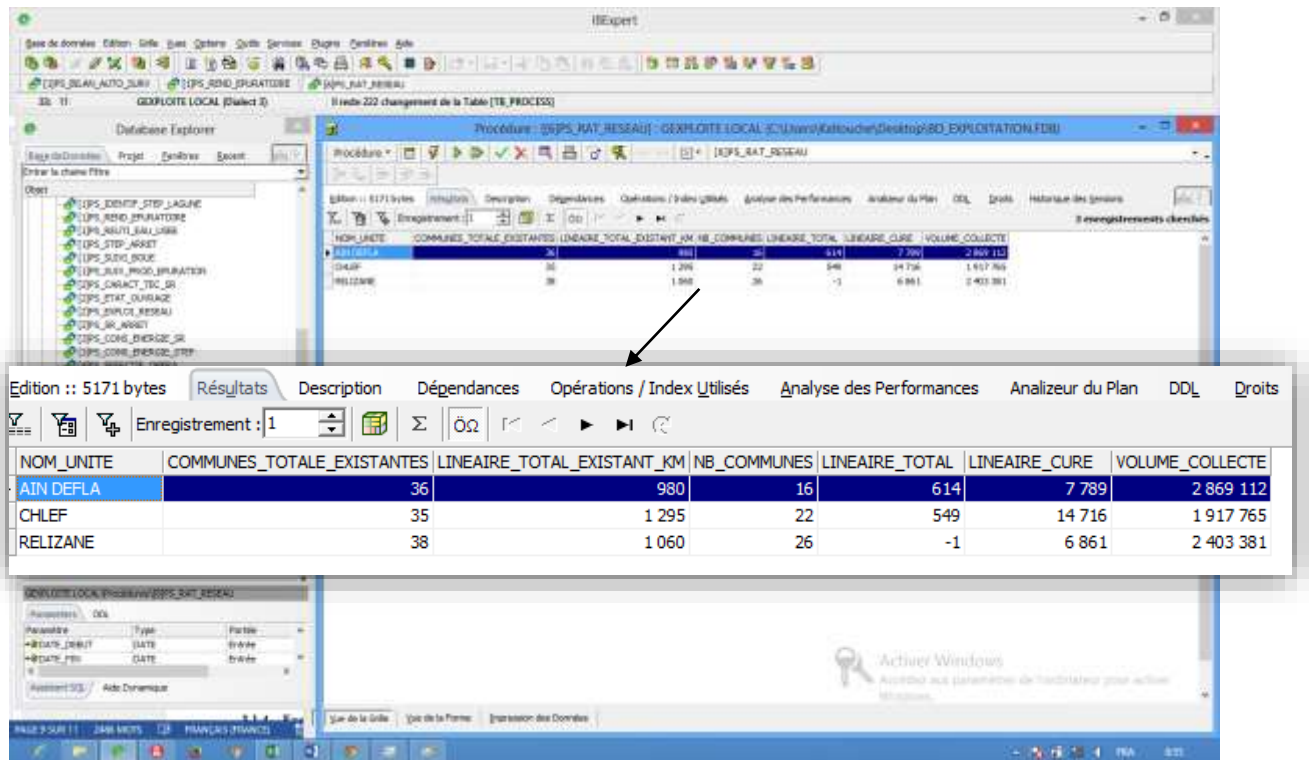


Figure 10. Display of operating parameters for sanitation networks – Output Results

**Example 4 : SP\_PRIX\_REV\_M3\_EPURE**

The purpose of this procedure is the price calculation of the cost of the cubic meter of the treated water in

WWTP. To be performed, it needs three parameters (Figure 11); the name of the WWTP, the start date, and the end date of the reporting period.

