GH-TR-GE-00-0001

GHRMAGHELE DWTP – SETTLING STAGE UPGRADING

TECHNICAL REPORT

26.09.25	0	First Issuance	JMM	EPT
DATE	**REVIEW**	**EMISSION**	**DRAFTED**	**VERIFIED**

Comments

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1. BACIVKGROUND

Ghrmaghele DWTP is an existing facility for drinking water supply to Tbilisi city, and it´s located nearby Tbilisi Sea (Tiflis – Georgia).

Raw water is treated with a conventional Physical-Chemical process, including the following stages:

- Dual raw water intake:
  - Jinvali dam feeding channel
  - Tbilisi Sea raw water pumping station

- Static Settling
  - Line 1: 10 tanks
  - Line 2: 12 tanks

- Sand media gravity filtration
  - Line 1: 10 filters
  - Line 2: 16 tanks

- 4 Treated water storage tanks, 10.000 m³ each.

- 2 Treated water storage tanks for filters backwashing, 4.000 m³ each.

- Poly-aluminum Chloride (PAC) – Storage and dosage facilities.

- Chlorination facilities:
  - Pre-Oxidation.
  - Treated water disinfection.

During heavy rain seasons, the current settling facilities cannot face high turbidity ranges in raw water. Therefore, the sand filter batteries must cope with these high turbidity levels in the raw water, and consequently in settled water, shortening their filtration runs and requiring more frequent backwashing operations.

2. DESIGN DATA

2.1. PRELIMINARY STUDIES

To develop the present document some baseline data has been provided:

- DWTP General Layout DWG drawing.
- Basic treatment process diagrams.
- Photographic Report.
- 3 D point cloud scanning of settling facilities

The design of the updated design facilities has been carried out considering the referred information.

2.2. TREATMENT FLOWS

The design flows required for the upgraded settlement stage are:

- Current treatment capacity:
    - Daily: 21.600 m^3/d (6,00 m^3/s)
    - Hourly: 900 m^3/h
- Future (once upgraded) treatment capacity:
    - Daily: 23.400 m^3/d (6,50 m^3/s)
    - Hourly: 975 m^3/h

2.3. RAW WATER CHARACTERISITICS

The main raw water characteristics (2024 yearly average) considered for designing the required facilities for settling upgrade are:

Temperature (°C)	10,45
pH	7,95
Turbidity (NTU)	7,03
Conductivity (µS/cm at 20 °C)	268
Total hardness (mg-equiv/l)	2,66
Al (mg/l)	0,52
Mn (mg/l)	0,02
Iron (mg/l)	0,23
Total suspended solids (mg/l)	15,22

2.5. EXISTING FACILITIES PHOTOGRAPHIC REPORT

Jinvali Dam

Raw Water Channel from Jinvali Dam –Northeast side view (Settler battery 1)

Raw Water Pumping Station intake(alternative) from Tbilisi Sea

Grmaghele DWTP – Existing Facilities

Existing settlement tanks – North view

Existing settlement tank inlet zone– Distribution chamber

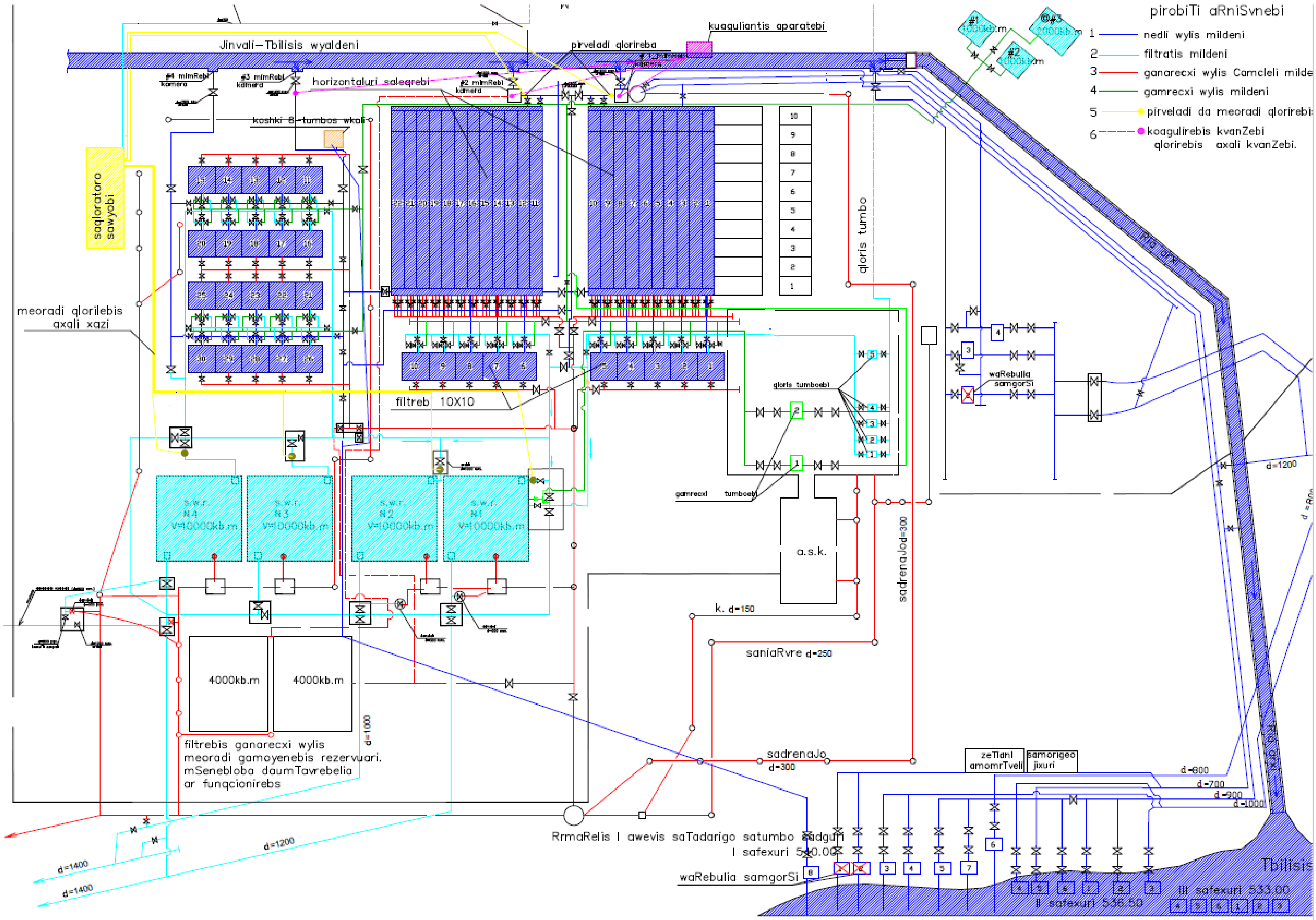
Existing settlement tank flocculation zones & Stream baffles – View from distribution chamber

Existing settlement tank static zones & sludge draw-off piping

Existing settlement tank– Outlet penstocks to filtration stage feeding channel

Existing settlement tanks– Outlet channel to filtration stage

Existing Building– sludge draw-off piping and filters feeding



Ghrmaghele DWTP Existing Facilities– General Layout

3. CURRENT STATUS AND TROUBLESHOOTING

As stated before. the raw water is currently treated with a conventional Physical-Chemical process, including the following stages:

- Dual raw water intake:
  - Jinvali dam feeding channel
  - Tbilisi Sea raw water pumping station

- Static Settling
  - Line 1: 10 tanks
  - Line 2: 12 tanks

- Sand media gravity filtration
  - Line 1: 10 filters
  - Line 2: 16 tanks

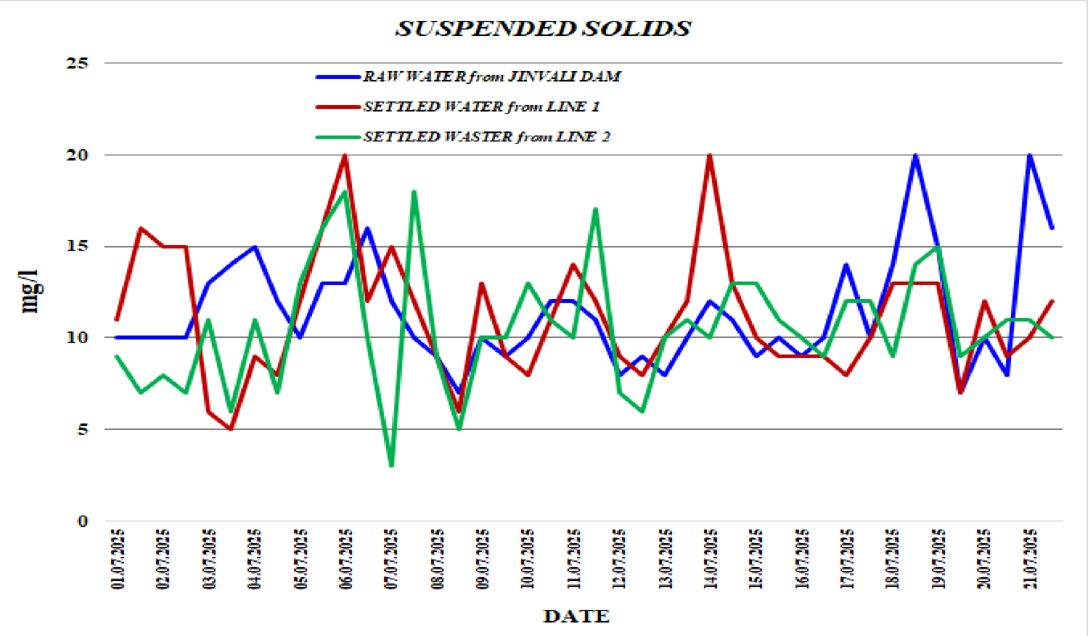
- 4 Treated water storage tanks, 10.000 m³ each.

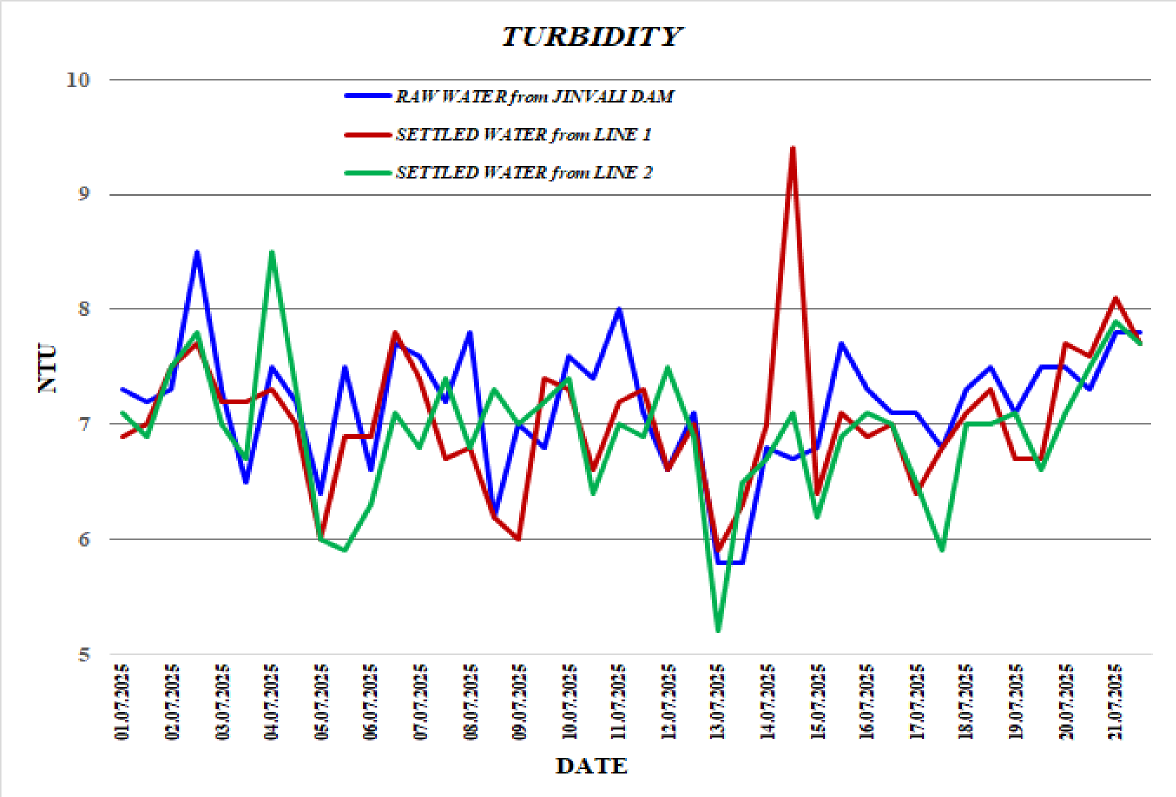
- 2 Treated water storage tanks for filters backwashing, 4.000 m³ each.

- Poly-aluminum Chloride (PAC) – Storage and dosage facilities.

- Chlorination facilities:
  - Pre-Oxidation.
  - Treated water disinfection.

During high turbidity events, such as heavy rainfall, the sedimentation process is generally ineffective at reducing turbidity and suspended solids (SS) levels in raw water. The graph below illustrates the performance of the sedimentation tanks during a sampling campaign conducted in July to assess the current efficiency of the treatment process. The results indicate minimal or no removal efficiency under these conditions.





The current settlers consist of rectangular shaped tanks built in reinforced concrete. Each tank with the following useful dimensions :56,30 x 5,75 x 4,00 / 4,50 m (L x W x H).

As shown, the expected treatment flow of 6,50 m³/s cannot be treated with process guarantees due to the high surface load and low hydraulic retention time obtained with existing tanks dimensions.

The surface load is over 3 m/h, and the overall retention time is under one hour. Consequently, turbidity and SS removal efficiency falls below the expected operational standards.

On the other hand, despite of the fact that poly-aluminum chloride is dosed, the mixing efficiency with the current configuration based on baffle walls and submerged weirs (up and down streaming), doesn't meet the adequate mixing rates with the raw water.

So, not only must the settling process be enhanced, but also the previous flash mixing and flocculation steps need to be upgraded in order to meet the proper mixing rates, allowing the adequate growing of flocs to be removed in the final settling zones of each tank.

4. PURPOSE OF THIS DOCUMENT

The purpose of this Document is to define the most suitable solution and corresponding associated works and installations for the drinking water treatment plant of Ghrmaghele (Tbilisi – Georgia) upgrading, related to settling stage, and their integration with the rest of existing structures and facilities.

Since Ghrmaghele DWTP has been facing for a long time some problems regarding turbidity and SS removal in settlement stage, the Document is mainly focused in this stage of the process.

The new design of the settlement stage has been carried out using the actual civil work structures, but including new elements inside the existing tanks in order to improve the efficiency of the physical-chemical process, upgrading the plant to an extend of being able to face average, and high season, raw water ratios in turbidity and SS.

The document also outlines the general guidelines for the design of the new upgraded treatment facilities, including location, flow rates to be treated, unit treatment processes, and elevation levels of the installations, ensuring proper flow distribution to all points and optimal connection between components. The works herein described are located within a plot that currently houses the existing facilities.

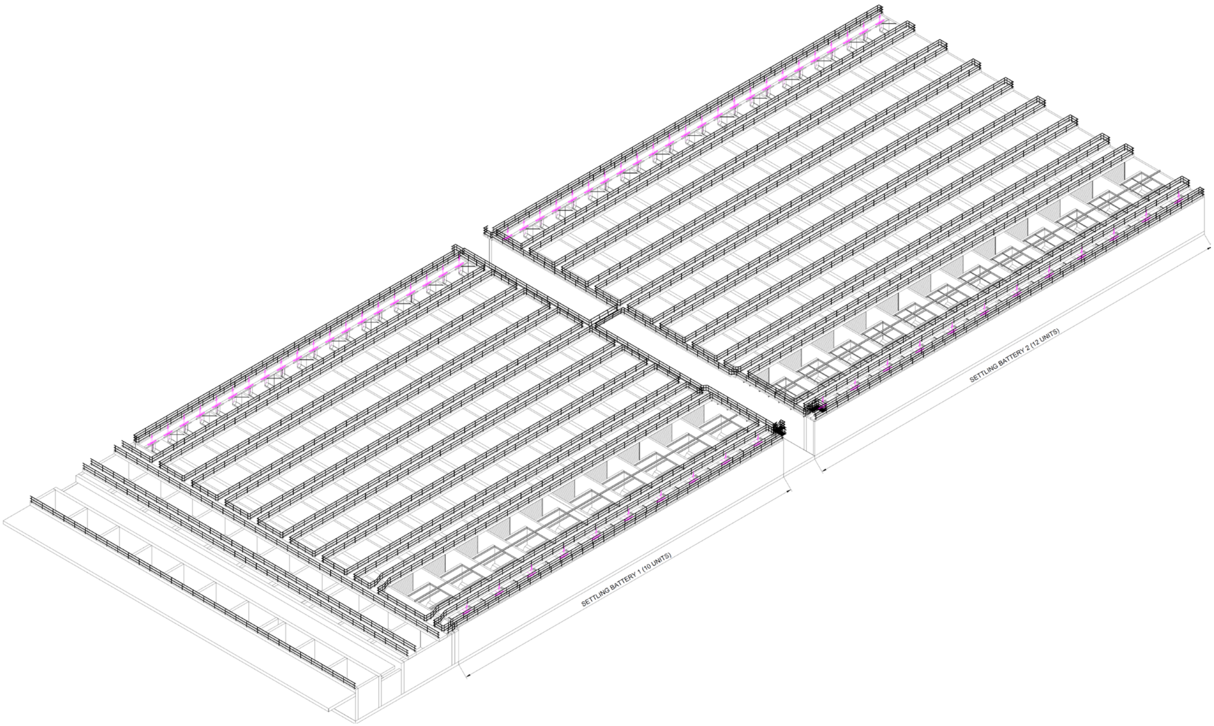
The elements included are therefore limited to the Settlement Stage Upgrading of the existing Drinking Water Treatment Plant (DWTP), within the boundaries of the currently occupied plot. It involves all civil, mechanical, and electrical works related to this stage of the treatment process upgrading, providing the technical and economic definition of the elements to be improved in the DWTP:

Upgrading of the DWTP is based on providing adequate treatment capacity under any raw water quality conditions within the limits established in the local regulation. The nominal treatment capacity has been defined for short-term future in 6,50 m^3/s.

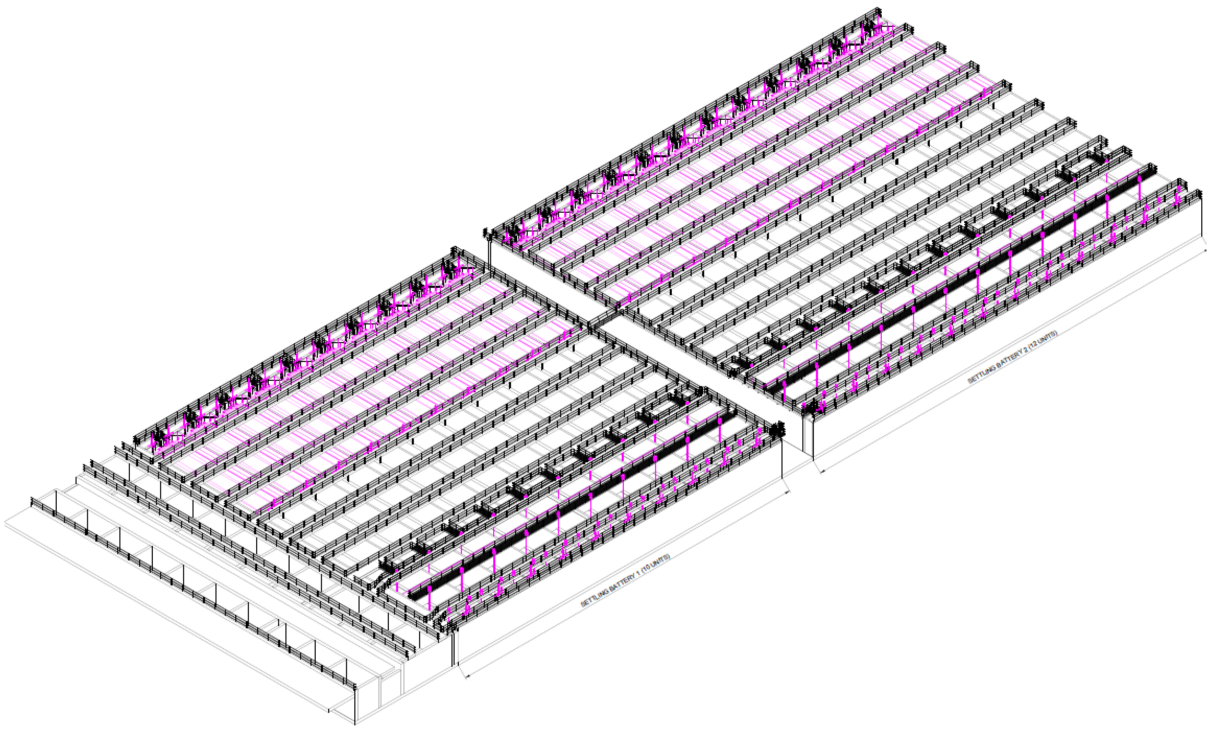
A key premise for the treatment installation and proposed improvements is to achieve maximum efficiency in terms of energy use, rational water use, and CO_2 emissions reduction, as well as maximum operational safety and flexibility, optimizing operating costs.

