

Project for the Biological Removal of Nitrogen and Phosphorus (Mining Exploitation in the Zamora-Chinchi Region, Ecuador)



Figure 1: BIOBOX Plant of 30 GPM, which is equivalent to 7 m³/h.

Technical Summary of the Article:

- **Influent:** Wastewater
- **Technology:** BIOBOX Nitrate; BIOBOX Ammonium; BIOBOX Phosphorus
- **Flow rate:** 30 GPM / 7 m³/h
- **Influent N-NO₃:** 90 mg/L (**NO₃** : 400 mg/L)
- **Influent N-NH₄⁺:** 47 mg/L (**NH₄⁺**: 60 mg/L)
- **Effluent Total N:** <10 mg/L
- **Phosphorus input:** 8 mg/L
- **Phosphorus output:** <2 mg/L
- **Plant Features**
 - Initial Prefiltration
 - Biological Denitrification
 - Biological Nitrification

In September 2021, BIOBOX® took on a new and exciting project for a mining company located in the south of Ecuador. The challenge involved the design and construction of a biological wastewater treatment plant in just 6 weeks.

The mining camp had an existing WWTP (Wastewater Treatment Plant) that treated wastewater from restrooms and kitchens. However, the water from the secondary decantation of this WWTP contained high levels of nutrients.

The discharge of organic load and nutrients, particularly nitrogen and phosphorus, causes eutrophication in surface waters. Summer algal blooms are a common example of this eutrophication and can pose problems for both ecosystems and people due to the: low dissolved oxygen levels, fish deaths, turbid water, and depletion of flora and fauna

Table 1: Treatment Results

Parameter	Influent	Treated effluent
Flow rate (GPM)	30	
Flow rate (m³ / h)	7	
Total Nitrogen in effluent (mg/L)	400	<10
Phosphorus (mg/L)	8	2
COD (mg/L)	500	<15

To avoid this problem, BIOBOX® proposed a compact containerized solution after the existing pretreatment, providing a technically and economically viable solution, while occupying a very small space (1 x 40-foot container).

The plant was designed to remove COD, nitrogenous contaminants (ammonium), nitrates, and phosphorus from an influent of 31 GPM (7 m³/h)

At the water treatment line level, the plant is organized into three stages: an initial prefiltration, biological denitrification, and biological nitrification.

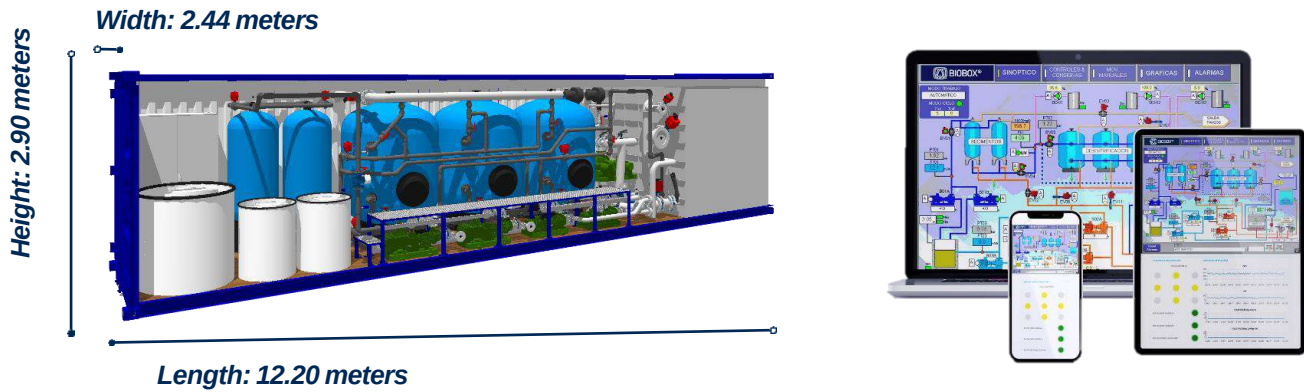


Figure 2: Interior and exterior images of the BIOBOX plant of 30 GPM (7 m³/h).

Although the plant was initially designed to treat concentrations of 250 mg/L of nitrate NO₃ (N-NO₃: 56 mg/L) and 60 mg/L of ammonium (NH₄⁺) (N-NH₄⁺: 47 mg/L), meeting the discharge limit of 10 mg/L, it ultimately managed to treat 400 mg/L of nitrate (NO₃) (N-NO₃: 90 mg/L) and 60 mg/L of ammonium (NH₄⁺) (N-NH₄⁺: 47 mg/L), while maintaining the same discharge compliance. Additionally, this process removes over 6 mg/L of phosphorus to meet the IFC standard

Process Description:

The initial pre-filtration is performed using a specific material designed to smooth out peaks of suspended solids (SS). Following this, an intensive anoxic denitrification process is carried out in three pressurized filters, designed to reduce the concentration of nitrates in the water. This process is automated with probes that monitor various parameters such as NO₃⁻, ORP, pH, and flow rate, and it is controlled by a PLC.



This type of denitrification, which consumes organic matter in combination with the biological oxygen demand (BOD) remaining in the wastewater, is similar to the treatment used in plants to reduce nitrates in well water with high concentrations of this compound.

Finally, the water undergoes a biological nitrification process in a biofilter, using a specially designed bed for this purpose, with the addition of alkalinity to remove ammoniacal nitrogen.

Results:

The installation achieved significant milestones in both planning and execution, with less than 5 weeks from project definition to delivery at the port.

Thanks to its fully prefabricated design, installation and commissioning were streamlined, allowing for a faster start-up of the on-site biological systems. Remote monitoring was implemented, and complete operational and maintenance knowledge was transferred to the end-user during the commissioning phase.

In summary, this plant provided an optimal solution, achieving over 90% removal of organic load and nutrients, fully complying with discharge regulations for river basins, and enabling the mining company to effectively uphold its commitment to minimizing environmental impact.