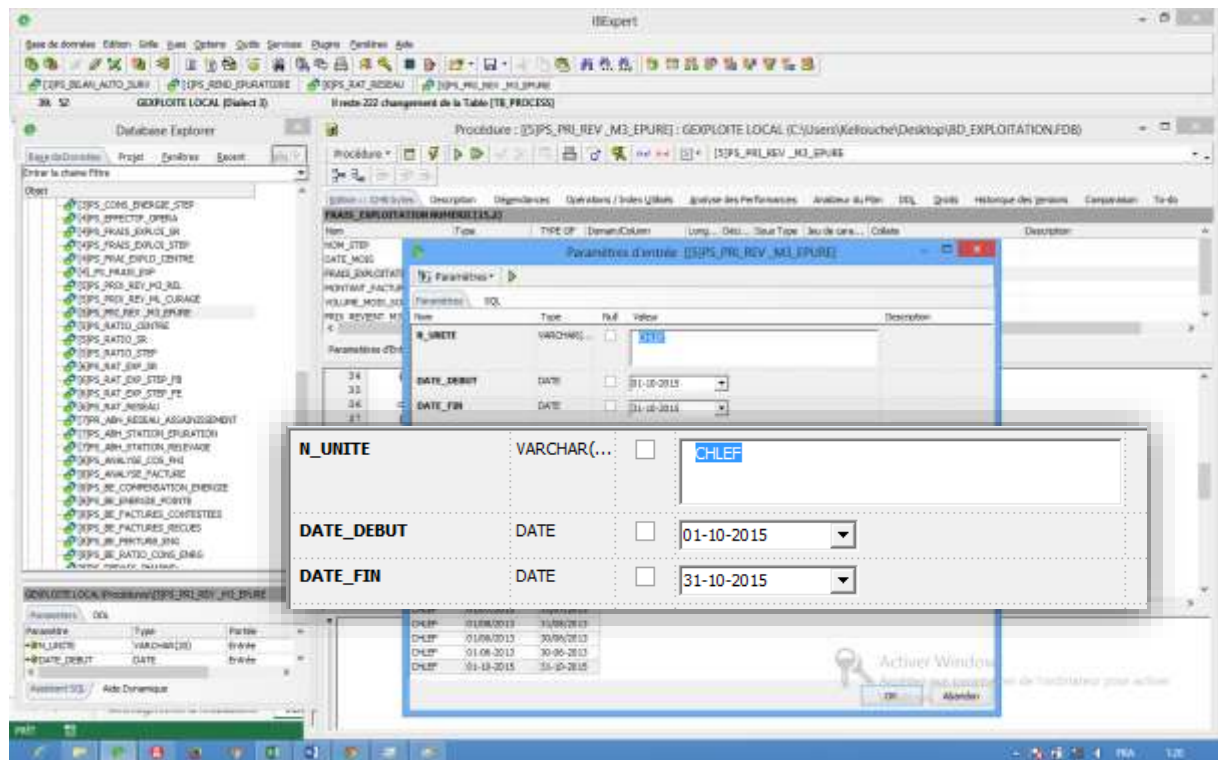


Figure 11. SP\_PRIX\_REV\_M3\_EPURE-Data entry



Figure 12 shows the cost of the treated cubic meter of the wastewater treatment plant of Chlef for the month of October 2015.