As a result of the above, the new treatment arrangement per tank will broadly consist of:

- Two (2) new flash mixing chambers per tank (settler) for proper chemical merging.
- One (1) new flocculation chamber configured as a two-stage unit with two (2) hydraulically connected compartments in series.
- One (1) static settling zone, with the possibility of partially removing from 0 ÷ 50 % of treatment flow per tank.
- One (1) final lamella settling zone to treat from 50 ÷ 100 % of treatment flow per tank.



Ghrmaghele DWTP – Existing facilities – Isometric view



Ghrmaghele DWTP – Upgraded facilities – Isometric view

5. SETTLING FACILITIES UPGRADING

5.1. FLASH MIXING – COAGULATION

Existing raw water inlet to current settlers is carried out by means of a slide manual operated penstock which leads from the general distribution channel per line to an internal channel-weir splitting channel, located inside the feeding column-chamber on the head of each settling tank.

The current tanks arrangement allows the incoming flow to be delivered from the feeding column-chamber into the settler by means of three outlet piping connections. These three pipes are connected with the two main distribution pipes located in the lower zone of the bottom slab (two demi-truncated pyramid shaped trenches).

Ghrmaghele DWTP – Existing facilities

Prior to raw water entering the column-chamber, two reagents are dosed, chlorine (oxidation) and poly-aluminum chloride (flocculation-coagulation).

Flash mixing (coagulation) should take place inside the inlet column-chamber, while flocculation occurs later, once the water is discharged from the bottom of the tanks in downstream flocculation zones, which are set up by using baffle walls.

This arrangement provides the raw water stream an up and down slow and controlled movement.

The current results clearly indicate that the system's efficiency is insufficient. Proper mixing of the coagulant reagents with the raw water is critical to ensure effective floc formation, which is a prerequisite for efficient sedimentation in the settling tanks.

The upgrading of this inlet and splitting structure consists of the following modifications:

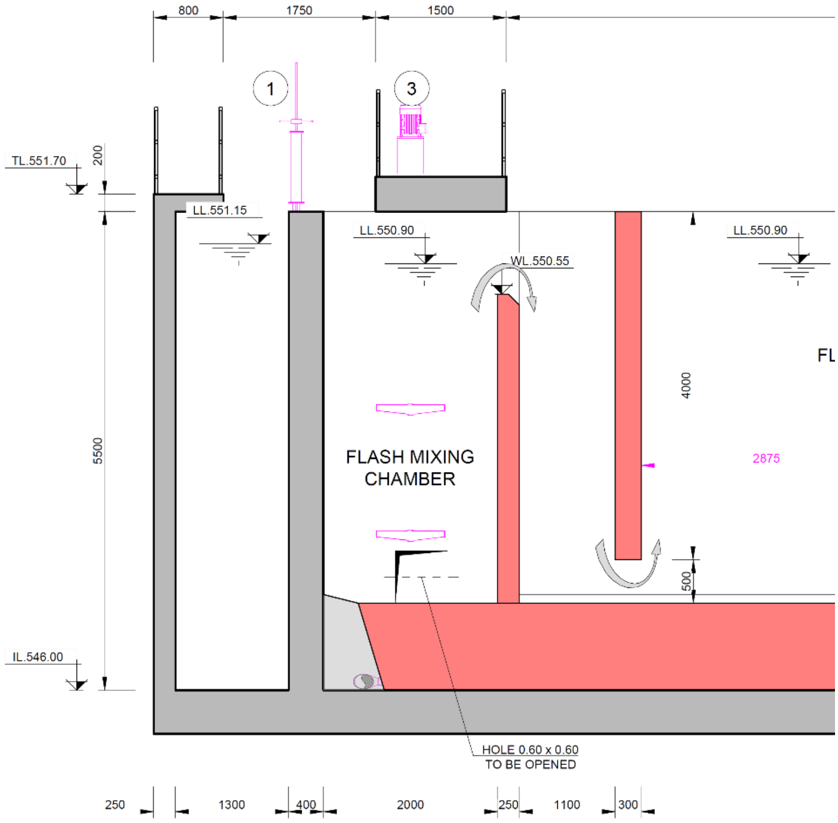
- Remove the existing distribution piping and connections.
- Level up the bottom of the tank with filling mortar
- Open two square inlet holes (0,60 x 0,60 m) at the bottom of the column-chambers where the current lateral connections are located.
- Build two overflow walls to set both lateral flash mixing chambers designed.
- Installation of two (2) rapid vertical shaft mixers in the middle of each new flash mixing chamber.
- Ancillary works in the existing interconnection & access platforms between clarifiers to allow mixers installation.

According to the available information, the two (2) new rapid mixing chambers are 2,00 x 2,00 m (L x W), with total height, once the bottom has been leveled, of 4,50 m, with an useful height of roughly 3,90 m. These dimensions provide, depending on nominal and maximum flow rates, a total residence time of approximately 1,80 minutes considering the useful volume.

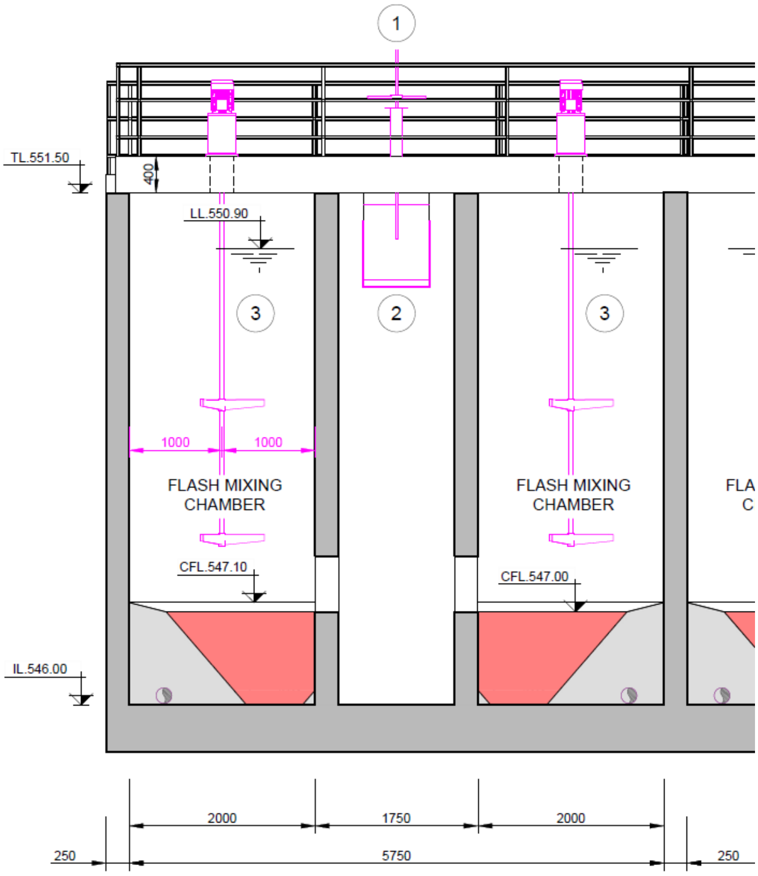
Water will enter each chamber from the bottom, passing through the new 0,60 x 0,60 m lateral openings. In the center of each new chamber, supported on the existing concrete walkway, a vertical-shaft rapid electro-mixer will be installed, otherwise without the agitator’s influence, the water flow would be upward, crossing the semi-diagonal of the square chamber.

The shaft and blades are made of stainless steel AISI 316 L, and the double propeller is driven by a 3,00 kW electric motor-reducer, with an output speed of 93 rpm.

The water overflows through two submerged weirs that are positioned perpendicular to the inlet opening. This configuration ensures that the water flow necessarily passes through the influence zone of the vertical mixer installed in the chamber, avoiding preferential paths and short-circuiting in the stream.



Ghrmaghele DWTP – Flash mixing chambers after upgrading – Longitudinal Section



Ghrmaghele DWTP – Flash mixing chambers after upgrading – Cross Section

5.2. SLOW MIXING – FLOCCULATION

Flocculation theory explains how the suspended tiny particles aggregate into larger, settleable masses called flocs, driven by overcoming repulsive forces between particles.

The process can be natural, occurring through factors like gravity and Brownian motion, or chemically induced with coagulants and flocculants that neutralize surface charges or physically bridge particles. Once formed, these larger flocs can be more easily removed from a liquid through processes like sedimentation or filtration, leading to improved clarification.

Therefore, flocculation is a key process for the optimal performance of the Water Treatment Plant (WTP), and requires proper design and control, ensuring the necessary layout and adjustment mechanisms to make it effective.

The fine solids coagulated in the flash mixing previous process, along with precipitates and other suspended solids carried by the water, are flocculated into larger and denser solids (flocs) easing the downstream settlement process. Flocculation is accelerated in the presence of preformed flocs.

For this reason, the solution designed for DWTP upgrading includes one chamber per tank (settler), each one divided into two compartments.

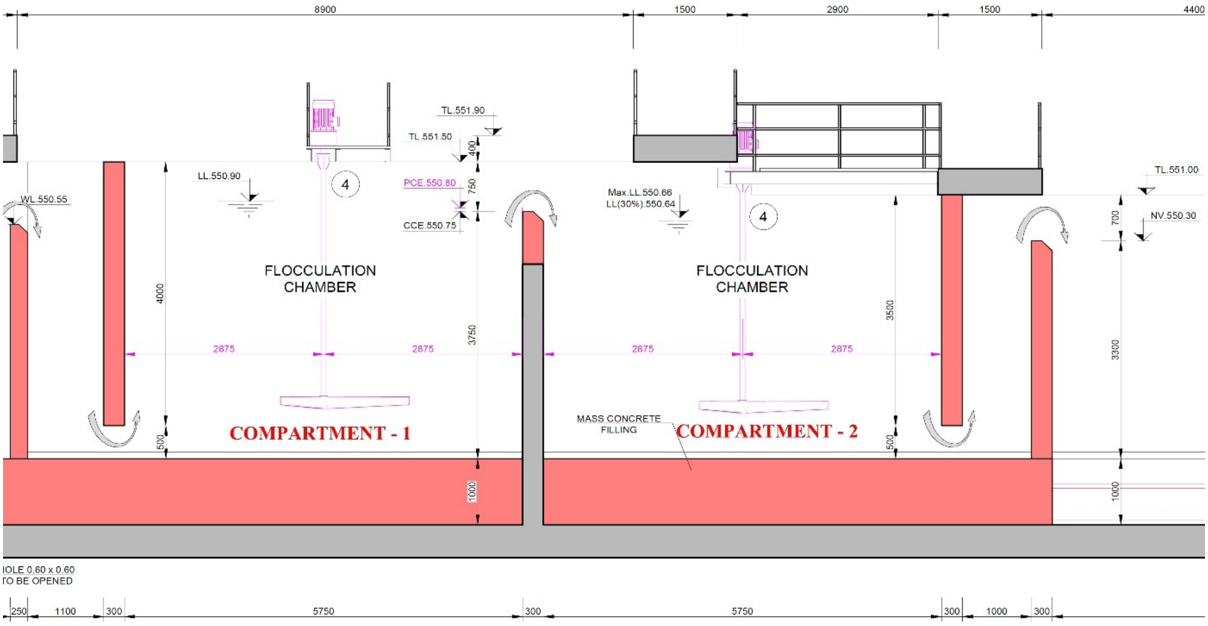
Water enters the first compartment through a submerged opening of 5,75 x 0,50 m. The outlet is configured as a suppressed rectangular weir with a free-flowing nappe, allowing direct discharge into the second compartment of the system.

Each compartment is equipped with one (1) slow-speed vertical mixer, driven by an electric motor and gearbox, with adjustable rotation velocity via frequency converter.

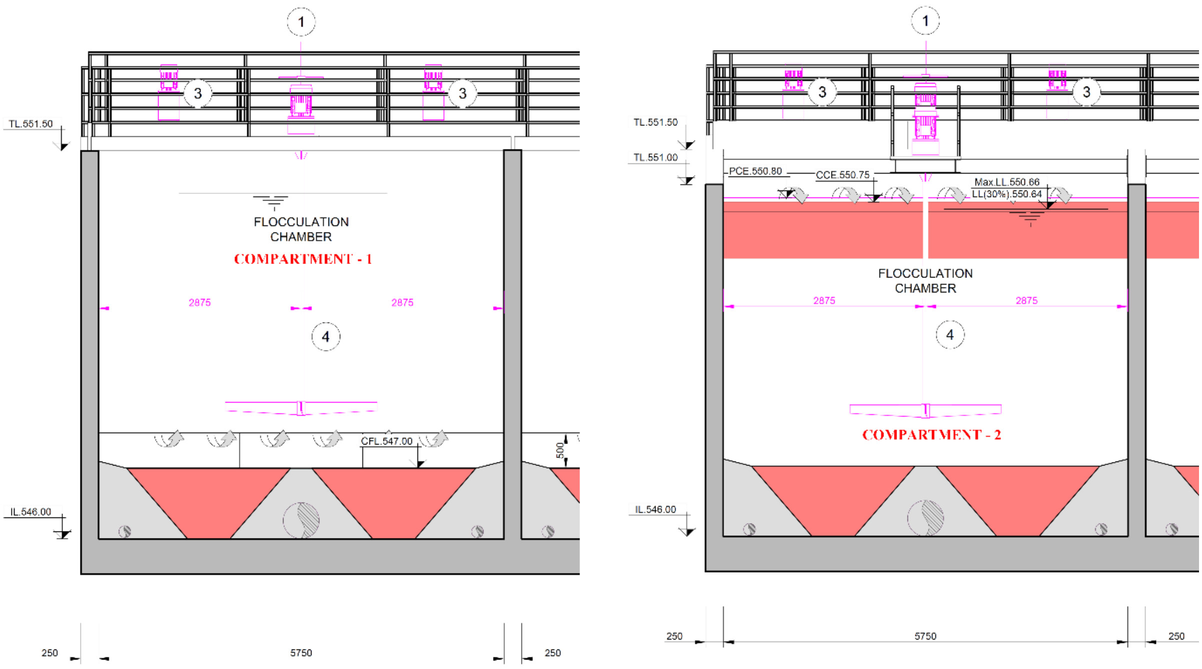
The outlet from the second compartment features a submerged baffle static settling zone at its lower zone. This configuration prevents short-circuiting of the water flow through the chambers, forcing the water stream to pass through the influence zone of propellers.

Each chamber has dimensions of 5,75 x 5,75 m. Water depth in the first one is 3,90 m, while in the second compartment the maximum will be 3,66 m.

These dimensions result in a total flocculation volume of roughly 250 m^3 per tank, resulting in a retention time of 14,10 minutes at future flow rate of 295 l/s per chamber, and 15,30 minutes at current flow of 273 l/s per chamber.



Ghrmaghele DWTP – Flocculation chambers after upgrading – Longitudinal Section



Ghrmaghele DWTP – Flocculation chambers after upgrading – Compartments Cross Sections

5.3. LAMELLAR SETTLEMENT

Following the flocculation stage, and in line with the flash mixing and flocculation chambers, the last part of the existing sedimentation tanks has been divided into two different settlement zones.

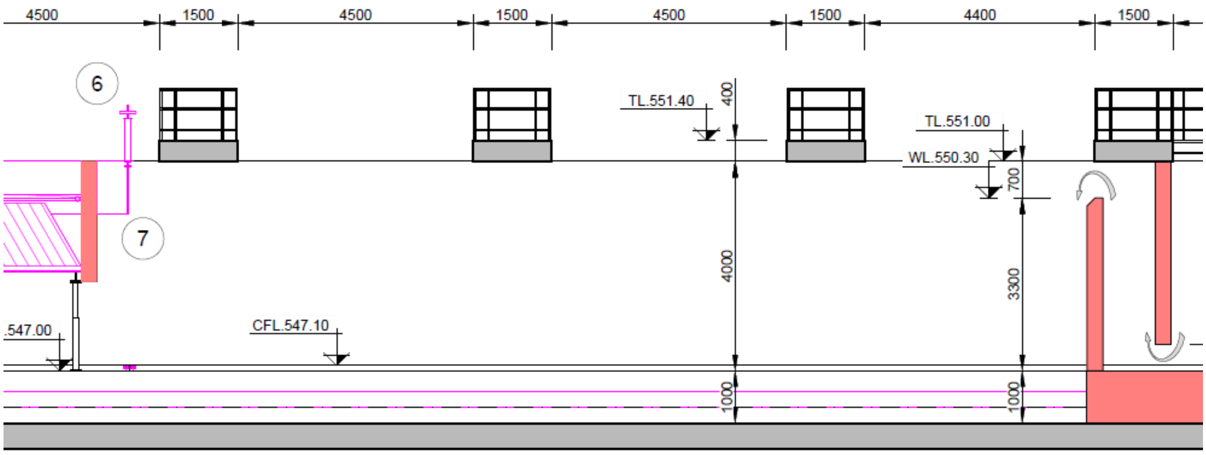
The first one has been upgraded to work as a static settlement zone, where stream is forced from upper to lower zone of the tank. This static zone is 18,95 m in length and 5,75 m in width. An average water depth of 3,65 m in this zone results in a rough hydraulic retention time between 22 ÷ 24 minutes. Part of the flow can be removed from this static zone by using a manual operated overflow weir-penstock located at the upper end of the zone. The weir -penstock has been designed to allow the operator to remove up to a 50 % of incoming flow.

The outlet from the static zone to the lamellar settling zone is made via a baffle wall, with a lower opening of 5,75 x 0,50 m, that forces the stream to enter the last part of the tank, the lamellar settlement zone. The upward flow in this last zone passes through lamella packages supported by FRP and stainless steel beams, and adjustable stainless steel pillars.

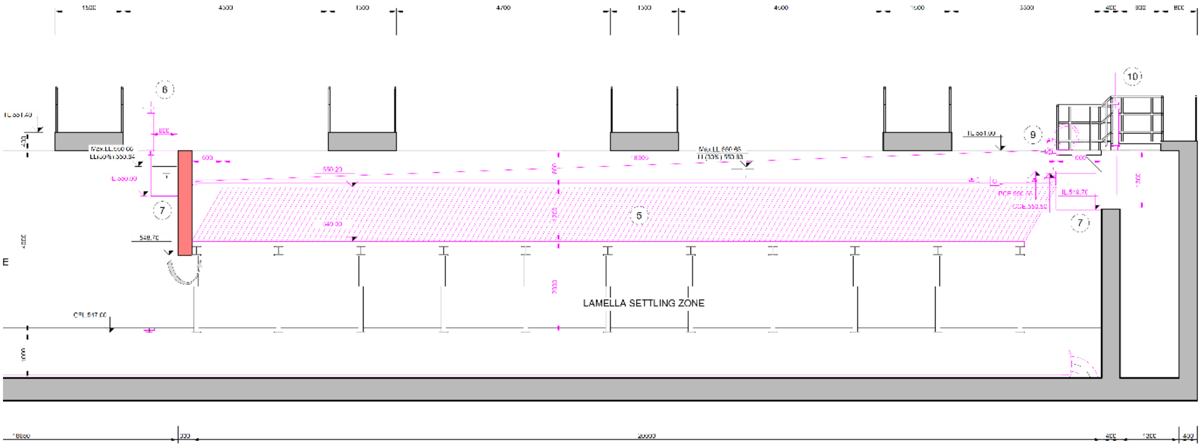
Each settler has been equipped with a large number of lamella packs, 1,20 m in vertical height, mounted at a 60º angle from the horizontal, covering 5,00 of total width of the tank.

