Application of advanced technology based on projects carried out by Black Horse Waste Water Solutions and its team in the expansion, modernization, and construction of wastewater treatment plants.

Many operators of activated sludge wastewater treatment plants face challenges related to changes in the inflowing wastewater—its volume, composition, and pollutant load—resulting from variations in the catchment area or water consumption patterns of the population. In addition, evolving regulations continue to tighten the requirements for the quality of treated effluent.

As a result, existing facilities are increasingly experiencing problems, particularly within biological treatment chambers and secondary settlement tanks, which demands greater involvement from both operational staff and process engineers to resolve. Over time, such problems become difficult to solve, and conventional solutions often prove ineffective, while also requiring substantial ongoing financial resources. Moreover, unexpected failures or planned maintenance works often present serious operational challenges.

Typical problems include: sludge bulking, sludge flotation, sludge washout, and the inability to maintain sufficient biomass within the process. These issues can compromise the quality of the treated effluent—a parameter that represents the core performance indicator of any wastewater treatment plant. Consequently, we face a need for modernization or even expansion of the facility.

The process of modernization or expansion is typically lengthy and often requires external financing. It generally consists of three main phases: preparation, design, and construction. The preparation phase is especially critical, as the final outcome of the entire investment depends heavily on decisions made at this stage.

Unfortunately, this initial phase is often conducted superficially, even though it determines key aspects of the entire project—such as total investment costs, future operational expenses, the scale and scope of the expansion, land requirements for new facilities, project timelines, expected performance outcomes, and other technical considerations of the future plant.

It is during this stage that we search for the most suitable solutions and conduct market analyses—e.g., through consultations—to assess available technologies that best address our specific needs.

There are several activated sludge wastewater treatment technologies available on the market, one of which is the technology used by Black Horse Waste Water Solutions, involving vacuum sludge degassing. Numerous completed projects—modernizationss, expansions, and new constructions—have confirmed the effectiveness of this technology in existing WWTPs.

Solutions tailored to the specific needs and conditions of each objects allowed for relatively fast and cost-effective integration with existing infrastructure. Naturally, each facility required a preliminary assessment, which defined the key parameters of the project, such as duration, cost, scope of work, and expected outcomes.

Experience has clearly demonstrated that each upgraded biological treatment system using this technology performed significantly better—even without the construction of new tanks or clarifiers. In many cases, this made it possible to avoid costly structural expansions, significantly reducing overall capital expenditure.

Below are examples of technology implementation at facilities of various sizes.

## *EXAMPLE 1*

Existing WWTP – post-modernization parameters:

- Population Equivalent (PE): 51,000
- Dry Weather Flow (DWF): 5,500 m³/d
- Wet Weather Flow (WWF): 6,800 m³/d

Required quality of treated effluent:

| Parameter | Unit | Required value |
|---|---|---|
| BOD | $mgO_2/dm^3$ | 25 |
| COD | $mgO_2/dm^3$ | 125 |
| TSS | $mg/dm^3$ | 35 |
| TN | $mgN/dm^3$ | 15 |
| TP | $mgP/dm^3$ | 2 |

The facility is characterized by significantly increased inflows during summer—up to four times the average flow. Before modernization, particularly during high inflow periods, typical operational problems occurred, leading to poor effluent quality, with especially high concentrations of nitrogen and suspended solids.

Objective of modernization:

- Increase DWF capacity from 3,500 m³/d to 4,100 m³/d; WWF 5125 m³/d
- Expand population capacity from 30,000 PE to 38,000 PE
- Ensure operation under load conditions of PE 51,000, DWF 5,500 m³/d, WWF 6,800 m³/d
- Maintain required effluent quality throughout the year

Modernization options considered:

In the initial planning phase, a traditional expansion approach was considered. This would require the construction of an additional treatment line and a new secondary settlement tank. Such an upgrade was deemed necessary to maintain adequate sludge concentration in the process and ensure proper secondary settlement tanks performance.

However, following a market review, the concept was revised. A modern technology involving vacuum sludge degassing was selected. This solution enabled an increase in biomass concentration in the existing reactors and higher loading of secondary settlement tanks, allowing for handling increased flow rates and maintaining stable operation without the high cost of construction of new objects.

Final solution and scope of biological treatment modernization:

- Construction of two aerobic sludge stabilization tanks
- Installation of vacuum sludge degassing technology
- Structural renovation of existing tanks

Achieved results:

- Increased sludge concentration in bioreactors from 3.5 kg/m³ to a minimum of 5.8 kg/m³, with the ability to temporarily maintain even around 8 kg/m³—ensuring the required biomass level
- Eliminated malfunctioning of secondary settlement tanks, including sludge bulking and sludge flotation
- Achieved stable WWTP operation and effluent quality even during peak rainwater inflows
- Met the capacity for target PE

Scope of modernization in existing technology

Existing tanks

Required construction of additional tanks (bioreactors)

Scope of modernization in technology with vacuum sludge degassing

Existing tanks

Designed tanks (aerobic sludge stabilizations)

***EXAMPLE 2***

Existing WWTP with post-modernization parameters:

- Population Equivalent (PE): 8,500
- Dry Weather Flow (DWF): 400 m³/d
- Wet Weather Flow (WWF): 650 m³/d

Required quality of treated effluent:

| Parameter | Unit | Required value |
|---|---|---|
| BOD | $mgO_2/dm^3$ | 35 |
| COD | $mgO_2/dm^3$ | 125 |
| TSS | $mg/dm^3$ | 35 |

The treatment plant was based on pond technology, covering a large surface area. Particularly during winter, when vegetation dies off, the plant failed to achieve satisfactory treatment results. In summer, a significant portion of the influent consists of hauled wastewater with high pollutant loads. This caused substantial stress on the system, leading to effluent quality issues and odor emissions from the large surface of the ponds.