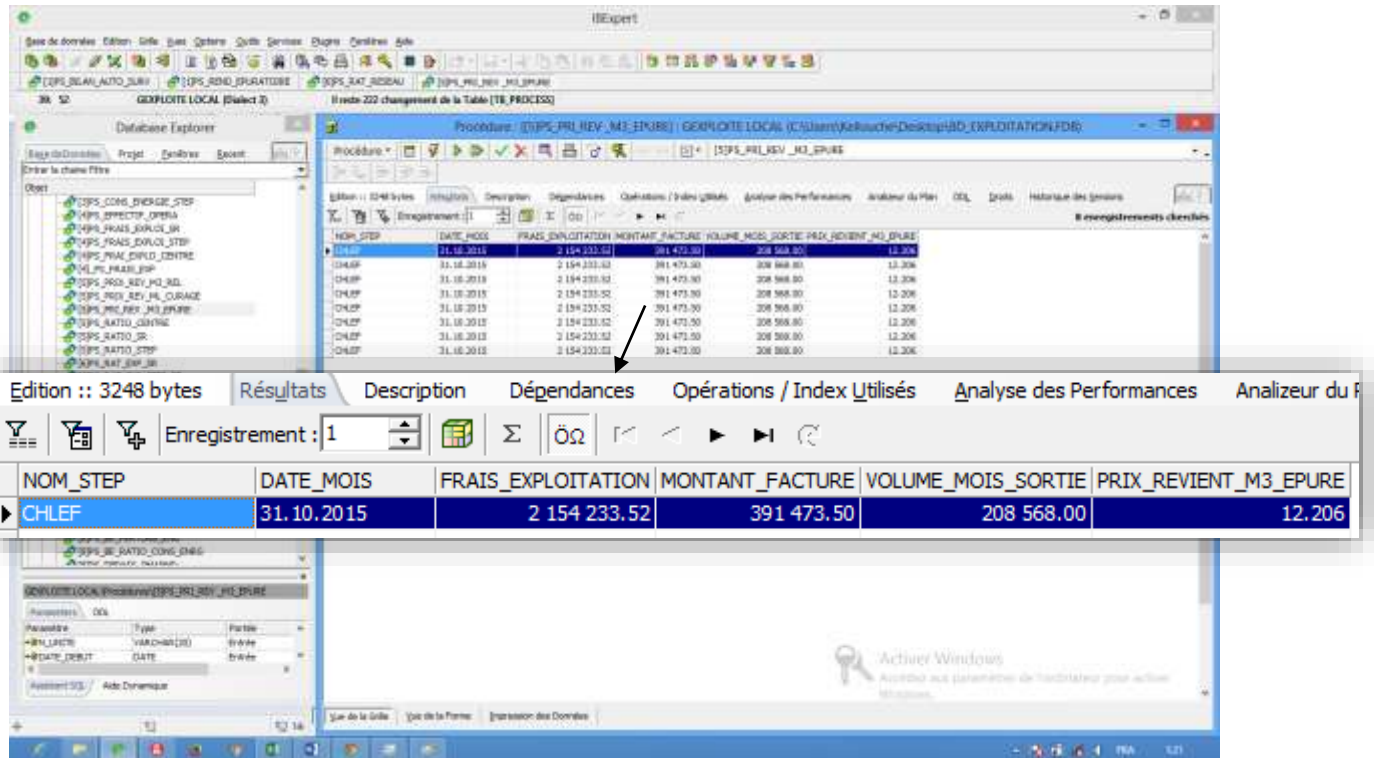


Figure 12. Viewing the cost of the cubic meter of treated wastewater from the treatment plant Chlef for the month of October 2015

The establishment of GEXPLOITE platform database and its validation are being completed; stored procedures made and defined entities, considerable time savings are realized. GEXPLOITE is an operating tool for the wastewater treatment plants, it helps to make the diagnosis of its infrastructure. The seizure, storage, and updating of data allow storing a history of operating problems useful for forecasts of interventions on the sewer network or wastewater treatment plants managed by the Chlef area.

The GEXPLOITE platform developed in this paper and the results obtained can be used not only for Chlef WWTP and its sewer network but also for other wastewater treatment plants and sewer networks to solve the urban sanitation problems. Several areas for improvement are underway to improve the analysis, synthesis, and decision-making.

## VI. Concluding remarks

GEXPLOITE platform database was developed as a methodological tool for the management of

wastewater (sewerage network and treatment plant) that allows for:

- Establishing operating assessments and interpretation of performance.
- Assisting the operator in conducting operations and in improving and purifying energy performance.
- Preparing the operator to track and control facilities.
- Helping to provide solutions and/or suggestions for improvement.

This work is the first step in a comprehensive process that aims to develop management support techniques. Once finalized, the GEXPLOITE database will enable users to:

- Help control emissions and protect the environment.
- Manage and optimally and sustainably exploit sanitation, reduce the operating cost of sewerage networks, reduce waterborne diseases (wrong connection) and optimize the operation of purification and pumping stations.

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