The total projected surface area of the lamellas ensures that the resulting upward Hazen velocity remains between 0,54 ÷ 0,80 m/h at 70 ÷ 100 % of future flow, which is expected to result in a very reasonable clear settled water. The design includes an automatic lamella cleaning system to allow the operator keep lamella package clean at every time, and that there is no need to stop the process during cleaning procedure.

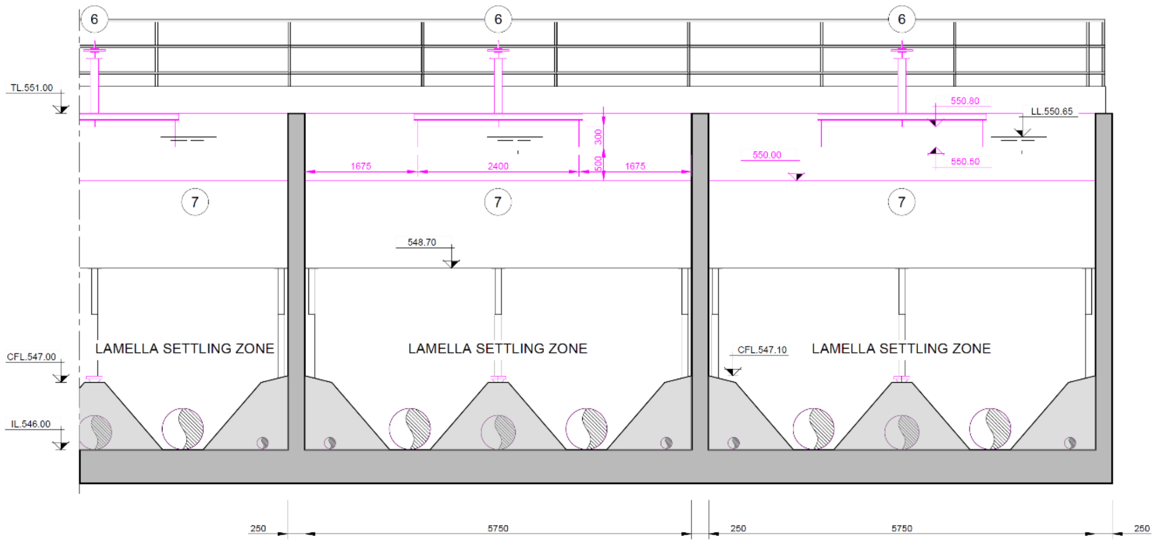
Flow removed from the static zone is collected into a 0,60 m width stainless steel cross channel. This channel leads to a 0,75 m width stainless steel longitudinal channel, parallel to lamella packages. Finally, this channel discharges into a 1,00 m width final settled water stainless steel cross channel. The outlet of each tank from final settled water collection channel is carried out by means of two existing slide manual operated penstocks.



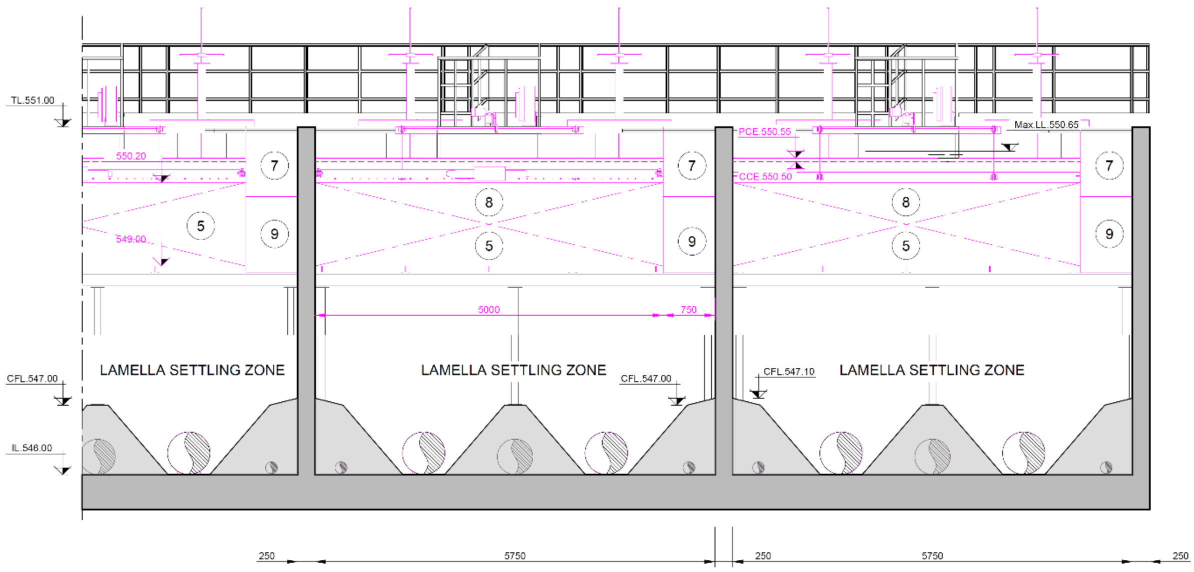
Ghrmaghele DWTP – Static settling zone after upgrading – Longitudinal Section



Ghrmaghele DWTP – Lamella settling zone after upgrading – Longitudinal Section



Ghrmaghele DWTP – Static zone overflow weir-penstock – Cross Section



Ghrmaghele DWTP – Lamellar zone– Cross Section

5.3.1. Lamella modules

The modules are manufactured from virgin polypropylene homopolymer suitable for contact with drinking water.

- Water type: Drinking water
- Application: Water stream - Settling
- Scope: 22 settlers
- Tanks per settler: 1
- Maximum flow per settler (m^3/h): 1.063
- Tank geometry: Rectangular
- Tank overall dimensions (m): 56,30 × 5,75 (L x W)
- Lamella zone dimensions (m): 19,00 × 5,00 (L x W)
- Water distribution: Inlet at tank head

The innovative features of the lamella modules are:

- An injection molding production, as opposed to traditional extrusion, which allows for a polished finish and eliminates rivets and sealing elements between lamellas, minimizing fouling and improving sludge evacuation.
- The homogenization system, integrated into the outlet geometry, which generates a head loss of approximately 3 mm water column, enabling balanced upward velocities across the entire lamella pack, regardless of the settler configuration, raw water input, or treated water outlet design.

Assembled lamella modules & Upper zone view of assembled modules

5.3.2. Water Inlet and Distribution

Water will be supplied from the flocculation tank at the head of the settler. The first 18,95 m of the tank will operate as a conventional static settler with an independent weir-penstock before the deflector that marks the lamella zone. This weir will collect 30% of the total flow in average (adjustable for optimization from 0 % to 50 %) and direct it, via stainless steel channel along the tank side, to the outlet channel. The remaining 19,00 m will operate as a lamellar settler, treating 70% of the flow in average, and discharging through a cross weir located in the new 1,00 m stainless steel channel.

Thanks to selected lamellar technology, water distribution is not critical for achieving balanced upward velocities across all lamella channels. The manufacturer design eliminates the need for traditional weir channels, resulting in significant cost savings in:

- Weir channels and their supports
- Associated civil works
- Assembly and transport

5.3.3. Lamella Modules Technical Specifications

Specification	Value
Model	Wss40-12-HV
Flow homogenization system	Included
Assembly	Internal bolted frame with SS rods
Anti-flotation system	Bottom anchoring, no top profile
Lamella spacing (mm)	40
Vertical settling distance (DVD) (mm)	80
Module height (mm)	1.200
Module volume (m³)	1,20
Lamella channel length (mm)	1.370
Inclination	60°
Projected surface (m²/m³)	12,50
Total projected surface per module (m²/m³)	15,00
Material	Virgin PP
Manufacturing process	Injection
Surface finish	Mirror-polished
Colour	White (RAL 9010)
Weight (kg/m³)	65
Max operating temperature (°C)	40°
Losses due to internal frame (%)	0,60
Losses due to support structures (%)	0
Losses due to anti-flotation structure (%)	0

Lower view of new lamella modules and supports

5.3.4. Homogenization System

WssDynamics modules incorporate WssHomogenizer technology, reducing maximum velocity differences within the lamella package to just 3 ÷ 4%.

Upper zone view of assembled modules – Homogeneization system

5.3.5. Support Structures

The main transverse framework consists of stainless-steel beams supported by a lower structure with adjustable height pillars, also stainless steel made.

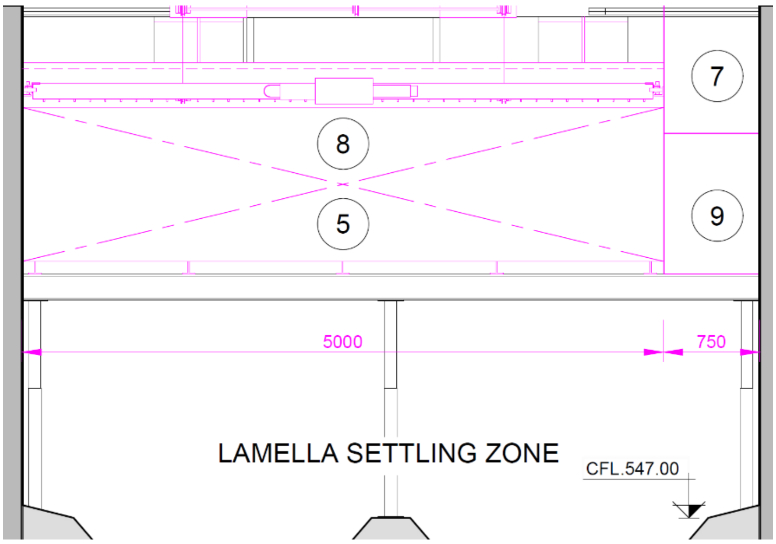
The longitudinal support profiles are FRP, in an inverted T-shape, on which the lamella modules rest and are anchored. These specific longitudinal profiles will be produced and supplied by WssDynamics. Their design and installation method ensure 0% loss of effective channel section due to support structures.

This mesh-type structure increases load-bearing capacity and ensures optimal alignment of installed modules.

Lamella assembly is done using an internal bolted frame and spacers made from virgin polypropylene homopolymer, eliminating welds, guides, clips, or any elements that promote sludge retention.

The anti-flotation system secures the modules to the longitudinal profiles using rivets, preventing lamella buoyancy. This improves sludge evacuation and reduces fouling by avoiding contact zones, maximizing available settling surface.

Lamella modules supporting system - Typical



Lamella modules supporting system – Upgrading design

5.3.6. Automatic cleaning system

The initial data considered for designing and defining the automatic cleaning system is the following:

Water type:	Drinking water
Application:	Water line settling
Scope:	22 settlers
Tank geometry:	Rectangular
Lamella zone length (m):	19,00
Lamella zone width (m):	5,00
Cleaning units per tank:	1
Installed lamella model:	WssDynamics
Anti-flotation profile:	Not applicable
Water layer height above lamella pack (m):	0,45 (maximum)

The Wss-Cleaner unit enables complete and effective cleaning of lamella channels across the settler surface. Cleaning is performed by injecting part of the effluent, which is pumped and sprayed through nozzles directed at each channel, generating velocity and turbulence to dislodge solids adhered to channel surfaces which are then evacuated to the bottom and directed to sludge hoppers. This facilitates periodic cleaning, reduces maintenance costs, avoids shutdowns, and allows continuous operation of the settler, improving performance.

The WssDynamics lamella model includes this cleaning system, allowing operation without shutdown for cleaning. Operation is automatic, initiated by a plant operator command. After cleaning, the unit returns to its starting position awaiting the next signal.

The main components of the system are:

- A submersible pump for required pressure and flow, fully stainless steel.
- A stainless steel manifold and nylon/PP injection nozzles covering full lamella width.
- A mobile stainless-steel frame.
- Automatic cable reels for pump power supply.
- Support and sliding elements, dual guide system, and gear motor for movement along lamella zone.
- A corrosion-resistant gear motor with stainless steel output shaft.
- Submersible stainless steel inductive position sensors.
- A control panel with manual and automatic operation, corrosion-resistant sealed fiber enclosure.

The operational advantages are the following:

- Minimum required water layer height above lamella pack, 250 mm.
- Allow installation of transverse evacuation ducts, if needed, for hydrodynamics in lamellar package improving.
- Fully automatic process – no labor or operator presence required.
- No need to empty the tank.
- Effective cleaning of all channel surfaces and full length.
- Easy access and inspection, located above lamella pack.
- Low operating costs – cleaning can be performed as frequently as needed, ensuring maximum settling efficiency.

Lamella Automatic Cleaning System

5.3.7. Advantages of the Proposed Lamellar System. Summary

- *Kinetic homogenization*: Lamellar modules incorporate a kinetic homogenization system that reduces maximum velocity differences within any zone of the lamella pack to just 10%.

- *Uniform flow distribution*: Water distribution from the inlet does not represent a critical factor for achieving balanced upward velocities across each lamellar channel throughout the entire installed surface.

- *Simplified water evacuation*: Settled water is discharged via a transverse weir (channel) spanning the full width of the lamellar zone of the tank, offering simplicity and ease of operation.

- *Structural support*: Lamella support structures are made of standardized FRP profiles with adjustable stainless steel AISI 316 beams and braces, offering excellent corrosion resistance. This design minimizes loss of effective cross-sectional area in the lamellar channels due to structural obstruction.

Long settlement tank upgrading - Lamella modules

ANNEX I

PROCESS DESIGN REPORT

GHRMAGHELE DWTP LAMELLA SETTLING

EXISTING FACILITIES UPGRADING

PROCESS DESIGN

INDEX

1. DESIGN DATA

1.1. - Design Flow

	Future flow	Current flow	
- Treatment capacity:	6,50	6,00	m^3/s
	23.400,00	21.600,00	m^3/h
	561.600	518.400	m^3/day

1.2. - Raw water SS

- SS average pollution:		
• At $Q_{current}$:	25	mg/l
• A Q_{future} :	30	mg/l
- SS inlet load:		
• At $Q_{current}$:	23	kg/h
	540	kg/d
• A Q_{future} :	29	kg/h
	702	kg/d

2. RAW WATER FEEDING CHANNELS

2.1. - Feeding channel dimensions. Zones & Sections

	Future flow		Current flow	
- Channel width:		1,30		m
- Channel height - Lower zone:		2,00		m
- Channel height - Upper zone:		2,00		m
- Water level (maximum at final section of upper zone) :	551,15		551,14	m.a.s.l.
- Channels approximate length:				
• Line 1 (10 settlers)		61,10		m
• Line 2 (12 settlers)		73,40		m

3. FLOW DISTRIBUTION & SETTLING BATTERIES FEEDING

3.1. - Design & Flow splitting

	Future flow	Current flow	
- Total design flows:	23.400	21.600	m³ / h
	6.500	6.000,00	l/s
- Number of lines :	2		uts
- Number of settlers per line :			
• Line 1:	10		uts
• Line 2:	12		uts

- Flow distribution per line :	Line 1	Line 2	
◊ Future (short term) flow:	10.636	12.764	m³/h
	2.955	3.545	l/s
◊ Current flow:	9.818	11.782	m³/h
	2.727	3.273	l/s

3.2. - Batteries inlet

	Line 1	Line 2	
- Type:	Feeeding Pipes		
- No. of pipes per battery :	2	2	uts
- Unit diameter :	1,00	1,00	m
- Inlet velocity:			
• At future flow:	1,88	2,26	m/s
• At current flow:	1,74	2,08	m/s

3.3. - Settlers inlet

	Future flow	Current flow	
- Type:	Slide Pestock - Manual operated		
- No. of penstocks per settler :	1		ut
- Unit dimensions :			
• Width:	0,70		m
• Height:	1,00		m
• Water depth:	0,84	0,83	m
- Inlet velocity:	0,50	0,47	m/s

3.4. - Flow inlet

	Future flow	Current flow	
- Type:	Inlet channel - Double sided overflow weir		
- No. of inlet channels per settler :	1		ut
- Unit dimensions :			
• Channel width:	0,70		m
• Channel height:	0,70		m
• Channel length:	2,00		m
• Overflowing length:	4,00		m
- Overflowing wave :	12	11	cm

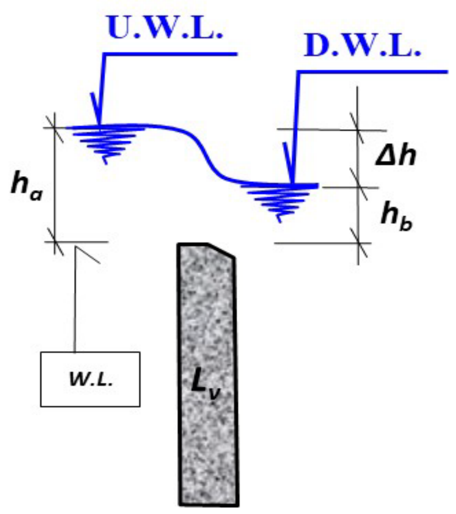
3.5. - Settling Stage By-pass	Future flow	Current flow	
- Type:	Pipes & Valves		
- No. of valves :	1	1	ut
- Valves diameter :	1,60	1,60	m
- By-pass velocity:			
• Line 1:	1,47	1,36	m/s
• Line 2:	1,76	1,63	m/s
- No. of general by-pass pipes :	1		ut
- Pipe diameter :	2,00		m
- By-pass velocity:	2,07	1,91	m/s

4. LAMELLA SETTLING TANKS

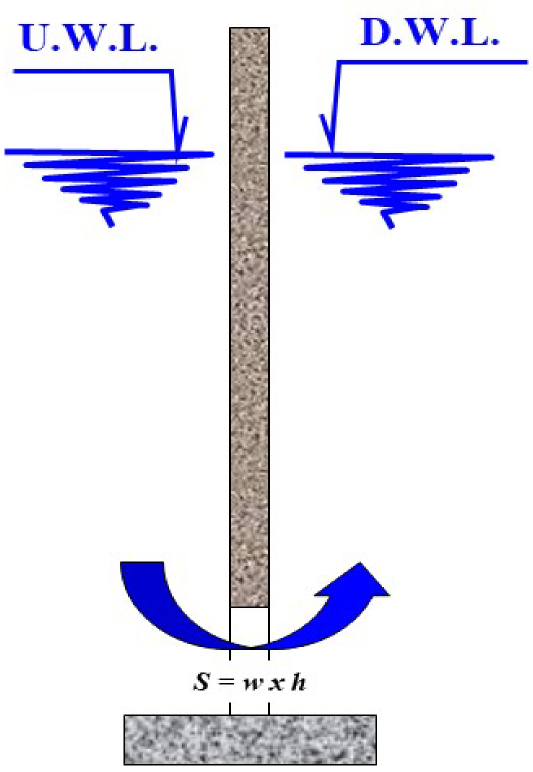
	Future flow	Current flow	
- Treatment capacity:	6,50	6,00	m³/s
	23.400	21.600	m³/h
- Reagents to be dosed:			
• Coagulation / Flocculation	Polyaluminum Chloride (PAC)		