Objective of modernization:

- Convert the treatment process to a flow-through system with activated sludge by constructing reactors
- Maintain the existing hydraulic capacity: DWF 400 $m^3/d$
- Maintain capacity for PE 8,500
- Achieve required effluent quality throughout the year

Modernization options considered:

At the initial stage, a conventional upgrade was considered, which involved building two new reactors with secondary settlement tanks. This scope was necessary to maintain adequate sludge concentration in the process and ensure proper operation of secondary settlement tanks.

During the pre-design phase, an alternative approach was proposed: implement vacuum sludge degassing technology and construct a single dual-line biological reactor of significantly smaller volume. Due to the lower investment cost and the ability to place the new system on a more suitable site (thanks to a smaller footprint), this solution was ultimately chosen.

Final solution and scope of biological treatment modernization:

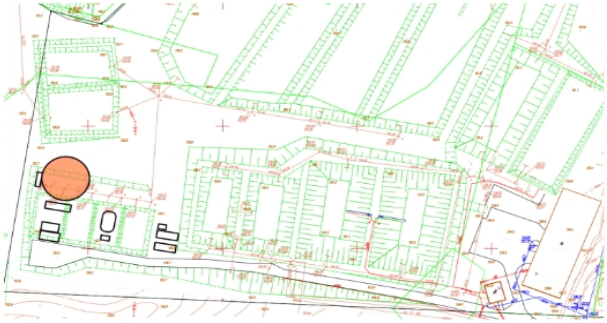
- Construction of one dual-line biological reactor
- Installation of vacuum sludge degassing technology
- Construction of new technical facilities for the upgraded plant

Achieved results:

- Project delivered within the planned low investment cost
- Achieved required effluent quality
- Targeted energy efficiency of the plant successfully met

Bioreactors and final settling tanks in nowadays technology

Designed tanks



Bioreactors and final settling tanks in technology with vacuum sludge degassing

Designed tanks

## *EXAMPLE 3*

Existing municipal WWTP – post-modernization parameters:

- Population Equivalent (PE): 14,168
- Dry Weather Flow (DWF): 1,300 $m^3/d$
- Wet Weather Flow (WWF): 1,755 $m^3/d$

Required quality of treated effluent:

| Parameter | Unit | Required value |
|---|---|---|
| BOD | $mgO_2/dm^3$ | 25 |
| COD | $mgO_2/dm^3$ | 125 |
| TSS | $mg/dm^3$ | 35 |
| TN | $mgN/dm^3$ | 15 |
| TP | $mgP/dm^3$ | 2 |

During summer, the influent flow increases up to two times the average daily flow. Before modernization, the plant faced persistent nitrogen removal issues. Periodically, sludge bulking and sludge flotation occurred in secondary settlement tanks, which, due to the lack of surface scraper, led to the formation of thick scum layers that had to be manually removed. Another operational challenge was the inability to shut down parts of the system for maintenance and maintaining effluent quality.

Objective of modernization:

- Achieve the required effluent quality throughout the year
- Enable partial shutdown of the treatment process for maintenance and repairs

Modernization options considered:

Initially, traditional expansion was considered, involving construction of a new treatment line and an additional secondary settlement tank. This was seen as necessary to maintain adequate biomass in the process and ensure proper secondary settlement tanks performance.

However, after a market review, the approach was revised. A modern solution using vacuum sludge degassing technology was selected, which allowed for increased biomass concentration in existing bioreactors and higher loading on clarifiers—facilitating increased flow capacity and stable operation without the need for costly construction of new objects.

Final solution and scope of biological treatment modernization:

- Construction of two aerobic sludge stabilization tanks
- Installation of vacuum sludge degassing technology
- Structural refurbishment of existing tanks

Achieved results:

- Increased sludge concentration in bioreactors from 3.5 kg/m³ to a minimum of 5.5 kg/m³, with the ability to temporarily reach even around 8 kg/m³—ensuring required biomass levels
- Eliminated poor performance of secondary clarifiers, including bulking and sludge flotation
- Achieved stable WWTP operation and consistent effluent quality, even during heavy rain events
- Reached target hydraulic and population load capacity (PE)

Scope of modernization in existing technology

Existing tanks

Required additional tank construction

Scope of modernization in Black Horse WWS technology with vacuum sludge degassing

Existing tanks

Existing tank designated for the reserve line

## ***Summary***

As demonstrated by the above examples of wastewater treatment plant expansions, it is advisable to thoroughly explore the market for available technologies. Modern solutions, such as those offered by BLACK HORSE WASTE WATER SOLUTIONS, can significantly reduce capital investment costs and often shorten the duration of the project—an increasingly important factor when managing the expenditure of public funds.