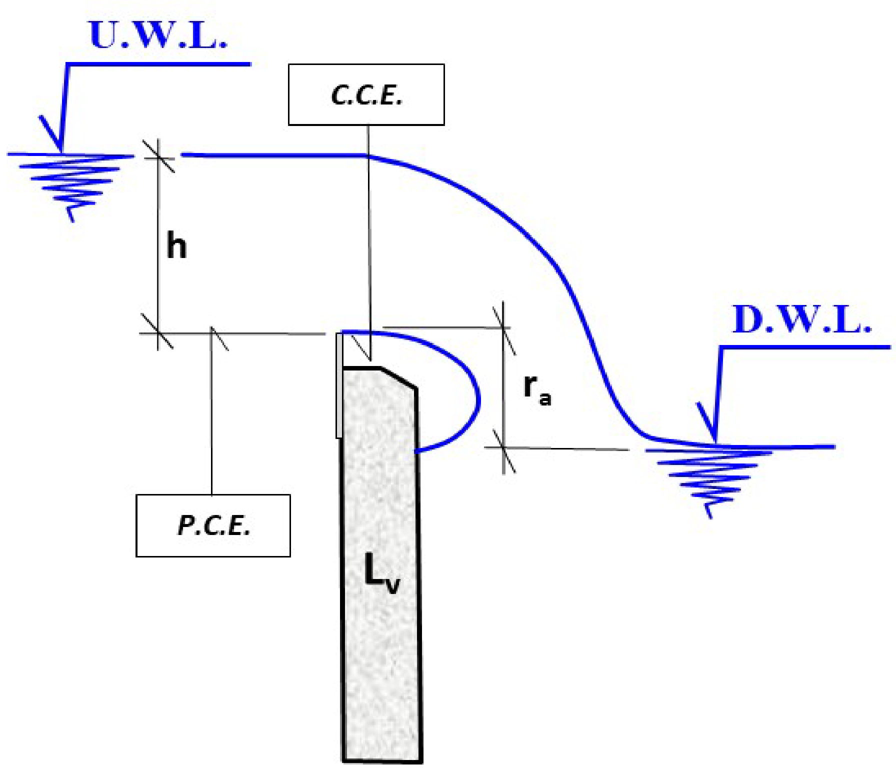
4.1. - Flash Mixing (inlet chambers)

- No of process rows :	22		uts
- No of chambers per row :	2		uts
- Chamber unit dimensions :			
• Length :	2,00		m.
• Width:	2,00		m.
• Water depth:	3,90		m.
• Total height (chamber):	4,50		m.
• Total height including platform thickness :	4,90		m.
- Unit surface:	4,00		m²
- Unit useful volume:	15,60		m³
- Hydraulic Retention Time (HRT) :	1,76	1,91	min
- Mixing system:	Vettical mixers		
- No of mixers per chamber :	1		ut
- Total No of mixers to be instaled :	44		uts
- No of propellers per mixer:	2,00		uts
- Propeller diameter:	900,00		mm
- Rotation speed:	93,00		rpm
- Motor rated power:	3,00		kW
- Chamber overflowing:	Sharp Crested Weir		
- Type :	Thin plate weir - Submerged nappe		
- Nº of overflow weirs per unit:	1		ut
- Overflowing weir length (L_v)	2,00		m
- Maximum overflow per weir:	531,82	490,91	m³/h
	0,14773	0,136	m³/s
- Werir Level (W.L.)	**550,55**	**550,55**	**m.a.s.l.**

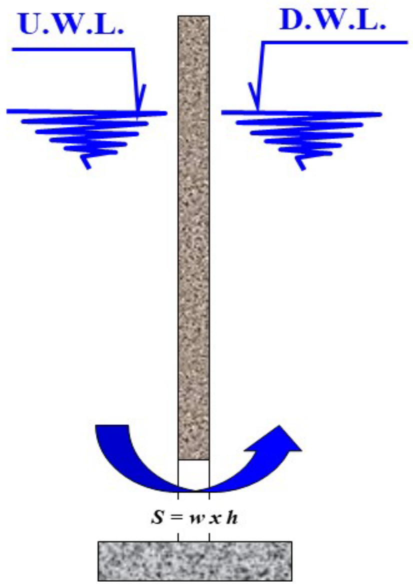


4.2. - Flocculation Zone	Future flow	Current flow	
- No of process rows :	22		uts
- No of chambers per row :	1		ut
- No of compartments per chamber :	2		uts
4.2.1. - First Compartment			
- 1st Compartment - Unitary dimensions :			
• Length :	5,75		m.
• Width:	5,75		m.
• Water depth (max):	3,90		m.
• Total height :	4,50		m.
- Unit surface:	33,06		m²
- Unit useful volume:	128,94		m³
- 1st Compartment inlet :	Submerged hole		
- Hole dimensions:			
• Hole width (***w***):	5,75		m
• Hole height (***h***):	0,50		m
• Velocity through hole ($V = Q / [w \times h]$)	1,39	0,00	m/s
- 1st Compartment overflowing :	Thin plate weir - Free nappe		
- Type :	Sharp Crested - Adjustable plate		
- Nº of overflow weirs per unit:	1		ut
- Overflowing weir length (L_v):	5,75		m
- Weir type:	Suppressed rectangular		
- Maximum overflow :	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Metallic Plate Crest elevation (**P.C.E.**) :	**550,80**	**550,80**	**m.a.s.l.**
- Concrete Crest Elevation (**C.C.E.**) :	**550,75**	**550,75**	**m.a.s.l.**





4.2.2. - Second Compartment	Future flow		Current flow	
- 2nd Compartment - Unitary dimensions :				
• Length :		5,75		m.
• Width:		5,75		m.
• Water depth (max):		3,66		m.
• Total height :		4,50 / 4,00		m.
- Unit surface:		33,06		m²
- Unit useful volume:		121,01		m³
- Intermediate baffle wall thicknes:		0,30		m
- 2nd Compartment outlet:		Submerged hole		
- Outlet hole dimensions:				
• Hole width (***w***):		5,75		m
• Hole height (***h***):		0,50		m
• Velocity through hole (***V = Q / [w x h]***)	0,10		0,09	m/s



4.2.3. - Flocculation chambers - Overall dimensions	Future flow		Current flow	
- Flocculation Chamber total dimensions per row:				
• Total length :		11,80		m.
• Width:		5,75		m.
• Water depth:		3,90 / 3,65		m.
• Total height :		4,50 / 4,00		m.
- Useful surface:		66,13		m²
- Unit useful volume:		249,95		m³
- Total flocculation volume :		5.498,96		m³
- Hydraulic Retention Time (HRT) :	14,10		15,28	min

4.2.4. - Mixing equipment		
- Mixing system:	Vertical mixers w/VFD	
- No of mixers per chamber :	1	ut
- Total No of mixers to be instaled :	44	uts
- No of propellers per mixer:	1,00	uts
- Propeller diameter:	2.500,00	mm
- Rotation speed:	13,00	rpm
- Motor rated power:	0,75	kW

4.3. - Static Setling Zone- General dimensions

	Future flow		Current flow	
- Number of rows :		22		uts
- No of settling tanks per row :		1		ut
- Total number of settling tanks :		22		uts
- Flow to be treated per tank :	1.063,64		981,82	m³/h
	0,295		0,273	m³/s
- Static zone settlement unit dimensions:				
• Settling zone - Total length :		18,95		m
• Settled water collection channel width:		0,60		m
• Tanks Width:		5,75		m
• Total height (maximum):		4,00		m
• Water depth (average):		3,65		m
- Static zone settling surface area :				
• Unit :		108,96		m²
• Total :		2.397,18		m²
- Static zone settling volume :				
• Unit :		397,71		m³
• Total :		8.749,69		m³
- Static Settling Zone Hydraulic Retention Time (HRT) :	22,44		24,30	min
	0,37		0,41	h
- Surface load in static settlement zone area:	9,76		9,01	m/h

4.4. - Static zone settled water collection

- Total Design Flows:	23.400		21.600	m³/h
	6,50		6,00	m³/s
- Nº of units (settlers):		22		uts
- Maximum flow percentage to be removed:		**50,00 %**		
- Maximum flow to be removed per unit (**Q**):	531,82		490,91	m³/h
	0,148		0,136	m³/s
- Average flow percentage to be removed :		**30,00 %**		
- Average flow to be removed per unit (**Q**):	319,09		294,55	m³/h
	0,089		0,082	m³/s
- Overflowing :		Sharp Crested - Adjustable overflow weir		
- Nº of overflow weirs per unit:		1		ut
- Overflowing weir length per channel (L_v)		**2,40**		**m**
- Weir type:		Contracted rectangular		
- Weir material:		AISI 316 L SS		
- Settled water collection system:		AISI 316 L Cross collection channel		
- Nº of overflow channels per unit:		1		uts
- Total number of overflowing channels:		22,00		uts
- Channel width:		**0,60**		**m**
- Channel Invert Level:		**550,00**		**m**
- Channel height:		**1,00**		**m**

4.5. - Lamella Settling Packages Zone

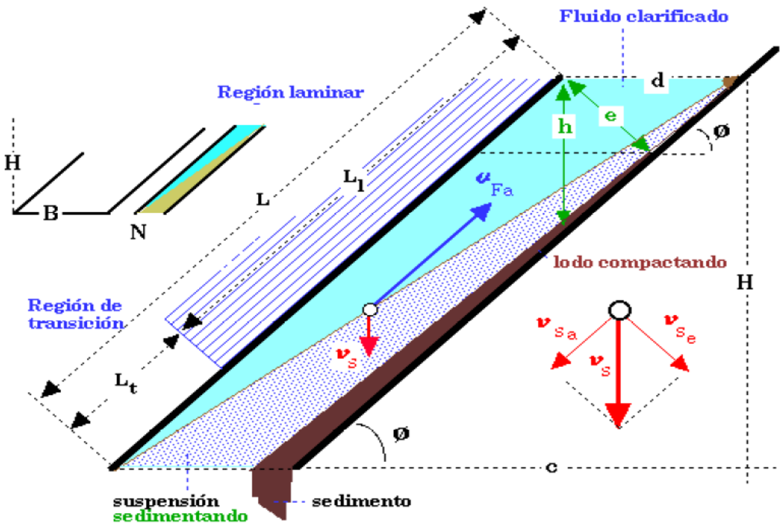
	Future flow	Current flow	
- Number of rows :	22		uts
- No of settling tanks per row :	1		uts
- Total number of settling tanks :	22		uts
- Flow to be treated per tank :	744,55	687,27	m³/h
	0,21	0,19	m³/s
- Settlement tank unit dimensions:			
• Lamella Settling Zone - Total length :	20,00		m
• Lamella Modules - Total length :	19,00		m
• Lamella packages - Effective length:	18,31		m
• Settled water collection channel width:	1,00		m
• Tanks Width:	5,75		m
• Lamella packages width:	5,00		m
• Tank total height (maximum):	4,00		m
• Water depth (average):	3,65		m
- Settling surface area :			
• Unit :	95,00		m²
• Total :	2.090,00		m²
- Settling volume :			
• Unit :	346,75		m³
• Total :	7.628,50		m³
- Lamella Settling Zone Hydraulic Retention Time (HRT) :	27,94	30,27	min
	0,47	0,50	h
- Flocculation + Settling - Total Volume :	21.877,14		m³
- Flocculation + Settling - Hydraulic Retention Time (HRT) :	56,10	60,77	min
	0,93	1,01	h

4.6. - Lamella Modules - WssDynamics

- Manufacturer:	Wss Dynamics	
- Type:	Wss - 40 - 12 - H	
- Shape:	Corrugated profile	
- Material:	Virgin PP	
- Lamella packages specific weight:	64,00	kg/m³
- Inclination angle:	60	º
- Average spacing between plates:	40,00	mm
- Lamella plates thickness:	1,20 (± 1)	mm
- Lamella plates length:	1,39	m
- Lamella packages height:	1,20	m
- Lamella modules width:	5,00	m
- Lamella Modules - Total length :	19,00	m
- Lamella packages - Effective length:	18,31	m
- Lamella package volume per tank:	109,86	m³
- Lamella packages total volume:	2.416,92	m³
- Projected surface ratio (per m³):	12,50	m²/m³
- Useful adopted ratio:	98,00	%
- Useful projected surface ratio:	12,25	m²/m³

4.7. - Operatinal Parameters of Lamella Settling

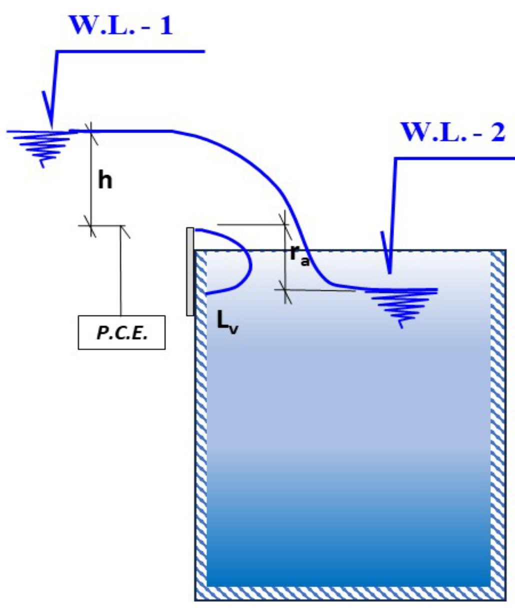
	Future flow	Current flow	
- Theoretical projected surface (**12,50** m²/m³) :			
• Unitary :	1.373,25		m²
• Total :	30.211,50		m²
- Useful projected surface (**12,25** m²/m³) :			
• Unitary :	1.345,79		m²
• Total :	29.607,27		m²
- Surface load in lamella settlement zone area:			
• Working at 70 % of maximum flow :	7,84	7,23	m/h
• Working at 100 % of maximum flow :	11,20	10,33	m/h
- Surface load in lamella packages surface area :			
• Working at 70 % of maximum flow :	8,13	7,51	m/h
• Working at 100 % of maximum flow :	11,62	10,72	m/h
- ***Hazen velocity*** :			
• Working at 70 % of maximum flow :			
◊ *Over theoretical projected surface:*	*0,54*	*0,50*	*m/h*
◊ *Over useful projected surface:*	***0,55***	***0,51***	***m/h***
• Working at 100 % of maximum flow :			
◊ *Over theoretical projected surface:*	*0,77*	*0,71*	*m/h*
◊ *Over useful projected surface:*	***0,79***	***0,73***	***m/h***



4.9. - Settled water collection

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
	6,50	6,00	m³/s
- Nº of units (settlers)	22		uts
- Flow per unit (**Q**)	744,55	687,27	m³/h
	0,207	0,191	m³/s
- Settled water collection system:	Cross collection metallic channel		
- Overflowing :	Sharp Crested Weir		
- Weir type:	Suppressed rectangular - Free Nappe		
- Nº of overflow channels per unit:	1		uts
- Total number of overflowing channels:	22		uts
- Channel width:	**1,00**		m
- Overflowing weir length per channel (L_v)	5,00		m

	Future flow	Current flow	
- Design average overflow (*70 % Q*)	744,55	687,27	m³/h
	0,207	0,191	m³/s
- Water level inside settlers / **W.L. - 1** :	**550,63**	**550,63**	**m.a.s.l.**
- Overflowing nappe (***h***)	0,08	0,08	m
- Metallic Plate Crest elevation (**P.C.E**) :	**550,55**	**550,55**	**m.a.s.l.**
- AISI 316 L Channel Crest Elevation (***C.C.E.***):	**550,50**	**550,50**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a)	0,18	0,18	m
- Total Head Loss ($\Delta H = h + r_a$)	***0,26***	***0,26***	***m***
- Water level in collection channel / **W.L. - 2** :	***550,37***	***550,37***	**m.a.s.l.**
- Design maximum overflow (*100 % Q*)	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Water level inside settlers / **W.L. - 1** :	**550,65**	**550,65**	**m.a.s.l.**
- Overflowing nappe (***h***)	0,10	0,10	m
- Metallic Plate Crest elevation (**P.C.E.**) :	**550,55**	**550,55**	**m.a.s.l.**
- AISI 316 L Channel Crest Elevation (***C.C.E.***):	**550,50**	**550,50**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a)	0,18	0,18	m
- Total Head Loss ($\Delta H = h + r_a$)	***0,28***	***0,28***	***m***
- Water level in collection channel / **W.L. - 2** :	***550,37***	***550,37***	**m.a.s.l.**



4.10. - Lammella packages - Automatic cleaning system

- Type:	Tubjet	
- No of systems per tank:	1	ut
- Total number of systems to be installed:	22	uts
- No of systems simultaneously on duty:	2	uts
- Mobile frame asembly::	High grade SS	
- Electrical power suply:	Automatic cable reel system	ut
- Water supply:	Centrifugal multistage pump	
- No of punmps per system:	1	ut
- Unit capacity: :	60,00	m³/h
- Head:	1,40	bar
- Rated power:	4,50	kW

ANNEX II

HYDRAULICS

GHRMAGHELE DWTP LAMELLA SETTLING

EXISTING FACILITIES UPGRADING

HYDRAULIC CALCULATIONS

1. DESIGN DATA

	Future flow		Current flow	
- Treatment capacity:	23.400,00		21.600,00	m³/h
	6,50		6,00	m³/s
- Number of lines :		2		uts
- Number of settlers per line :				
• Line 1:		10		uts
• Line 2:		12		uts
- Flow distribution per line :				
◊ Line 1 - 10 Settlers: :	10.636		9.818	m³/h
	2.955		2.727	l/s
◊ Line 2 - 12 Settlers: :	12.764		11.782	m³/h
	3.545		3.273	l/s

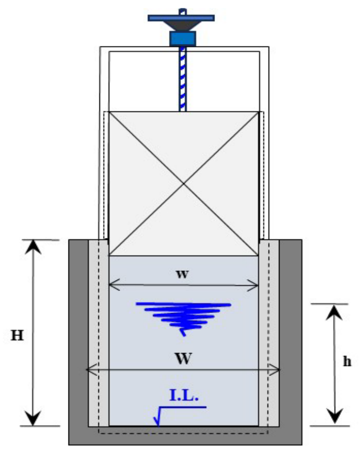
	Future flow	Current flow	
- Water level at lower zone of general main distribution channels:	**551,15**	**551,14**	m.a.s.l.

2. INLET CHAMBERS

2.1. - Inlet penstocks headloss

	Future flow		Current flow	
- Total flow:	23.400,00		21.600,00	m³/h
	6,50		6,00	m³/s
- No of rows / settlers:	22		22	uts
- Flow per tank:	1.063,64		981,82	m³/h
	0,295		0,273	m³/s
- Type:	Slide Pestock - Manual operated			
- No. of penstocks per settler :		1		ut
- Channel unitary dimensions :				
• Overall width (***W***):		0,70		m
• Penstock useful width (***w***):		0,70		m
• Height (H)		1,00		m
• Penstock height :		1,00		m
• Water depth:	0,65		0,64	m
- Inlet velocity:	0,65		0,61	m/s
- Penstock invert level (*I.L.*)	**550,50**		**550,50**	**m.s.n.m.**
- Head losses				
• Head loss coefficient (***K***)		1,50		
• $\Delta H = K \times V^2 / 2g$	***0,03***		***0,03***	***m***

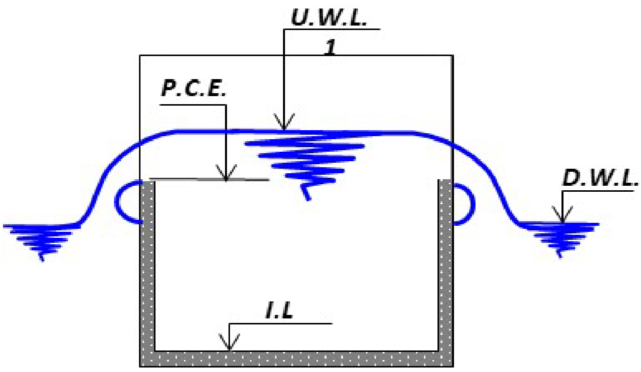
	Future flow	Current flow	
Water Level at distribution weir-channel	**551,12**	**551,11**	m.a.s.l.



	Future flow	Current flow	
Water Level at distribution weir-channel	551,12	551,11	m.a.s.l.

2.2. - Splitting weir-channel

	Future flow	Current flow	
- Flow splitting :	Overflow weir-channel		
- Overflowing :	Sharp Crested		
- Nº of distribution channels per unit:	1		ut
- Channel length:	2,00		m
- Total overflowing weir length (L_v):	4,00		m
- Weir type:	Suppressed rectangular		
- Maximum overflow :	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Upstream water level (*U.W.L.*) :	**551,12**	**551,11**	**m.a.s.l.**
- Overflowing nappe (*h*) :	0,12	0,11	m
- Metallic Plate Crest elevation (**P.C.E.**) :	**551,00**	**551,00**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a) :	0,08	0,09	m
- Total Head Loss ($\Delta H = h + r_a$) :	0,20	0,20	m
- Downstream water level (*D.W.L.*) :	***550,92***	***550,91***	**m.a.s.l.**

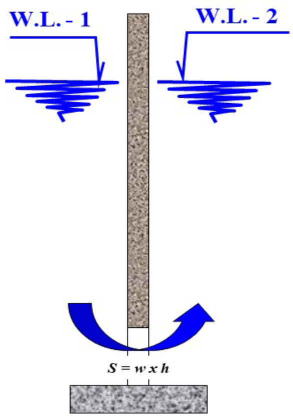


	Future flow	Current flow	
Water level at splitting chambers	550,92	550,91	m.a.s.l.

3. FLASH MIXING CHAMBERS

3.1. - Flash mixing inlet

	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of flash mixing chambers per tank:	2	2	uts
- Flow per chamber	531,82	490,91	m³/h
- No of inlet holes per chamber:	1	1	ut
- Flow per hole (*Q*)	531,82	490,91	m³/h
- Main dimensions:			
• Hole width (*w*):	0,60	0,60	m
• Hole height (*h*):	0,60	0,60	m
• Velocity through hole ($V = Q / [w \times h]$)	0,41	0,38	m/s
- Head losses			
• Head loss coefficient (*K*)	2,50	2,50	
• $\Delta H = K \times V^2 / 2g$	***0,02***	***0,02***	***m***

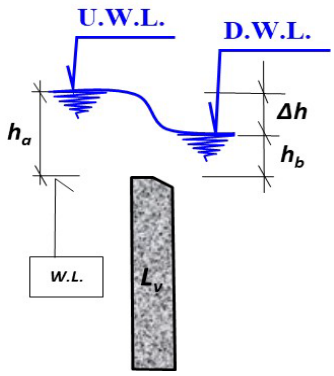


	Future flow	Current flow	
Water level at flash mixing chambers	550,90	550,89	m.a.s.l.

	Future flow	Current flow	
Water level at flash mixing chambers	**550,90**	**550,89**	m.a.s.l.

3.2 - Flash mixing chambers overflowing

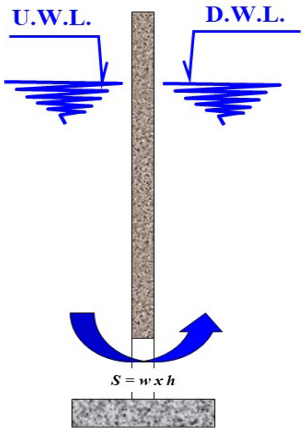
	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of flash mixing chambers per tank:	2	2	uts
- Chamber overflowing:	Sharp Crested Weir		
- Type :	Thin plate weir - Submerged nappe		
- Nº of overflow weirs per unit:	1		ut
- Overflowing weir length (L_v)	2,00		m
- Maximum overflow per weir:	531,82	490,91	m³/h
	0,148	0,136	m³/s
- Upstream water level (*U.W.L.*) :	**550,90**	**550,89**	**m.a.s.l.**
- Upstream nappe height (h_a):	0,35	0,34	m
- Weir level (*W.L.*) :	**550,55**	**550,55**	**m.a.s.l.**
- Overflow in a free nappe weir :	2.740,48	2.623,88	m³/h
- Downstream nappe height (h_b) :	0,35	0,34	
- Total Head Loss ($\Delta H = h_a - h_b$) :	0,00	0,00	m
- Downstream water level (*D.W.L.*) :	***550,90***	***550,89***	**m.a.s.l.**



	Future flow	Current flow	
Water level at flash mixing chamber outlet	**550,90**	**550,89**	m.a.s.l.

3.3. - Flocculation chamber inlet - submerged hole

	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of flocculation chambers per tank:	1	1	ut
- Flow per chamber	1.063,64	981,82	m³/h
- No of inlet holes per chamber:	1	1	ut
- Flow per hole (*Q*)	1.063,64	981,82	m³/h
- Hole dimensions:			
• Hole width (*w*):	5,75	5,75	m
• Hole height (*h*):	0,50	0,50	m
• Velocity through hole ($V = Q / [w \times h]$)	0,10	0,09	m/s
- Head losses			
• Head loss coefficient (*K*)	2,50	2,50	
• $\Delta H = K \times V^2 / 2g$	***0,00***	***0,00***	***m***



	Future flow	Current flow	
Water level at 1st compartment of flocculation chambers	**550,90**	**550,89**	m.a.s.l.

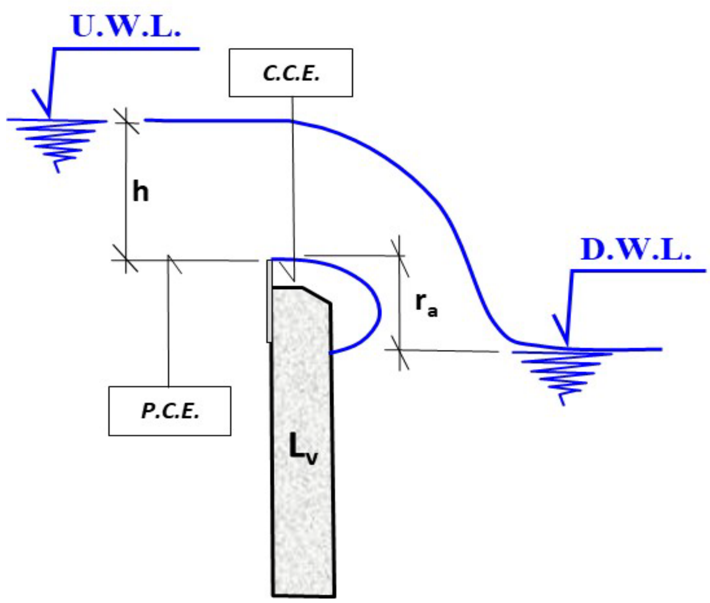
	Future flow	Current flow	
Water level at 1st compartment of flocculation chambers	550,90	550,89	m.a.s.l.

4. FLOCCULATION CHAMBERS

4.1. - Flocculation chambers - 1st compartment overflowing

	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of flocculation chambers per tank:	1	1	ut
- Chamber overflowing:	Sharp Crested - Adjustable plate		
- Type :	Thin plate weir - Free nappe		
- Nº of overflow weirs per unit:	1		ut
- Overflowing weir length (L_v):	5,75		m
- Weir type:	Suppressed rectangular		
- Maximum overflow per weir:	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Upstream water level (*U.W.L.*) :	**550,90**	**550,89**	**m.a.s.l.**
- Overflowing nappe height (*h*) :	0,10	0,09	m
- Metallic Plate Crest elevation (**P.C.E.**) :	**550,80**	**550,80**	**m.a.s.l.**
- Concrete Crest Elevation (**C.C.E.**) :	**550,75**	**550,75**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a) :			
• 50 % Q removed in static zone:	0,18	0,18	m
• 30 % Q removed in static zone:	0,16	0,16	m
• 0 % Q removed in static zone:	0,14	0,14	m
- Total Head Loss ($\Delta H = h + r_a$) :			
• 50 % Q removed in static zone:	***0,28***	***0,27***	***m***
• 30 % Q removed in static zone:	***0,26***	***0,25***	***m***
• 0 % Q removed in static zone:	***0,24***	***0,23***	***m***

	Future flow	Current flow	
Water level at 2nd compartment of flocculation chambers (D.W.L.)			
• 50 % Q removed in static zone:	**550,62**	**550,62**	m.a.s.l.
• 30 % Q removed in static zone:	**550,64**	**550,64**	m.a.s.l.
• 0 % Q removed in static zone:	**550,66**	**550,66**	m.a.s.l.

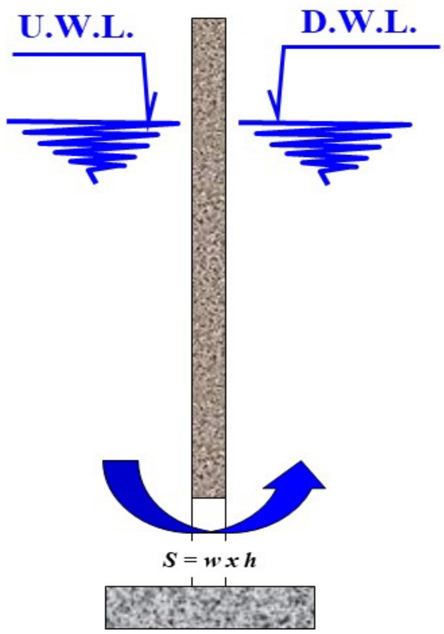


	Future flow	Current flow	
Water level at 2nd compartment of flocculation chambers (U.W.L.)			
• 50 % Q removed in static zone:	550,62	550,62	m.a.s.l.
• 30 % Q removed in static zone:	550,64	550,64	m.a.s.l.
• 0 % Q removed in static zone:	550,66	550,66	m.a.s.l.

4.2. - Flocculation chamber - 2nd compartment outlet - Submerged hole

	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of flocculation chambers per tank:	1	1	ut
- Flow per chamber	1.063,64	981,82	m³/h
- No of outlet holes per chamber:	1	1	ut
- Flow per hole (*Q*)	1.063,64	981,82	m³/h
- Hole dimensions:			
• Hole width (*w*):	5,75	5,75	m
• Hole height (*h*):	0,50	0,50	m
• Velocity through hole ($V = Q / [w \times h]$)	0,10	0,09	m/s
- Head losses			
• Head loss coefficient (*K*)	2,50	2,50	
• $\Delta H = K \times V^2 / 2g$	***0,00***	***0,00***	***m***

	Future flow	Current flow	
Water level at intermediate baffle (D.W.L.)			
• 50 % Q removed in static zone:	550,62	550,62	m.a.s.l.
• 30 % Q removed in static zone:	550,64	550,64	m.a.s.l.
• 0 % Q removed in static zone:	550,66	550,66	m.a.s.l.



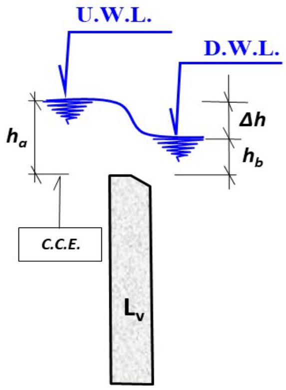
	Future flow	Current flow	
Water levels at static settling zone intermediate baffle (U.W.L.)			
• 50 % Q removed in static zone:	550,62	550,62	m.a.s.l.
• 30 % Q removed in static zone:	550,64	550,64	m.a.s.l.
• 0 % Q removed in static zone:	550,66	550,66	m.a.s.l.

5. STATIC SETTLEMENT ZONE

5.1. - Inlet weir

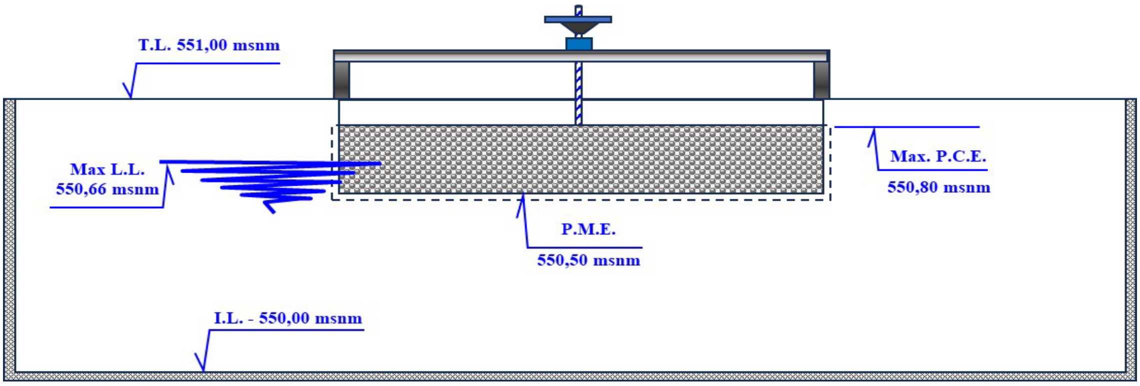
	Future flow	Current flow	
	23.400,00	21.600,00	m³/h
- Total flow:	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
- No of static zones per tank:	1	1	uts
- Static zone inlet:	Sharp Crested Weir		
- Type :	Thin plate weir - Submerged nappe		
- Nº of overflow weirs per unit:	1		ut
- Overflowing weir length (L_v)	5,75		m
- Maximum overflow per weir:	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Upstream water level (*U.W.L.*) :			
• 50 % Q removed in static zone:	**550,62**	**550,62**	**m.a.s.l.**
• 30 % Q removed in static zone:	**550,64**	**550,64**	**m.a.s.l.**
• 0 % Q removed in static zone:	**550,66**	**550,66**	**m.a.s.l.**
- Upstream nappe height (h_a):			
• 50 % Q removed in static zone:	0,32	0,32	m
• 30 % Q removed in static zone:	0,34	0,34	m
• 0 % Q removed in static zone:	0,36	0,36	m
- Concrete Crest Elevation (*C.C.E.*)	**550,30**	**550,30**	**m.a.s.l.**
- Overflow in a free nappe weir :			
• 50 % Q removed in static zone:	6.887,92	6.887,92	m³/h
• 30 % Q removed in static zone:	7.543,65	7.543,65	m³/h
• 0 % Q removed in static zone:	8.218,96	8.218,96	m³/h
- Downstream nappe height (h_b):			
• 50 % Q removed in static zone:	0,32	0,32	m
• 30 % Q removed in static zone:	0,34	0,34	m
• 0 % Q removed in static zone:	0,36	0,36	m
- Total Head Loss ($\Delta H = h_a - h_b$)			
• 50 % Q removed in static zone:	0,00	0,00	m
• 30 % Q removed in static zone:	0,00	0,00	m
• 0 % Q removed in static zone:	0,00	0,00	m

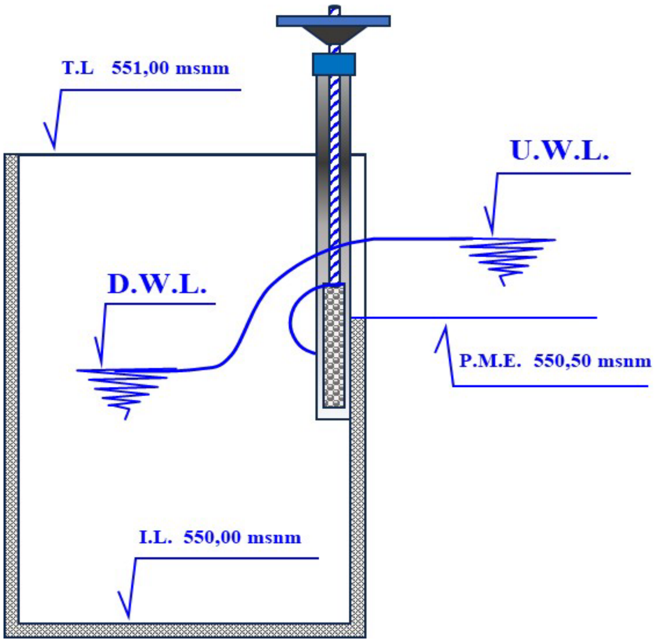
	Future flow	Current flow	
Water levels at static settling zone inlet (D.W.L.)			
• 50 % Q removed in static zone:	550,62	550,62	m.a.s.l.
• 30 % Q removed in static zone:	550,64	550,64	m.a.s.l.
• 0 % Q removed in static zone:	550,66	550,66	m.a.s.l.



5.2. -Overflowing weir & Cross collection channel design data

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22		uts
- Flow to be removed from static zone :	**0 ÷ 50**		%
- Settled water collection system:	Cross collection channel		
- Nº of overflow cross collection channels per unit:	1		uts
- Total number of overflowing channels:	22		uts
- Cross collection channel width:	**0,60**		m
- Cross collection channel length:	**5,75**		m
- Maximum flow percentage to be removed:	**50,00 %**		
- Maximum flow to be removed per unit (**Q**):	531,82	490,91	m³/h
	0,148	0,136	m³/s
- Average flow percentage to be removed :	**30,00 %**		
- Average flow to be removed per unit (**Q**):	319,09	294,55	m³/h
	0,089	0,082	m³/s
- Critical depth in the collection channel:	19	18	cm
- Critical depth in the collection channel:	14	13	cm
- Overflowing :	Adjustable overflow weirs		
- Type of weir:	Sharp Crested - Free nappe		
- Nº of overflow weirs per unit:	1		uts
- Overflowing weir length per channel (L_v)	2,40		m
- Weir type:	Contracted rectangular		
- Weir position drive:	Manual operated		
- Water level levels in lamella settling zone :			
• 50 % Q:	**550,61**	**550,61**	**m.a.s.l.**
• 30 % Q:	**550,63**	**550,63**	**m.a.s.l.**
• 0 % Q:	**550,65**	**550,65**	**m.a.s.l.**
- Headlosses across lamela settling zone :	0,01	0,01	m
- Water levels inside static settling zone :			
• 50 % Q:	**550,62**	**550,62**	**m.a.s.l.**
• 30 % Q:	**550,64**	**550,64**	**m.a.s.l.**
• 0 % Q:	**550,66**	**550,66**	**m.a.s.l.**
- Overflowing nappe (h)			
• 50 % Q:	0,10	0,10	m
• 30 % Q:	0,07	0,07	m
• 0 % Q:	0,00	0,00	m
- Hydraulic guard over maximum water level	0,14	0,14	m
- Metallic Plate crest minimum elevation (***P.M.E.***) :	**550,50**	**550,50**	**m.a.s.l.**
- Metallic Plate Crest elevation (***P.C.E.***) :			
• 50 % Q:	**550,52**	**550,52**	**m.a.s.l.**
• 30 % Q:	**550,57**	**550,57**	**m.a.s.l.**
• 0 % Q:	**550,80**	**550,80**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a)			
• 50 % Q:	0,12	0,12	m
• 30 % Q:	0,18	0,19	m





	Future flow	Current flow	
- Total Head Loss ($\Delta H = h + r_a$)			
• 50 % Q:	*0,22*	*0,22*	
• 30 % Q:	*0,23*	*0,24*	*m*
- Cross collection channels invert level / ***I.L.*** :	*550,00*	*550,00*	m.a.s.l.
- Cross collection channels top level / T.***L.*** :	*551,00*	*551,00*	m.a.s.l.

	Future flow	Current flow	
Water level at high zone of cross collection channels (D.W.L.)			
• 50 % Q:	**550,40**	**550,40**	m.a.s.l.
• 30 % Q:	**550,39**	**550,38**	m.a.s.l.

	Future flow	Current flow	
Water level at high zone of cross collection channels			
• 50 % Q:	550,40	550,40	m.a.s.l.
• 30 % Q:	550,39	550,38	m.a.s.l.

5.3. - Cross collection channels head losses

$$V = \frac{1}{\eta} R_h^{2/3} i^{1/2}$$

Manning - Strickler

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
- No of rows / settlers:	22		uts
- Flow per row (*Q*) :			
‣ *50 % Q* :	531,82	490,91	m³/h
	0,148	0,136	m³/s
‣ *30 % Q* :	319,09	294,55	m³/h
	0,089	0,082	m³/s
- Type of channel:	Rectangular cross section		
- Material :	AISI 316 L - SS		
- Channel characteristics :			
• Width (*W*) :	0,60	0,60	m
• Height (*H*) :	1,00	1,00	m
• Critical depths (*hc*) :			
‣ *50 % Q* :	0,19	0,18	m
‣ *30 % Q* :	0,14	0,13	m
• Water depths (*h*) :			
‣ *50 % Q* :	0,40	0,40	m
‣ *30 % Q* :	0,39	0,38	m
- Cross Collection Channel Invert Level :	**550,00**	**550,00**	**msnm**
- Manning coefficient (η) :	0,0105	0,0105	
- Cross sectional area ($S = w \times h$) :			
‣ *50 % Q* :	0,24	0,24	m²
‣ *30 % Q* :	0,23	0,38	m²
- Perimeter ($P_m = w + 2 \times h$) :			
‣ *50 % Q* :	1,40	1,40	m
‣ *30 % Q* :	1,38	1,36	m
- Hydraulic Radius ($R_h = S / P_m$) :			
‣ *50 % Q* :	0,17	0,17	m
‣ *30 % Q* :	0,17	0,28	m
- Velocity ($V = Q / S$) :			
‣ *50 % Q* :	0,62	0,57	m/s
‣ *30 % Q* :	0,38	0,22	m/s
- Channel length (*L*) :	**5,75**	**5,75**	**m**
- Gradient ($i = [V \times \eta / R_h^{2/3}]^2$) :			
‣ *50 % Q* :	4,39E-04	3,74E-04	m/m
‣ *30 % Q* :	1,69E-04	2,80E-05	m/m

I) Major (friction) head losses ($\Delta H_L = L \times i$)

‣ *50 % Q* :	***0,00***	***0,00***	***m***
‣ *30 % Q* :	***0,00***	***0,00***	***m***

II) Minor (local) head losses

Singularities	Nº Uds (n_i)	Coef. ud (k_i)	$n_i \times k_i$
• *Streams joining*	1	0,50	0,50
• *Discharge*	1	0,15	0,15
	Coeficiente total ($K_T = \Sigma n_i k_i$) =		***0,65***

$\Delta H_S = K_T \times V^2 / 2g$

• 50 % Q:	***0,01***	***0,01***	***m***
• 30 % Q:	***0,01***	***0,00***	***m***

Total head losses in static zone cross collection channels (I + II)

• 50 % Q:	***0,01***	***0,01***	***m***
• 30 % Q:	***0,01***	***0,00***	***m***

	Future flow	Current flow	
Water levels at low zone of cross collection channels			
• 50 % Q:	550,39	550,39	m.a.s.l.
• 30 % Q:	550,38	550,38	m.a.s.l.

	Future flow	Current flow	
Water levels at low zone of cross collection channels			
• **50 % Q:**	**550,39**	**550,39**	**m.a.s.l.**
• **30 % Q:**	**550,38**	**550,38**	**m.a.s.l.**

5.4. - Static settlement zone overflowing to final discharge - Lateral collection channels dessign data

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22		uts
- Flow to be removed from static zone :	**0 ÷ 50**		%
- Settled water collection to final discharge channel:	Lateral collection channel		
- No of lateral collecytion channels per settler:	1		ut
- Total No of lateral collection channels:	22		uts
- Lateral collection channel width:	**0,75**		m
- Lateral collection channel length:	**19,00**		m
- Maximum flow percentage to be removed :	**50,00 %**		
- Maximum flow to be removed per unit (**Q**):	531,82	490,91	m³/h
	0,148	0,136	m³/s
- Average flow perrcentage to be removed :	**30,00 %**		
- Average flow to be removed per unit (**Q**):	319,09	294,55	m³/h
	0,089	0,082	m³/s
- Critical water depths in static zone overflowing lateral collection channel:			
• ***50 % Q:***	16	15	cm
• ***30 % Q:***	12	11	cm
- Critical water levels in lateral collection channels :			
• ***50 % Q:***	***550,16***	***550,15***	**m.a.s.l.**
• ***30 % Q:***	***551,12***	***551,11***	**m.a.s.l.**
- Water levels at high zone of static zone overflowing lateral collection channels:			
• ***50 % Q:***	***550,39***	***550,39***	**m.a.s.l.**
• ***30 % Q:***	***550,38***	***550,38***	**m.a.s.l.**
- Water levels at low zone of lateral collection channels:	***550,37***	***550,37***	**m.a.s.l.**
- Lateral collection channels invert level / ***I.L.*** :	***550,00***	***550,00***	**m.a.s.l.**
- Lateral collection channels top level / ***T.L.*** :	***551,00***	***551,00***	**m.a.s.l.**
- Static zone cross collection channels invert level / ***I.L.***	***550,00***	***550,00***	**m.a.s.l.**
- Static zone cross collection channels top level / ***T.L.***	***551,00***	***551,00***	**m.a.s.l.**
- Critical water levels in static zone overflowing cross collection channel:			
• ***50 % Q:***	***550,19***	***550,18***	**m.a.s.l.**
• ***30 % Q:***	***550,14***	***550,13***	**m.a.s.l.**

	Future flow	Current flow	
Water levels at high zone of lateral collection channels			
• **50 % Q:**	**550,39**	**550,39**	**m.a.s.l.**
• **30 % Q:**	**550,38**	**550,38**	**m.a.s.l.**

	Future flow	Current flow	
Water levels at high zone of lateral collection channels			
• 50 % Q:	550,39	550,39	m.a.s.l.
• 30 % Q:	550,38	550,38	m.a.s.l.

5.5 - Lateral collection channels head losses

$$V = \frac{1}{\eta} R_h^{2/3} i^{1/2}$$

Manning - Strickler

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
- No of rows / settlers:	22		uts
- Flow per row (*Q*) :			
‣ *50 % Q* :	531,82	490,91	m³/h
	0,148	0,136	m³/s
‣ *30 % Q* :	319,09	294,55	m³/h
	0,089	0,082	m³/s
- Type of channel:	Rectangular cross section		
- Material :	AISI 316 L - SS		
- Channel characteristics :			
• Width (*w*) :	0,75	0,75	m
• Height (*H*) :	1,00	1,00	m
• Critical depths (*hc*) :			
‣ *50 % Q* :	0,16	0,15	m
‣ *30 % Q* :	0,12	0,11	m
• Water depths (*h*) :			
‣ *50 % Q* :	0,39	0,39	m
‣ *30 % Q* :	0,38	0,38	m
- Lateral Channel Invert Level :	**550,00**	**550,00**	**msnm**
- Manning coefficient (η) :	0,0105	0,0105	
- Cross sectional area ($S = w \times h$) :			
‣ *50 % Q* :	0,29	0,29	m²
‣ *30 % Q* :	0,29	0,38	m²
- Perimeter ($P_m = w + 2 \times h$) :			
‣ *50 % Q* :	1,53	1,53	m
‣ *30 % Q* :	1,51	1,51	m
- Hydraulic Radius ($R_h = S / P_m$) :			
‣ *50 % Q* :	0,19	0,19	m
‣ *30 % Q* :	0,19	0,25	m
- Velocity ($V = Q / S$) :			
‣ *50 % Q* :	0,51	0,47	m/s
‣ *30 % Q* :	0,31	0,22	m/s
- Channel length (*L*) :	**19,00**	**19,00**	**m**
- Gradient ($i = [\, V \times \eta / R_h^{2/3} \,]^2$) :			
‣ *50 % Q* :	2,55E-04	2,18E-04	m/m
‣ *30 % Q* :	9,85E-05	3,22E-05	m/m

I) Major (friction) head losses ($\Delta H_L = L \times i$)

‣ *50 % Q* :	***0,00***	***0,00***	***m***
‣ *30 % Q* :	***0,00***	***0,00***	***m***

II) Minor (local) head losses

Singularities	Nº Uds (n_i)	Coef. ud (k_i)	$n_i \times k_i$
• *Direction change*	1	1,15	1,15
• *Discharge*	1	0,15	0,15
	Coeficiente total ($K_T = \Sigma\, n_i\, k_i$) =		***1,30***

$\Delta H_S = K_T \times V^2 / 2g$

• 50 % Q:	***0,02***	***0,02***	***m***
• 30 % Q:	***0,01***	***0,01***	***m***

Total head losses in lateral collection channels (I + II)

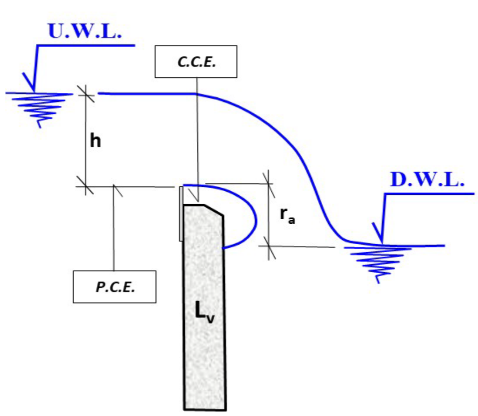
• 50 % Q:	***0,02***	***0,02***	***m***
• 30 % Q:	***0,01***	***0,01***	***m***

	Future flow	Current flow	
Water level at high zone of final discharge cross collection channels	550,37	550,37	m.a.s.l.

	Future flow	Current flow	
Water level at lamella settling zone			
• 50 % oveflow at static zone :	550,61	550,61	m.a.s.l.
• 30 % oveflow at static zone :	550,63	550,63	m.a.s.l.
• 0 % oveflow at static zone :	550,65	550,65	m.a.s.l.

6. LAMELLA SETTLEMENT ZONE

	Future flow	Current flow	
6.1.- Lamella settlement outlet - Overflowing weir			
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:			
• 50 % oveflowing at static zone :	531,82	490,91	m³/h
• 30 % oveflowing at static zone :	744,55	687,27	m³/h
• 0 % oveflowing at static zone :	1.063,64	981,82	m³/h
- Lamella settlement zone overflowing:	Sharp Crested - Adjustable plate		
- Type :	Thin plate weir - Free nappe		
- Nº of overflow weirs per zone:	1		ut
- Overflowing weir length (L_v):	**5,00**		m
- Weir type:	Suppressed rectangular		
- Maximum overflow per weir:			
• 50 % oveflowing at static zone :	531,82	490,91	m³/h
	0,148	0,136	m³/s
• 30 % oveflowing at static zone :	744,55	687,27	m³/h
	0,207	0,191	m³/s
• 0 % oveflowing at static zone :	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Upstream water level (***U.W.L.***) :			
• 50 % oveflowing at static zone :	**550,61**	**550,61**	**m.a.s.l.**
• 30 % oveflowing at static zone :	**550,63**	**550,63**	**m.a.s.l.**
• 0 % oveflowing at static zone :	**550,65**	**550,65**	**m.a.s.l.**
- Overflowing nappe (***h***)			
• 50 % oveflowing at static zone :	0,06	0,06	m
• 30 % oveflowing at static zone :	0,08	0,08	m
• 0 % oveflowing at static zone :	0,10	0,10	m
- Metallic Plate Crest elevation (***P.C.E.***) :	**550,55**	**550,55**	**m.a.s.l.**
- AISI 316 L Channel Crest Elevation (***C.C.E.***):	**550,50**	**550,50**	**m.a.s.l.**
- Nappe aeration - Safety clearance (r_a):	0,18	0,18	m
- Total Head Loss ($\Delta H = h + r_a$)			
• 50 % oveflowing at static zone :	***0,24***	***0,24***	***m***
• 30 % oveflowing at static zone :	***0,26***	***0,26***	***m***
• 0 % oveflowing at static zone :	***0,28***	***0,28***	***m***
- Downstream water level (***D.W.L.***) :	***550,37***	***550,37***	**m.a.s.l.**



Future flow Current flow

Water level at high zone of final discharge cross collection channels	**550,37**	**550,37**	**m.a.s.l.**

	Future flow	Current flow	
Water level at high zone of final discharge cross collection channels	**550,37**	**550,37**	**m.a.s.l.**

6.2. - Final discharge cross collection channels

$$V = \frac{1}{\eta} R_h^{2/3} i^{1/2}$$

Manning - Strickler

	Future flow	Current flow	
- Total Design Flows:	23.400	21.600	m³/h
- No of rows / settlers:	22		uts
- Flow per row (***Q***) :	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Flow demi-channel - Half flow per row (***Q/2***) :	531,82	490,91	m³/h
	0,148	0,136	m³/s
- Type of channel:	Rectangular cross section		
- Material :	AISI 316 L - SS		
- Channel characteristics :			
• Width (***w***) :	1,00	1,00	m
• Height (***H***) :	1,30	1,30	m
• Critical depth (***hc***) :	0,14	0,13	m
• Water depth (***h***) :	0,67	0,67	m
- Channel Invert Level :	**549,70**	**549,70**	**msnm**
- Manning coefficient (η) :	0,0105	0,0105	
- Cross sectional area ($S = w \times h$) :	0,67	0,67	m²
- Perimeter ($P_m = w + 2 \times h$) :	2,34	2,34	m
- Hydraulic Radius ($R_h = S / P_m$) :	0,29	0,29	m
- Velocity ($V = Q / S$) :	0,22	0,20	m/s
- Demi-channel length (***L***) :	**2,875**	**2,875**	**m**
- Gradient ($i = [\, V \times \eta / R_h^{2/3} \,]^2$) :	2,84E-05	2,42E-05	m/m
I) Major (friction) head losses ($\Delta H_L = L \times i$)	***0,00***	***0,00***	***m***

II) Minor (local) head losses

Singularities	Nº Uds (n_i)	Coef. ud (k_i)	$n_i \times k_i$
• *Streams joining*	1	1,10	1,10
• *Flow splitting*	1	1,20	1,20
	Coeficiente total ($K_T = \Sigma\, n_i\, k_i$) =		***2,30***

	Future flow	Current flow	
$\Delta H_S = K_T \times V^2 / 2g$	***0,01***	***0,01***	***m***
Total head losses in final discharge channels (I + II)	***0,01***	***0,01***	***m***

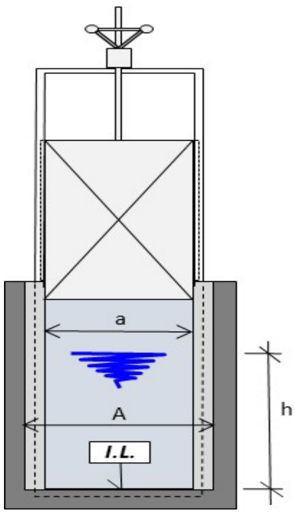
	Future flow	Current flow	
Water level at low zone of settled water discharge cross collection channels	**550,36**	**550,36**	**m.a.s.l.**

	Future flow	Current flow	
Water level at low zone of settled water discharge cross collection channels	**550,36**	**550,36**	m.a.s.l.

6.3. - Outlet penstocks head loss

	Future flow	Current flow	
- Total flow:	23.400,00	21.600,00	m³/h
	6,50	6,00	m³/s
- No of rows / settlers:	22	22	uts
- Flow per tank:	1.063,64	981,82	m³/h
	0,295	0,273	m³/s
- Type:	Slide Pestock - Manual operated		
- No. of penstocks per settler :	2		uts
- Channel unitary dimensions :			
• Width:	0,70		m
• Height:	1,35		m
• Penstock height:	0,80		m
• Water depth:	0,66	0,66	m
- Outlet velocity:	0,32	0,30	m/s
- Penstock invert level (*I.L.*)	**549,70**	**549,70**	**m.a.s.l.**
- Head losses			
• Head loss coefficient (*K*)	1,50		
• $\Delta H = K \times V^2 / 2g$	***0,01***	***0,01***	***m***

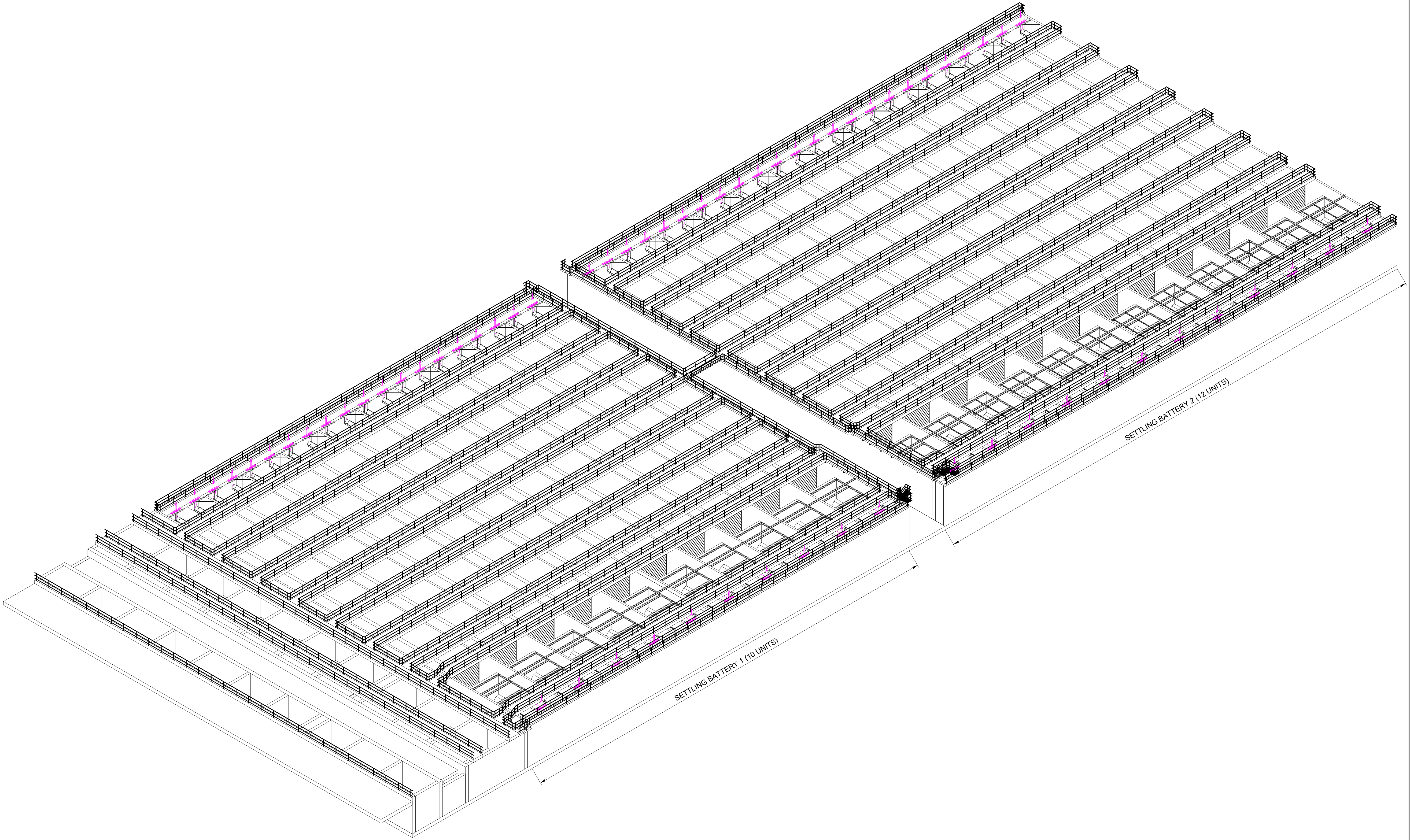
	Future flow	Current flow	
Water Level at general settled water channel	**550,35**	**550,35**	m.a.s.l.



ANNEX III

DRAWINGS

FILE: GHR-DWG-ME-00-0001 SHEET: GHR-DWG-ME-00-0001 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)



ISOMETRIC VIEW
SCALE 1:200

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

DATE: SEPTEMBER 2025

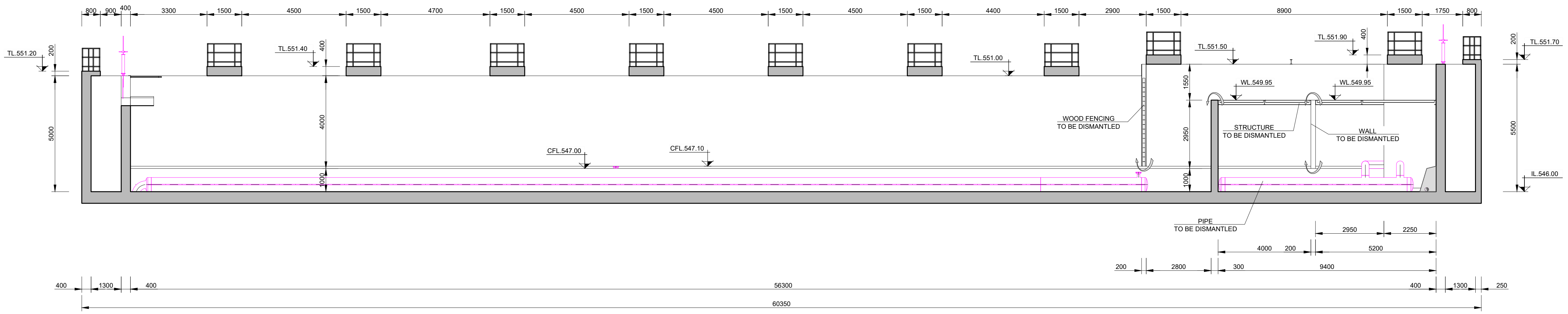
PROJECT TITLE: GHRMAGHELE DWTP
SETTLEMENT EXISTING FACILITIES UPGRADING

DRAWING TITLE: SETTLING BATTERIES
CURRENT STATUS
ISOMETRIC VIEW

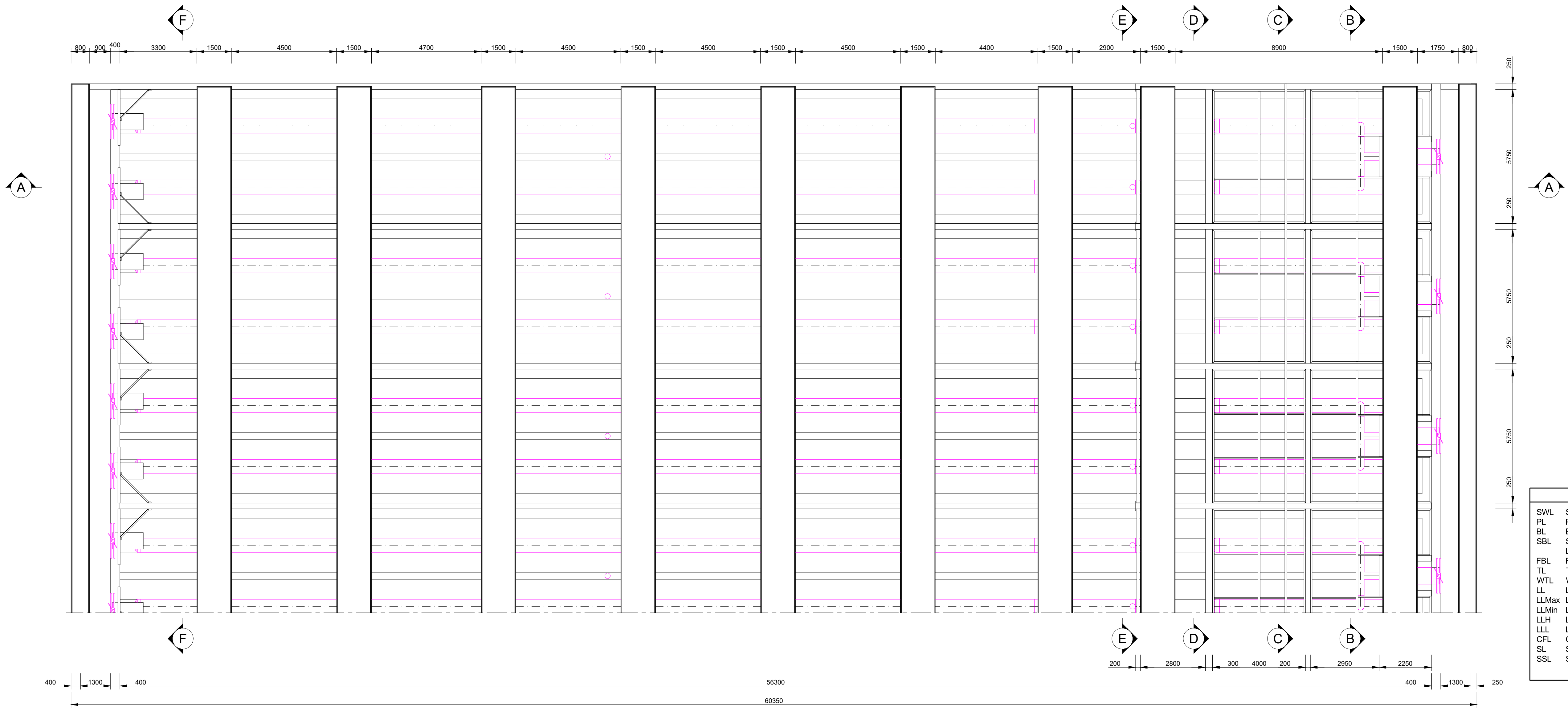
SCALE (DIN A1): 1:200

DRAWING No: GHR-DWG-ME-00-0001

FILE: GHR-DWG-ME-00-0001 SHEET: GHR-DWG-ME-00-0002 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)



SECTION A-A
SCALE 1:100



PLAN VIEW
SCALE 1:100

LEVELS ACRONYMS			
SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

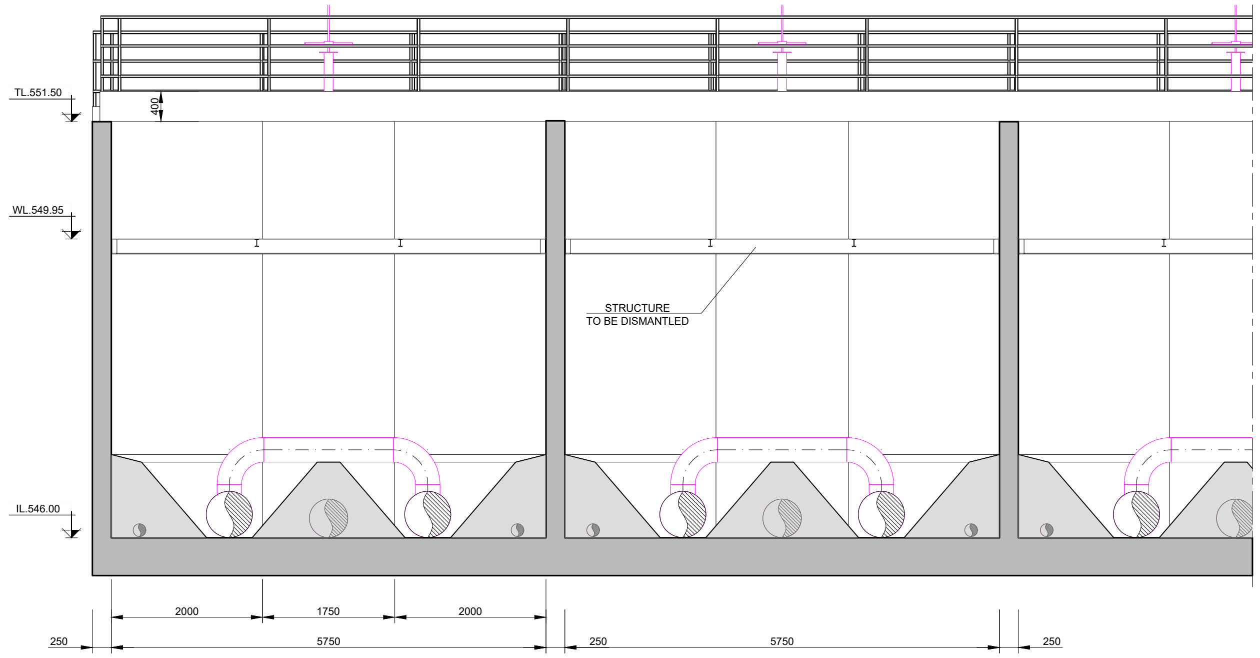
DATE: SEPTEMBER 2025

PROJECT TITLE: GHRMAGHELE DWTP SETTLEMENT EXISTING FACILITIES UPGRADING

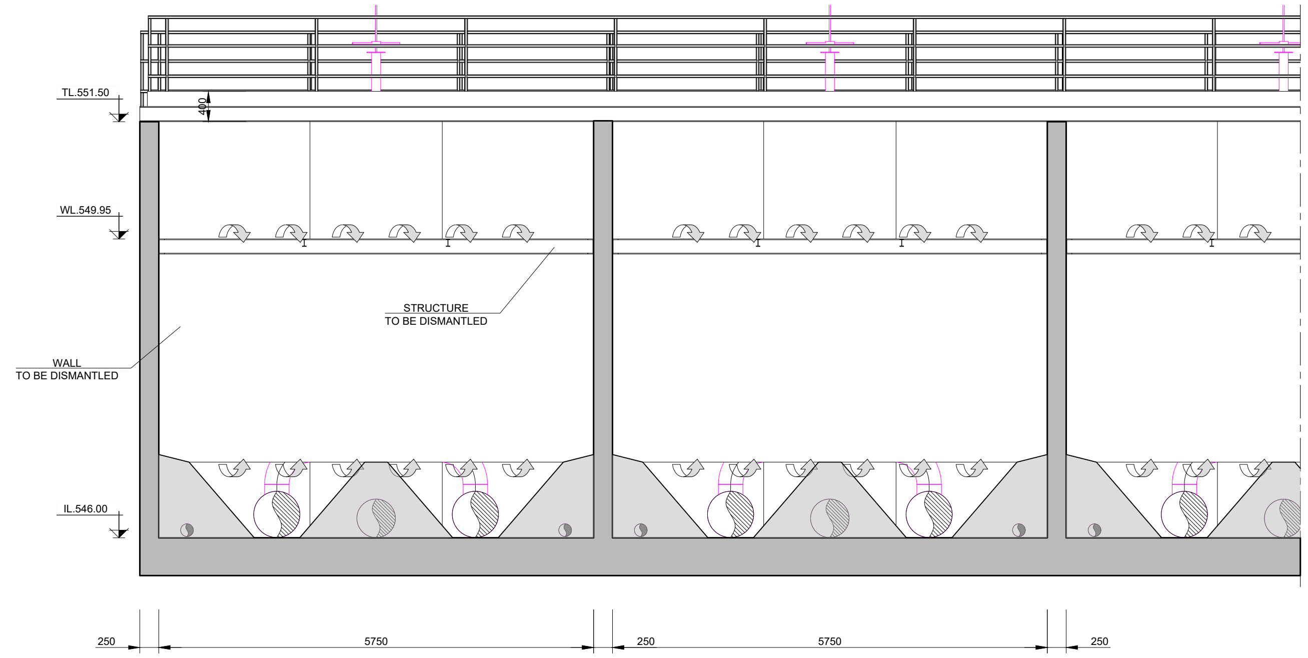
DRAWING TITLE: EXISTING SETTLERS CURRENT STATUS PLAN VIEW Y SECTION

SCALE (DIN A1): 1:100

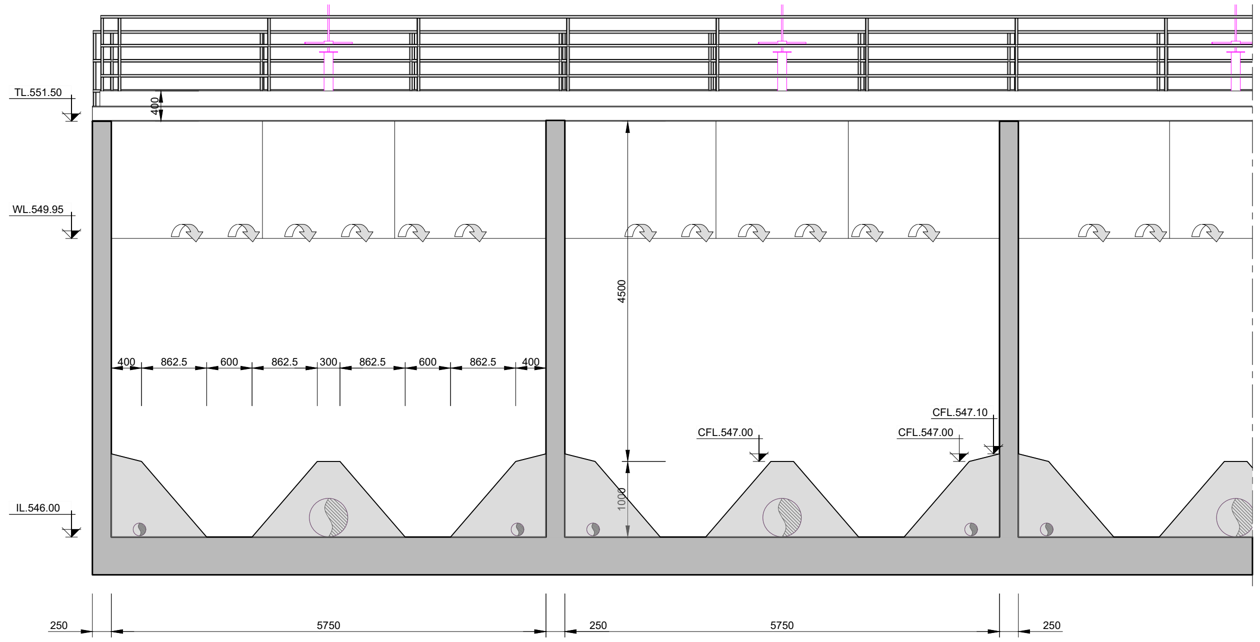
DRAWING No: GHR-DWG-ME-00-0002



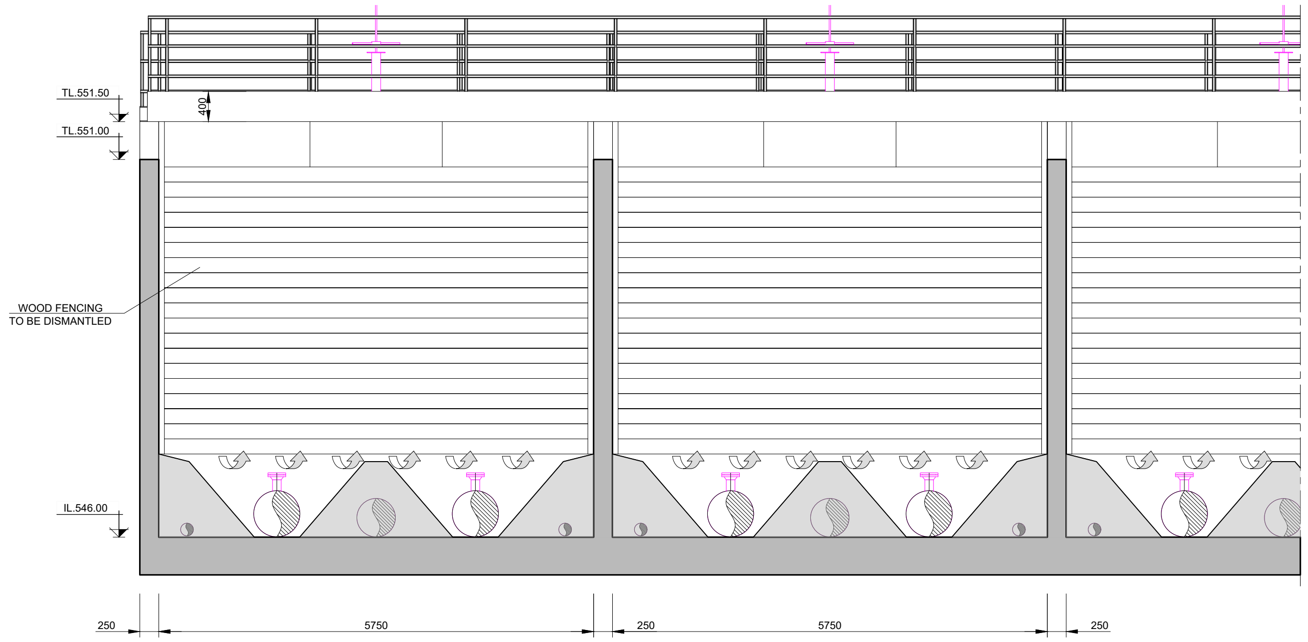
SECTION B-B
SCALE 1:50



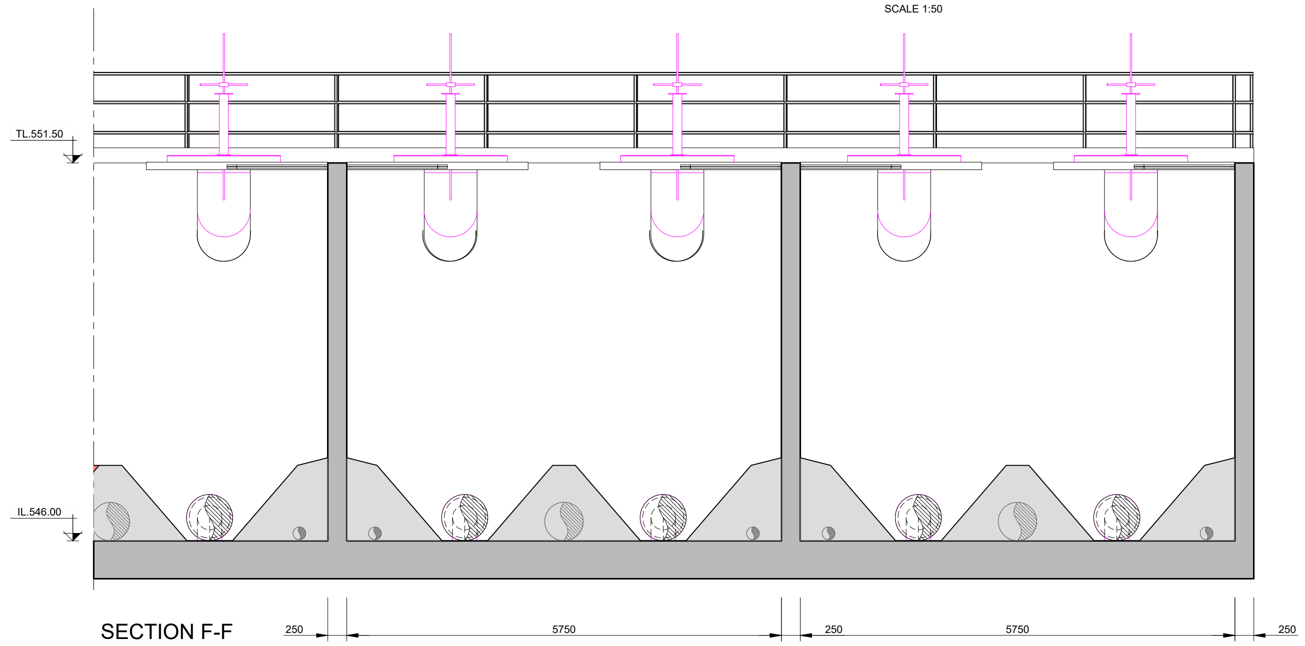
SECTION C-C
SCALE 1:50



SECTION D-D
SCALE 1:50



SECTION E-E
SCALE 1:50



SECTION F-F
SCALE 1:50

LEVELS ACRONYMS			
SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

DATE: **SEPTEMBER 2025**

PROJECT TITLE: GHRMAGHELE DWTP
SETTLEMENT EXISTING FACILITIES UPGRADING

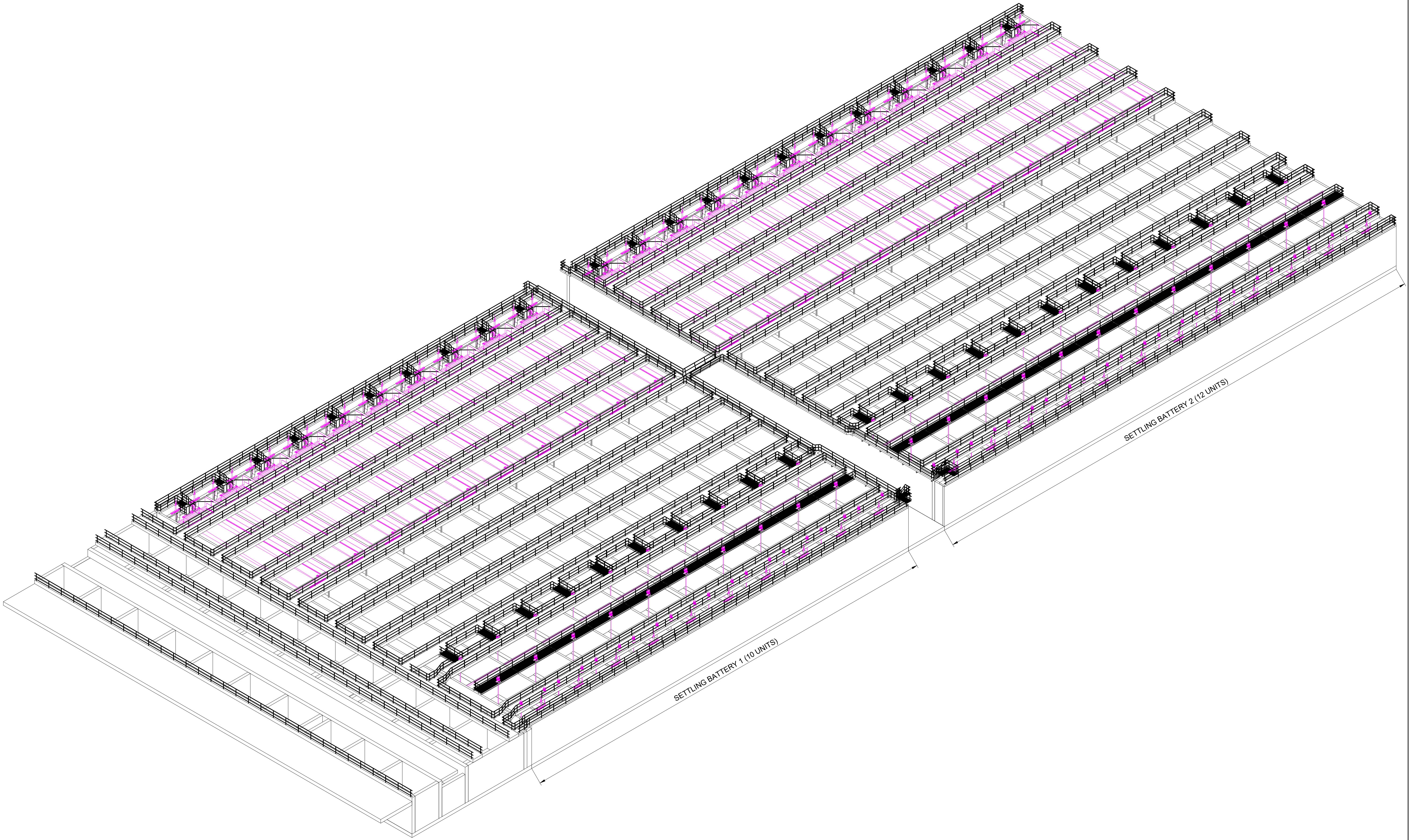
DRAWING TITLE: EXISTING SETTLERS
CURRENT STATUS
SECTIONS

SCALE (DIN A1): 1:50

DRAWING No: GHR-DWG-ME-00-0003

FILE: GHR-DWG-ME-00-0001 SHEET: GHR-DWG-ME-00-0003 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)

FILE: GHR-DWG-ME-00-0011 SHEET: GHR-DWG-ME-00-0011 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)



ISOMETRIC VIEW
SCALE 1:200

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

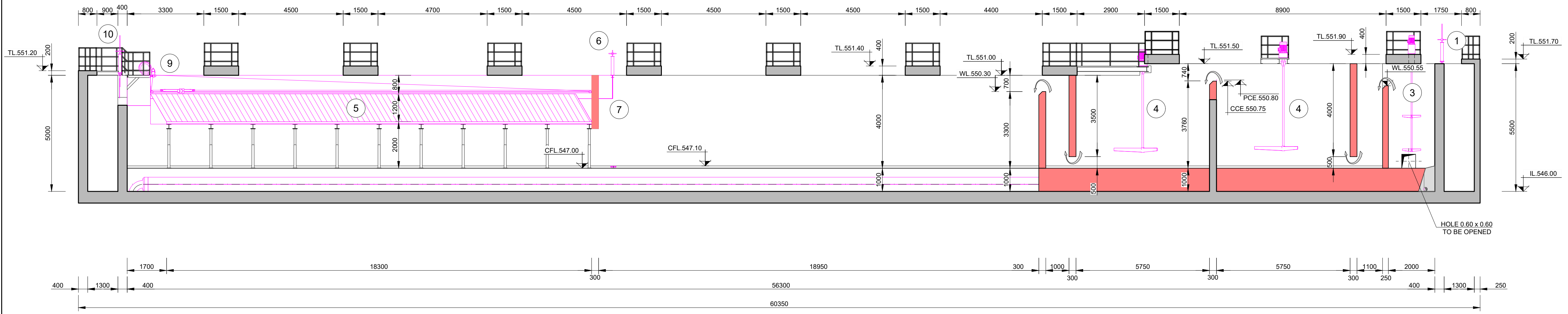
DATE: SEPTEMBER 2025

PROJECT TITLE: GHRMAGHELE DWTP
SETTLEMENT EXISTING FACILITIES UPGRADING

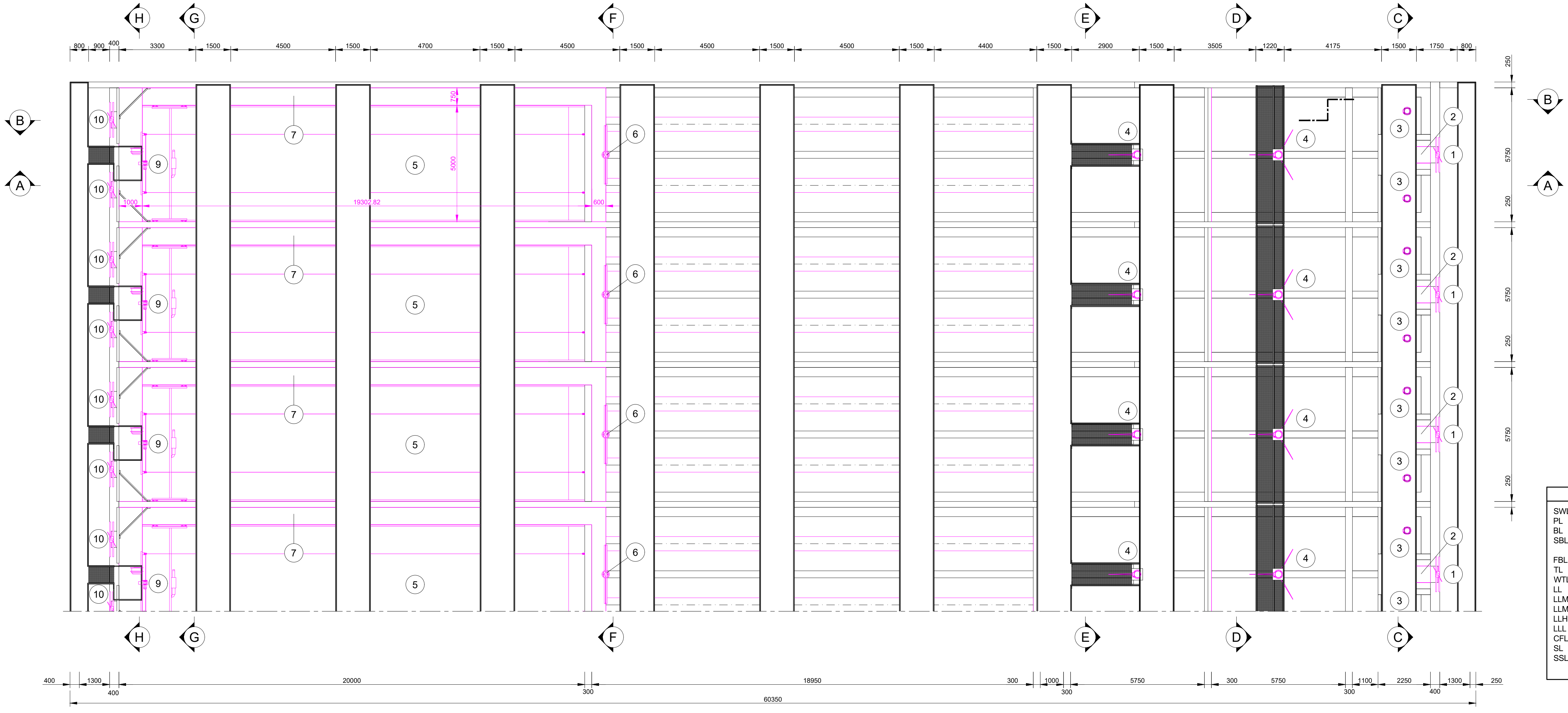
DRAWING TITLE: EXISTING SETTLERS
UPGRADED STATUS
ISOMETRIC VIEW

SCALE (DIN A1): 1:200

DRAWING No: GHR-DWG-ME-00-0011



SECTION A-A
SCALE 1:100



PLAN VIEW
SCALE 1:100

EQUIPMENT LEGEND

1. MANUAL INLET PENSTOCK (EXISTING)
2. SPLITTING WEIR CHANNEL (EXISTING)
3. FLASH MIXING VERTICAL MIXER
4. FLOCCULATION VERTICAL MIXER
5. LAMELLA MODULES
6. ADJUSTABLE OVERFLOW WEIR
7. COLLECTION CHANNEL
8. LAMELLA AUTOMATIC CLEANING SYSTEM
9. BAFFLE
10. MANUAL OUTLET PENSTOCK (EXISTING)

LEVELS ACRONYMS			
SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

DATE: SEPTEMBER 2025

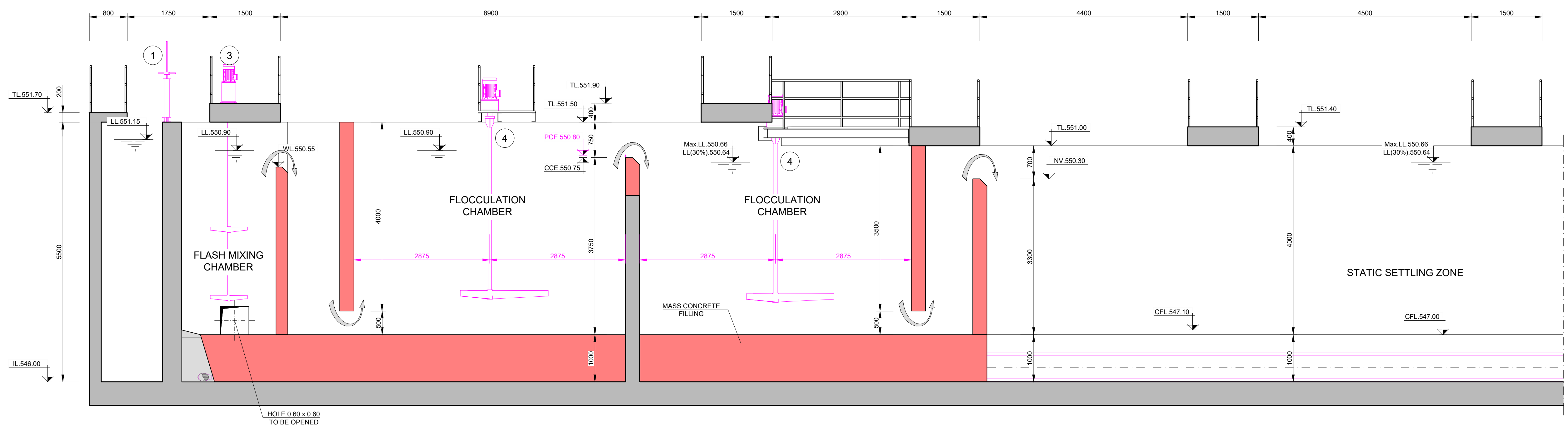
PROJECT TITLE: GHRMAGHELE DWTP
SETTLEMENT EXISTING FACILITIES UPGRADING

DRAWING TITLE: EXISTING SETTLERS
UPGRADED STATUS
PLAN VIEW AND SECTION

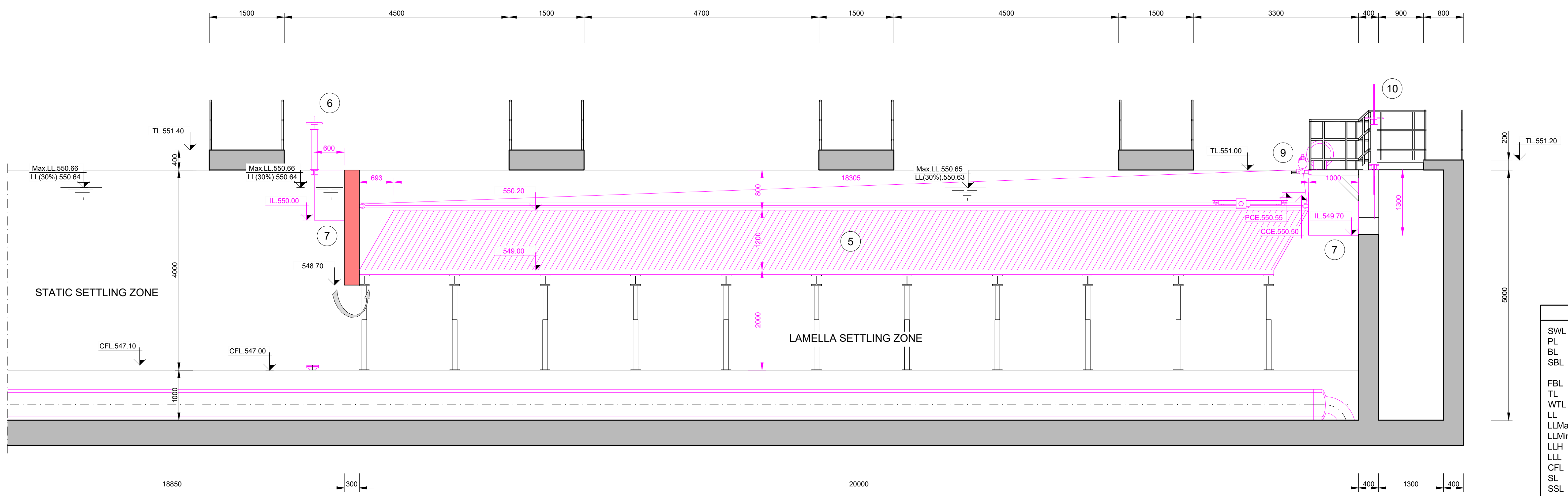
SCALE (DIN A1): 1:100

DRAWING No: GHR-DWG-ME-00-0012

FILE: GHR-DWG-ME-00-0011 SHEET: GHR-DWG-ME-00-0012 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)



SECTION B-B
SCALE 1:50



SECTION B-B
SCALE 1:50

EQUIPMENT LEGEND

1. MANUAL INLET PENSTOCK (EXISTING)
2. SPLITTING WEIR CHANNEL (EXISTING)
3. FLASH MIXING VERTICAL MIXER
4. FLOCCULATION VERTICAL MIXER
5. LAMELLA MODULES
6. ADJUSTABLE OVERFLOW WEIR
7. COLLECTION CHANNEL
8. LAMELLA AUTOMATIC CLEANING SYSTEM
9. BAFFLE
10. MANUAL OUTLET PENSTOCK (EXISTING)

LEVELS ACRONYMS

SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

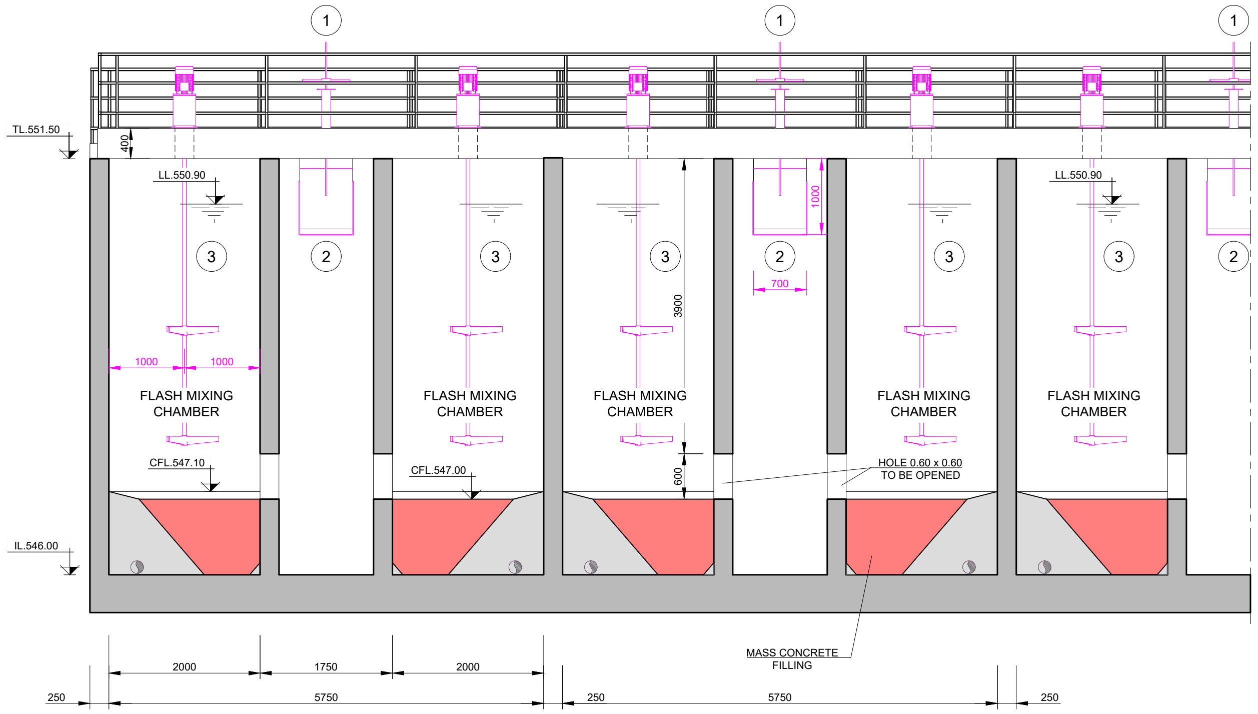
DATE: SEPTEMBER 2025

PROJECT TITLE: GHRMAGHELE DWTP SETTLEMENT EXISTING FACILITIES UPGRADING

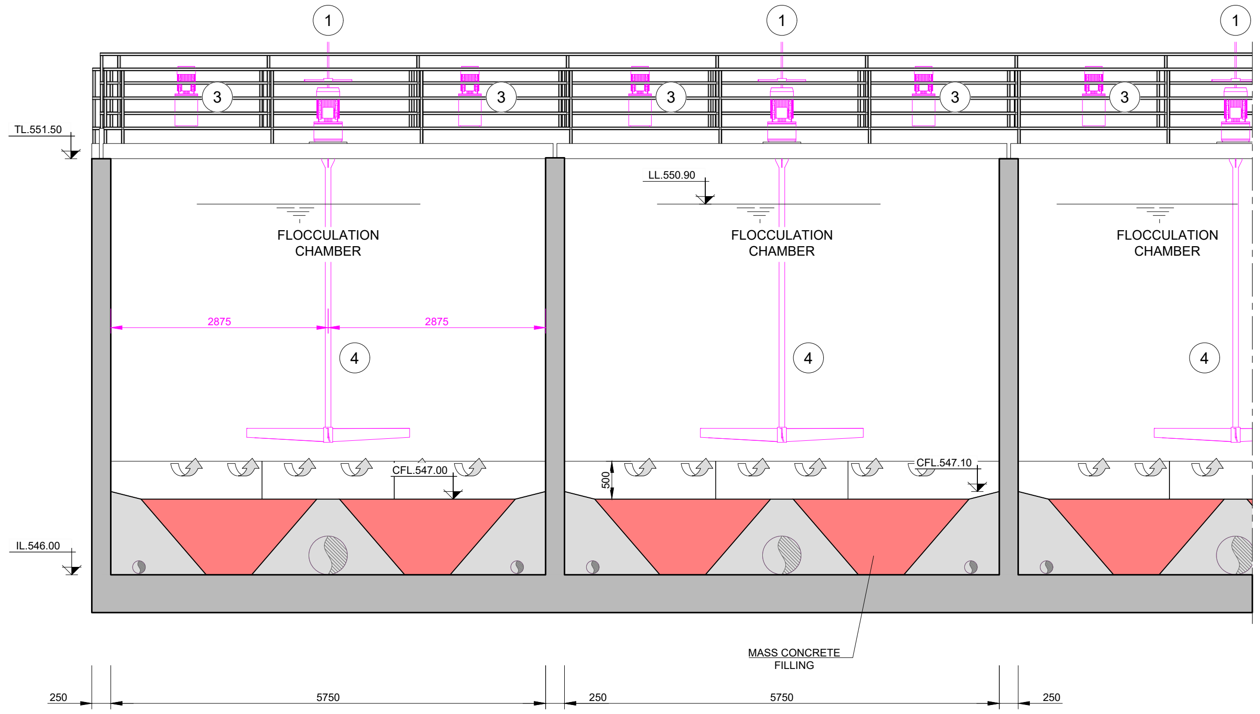
DRAWING TITLE: EXISTING SETTLERS UPGRADED STATUS SECTION

SCALE (DIN A1): 1:50

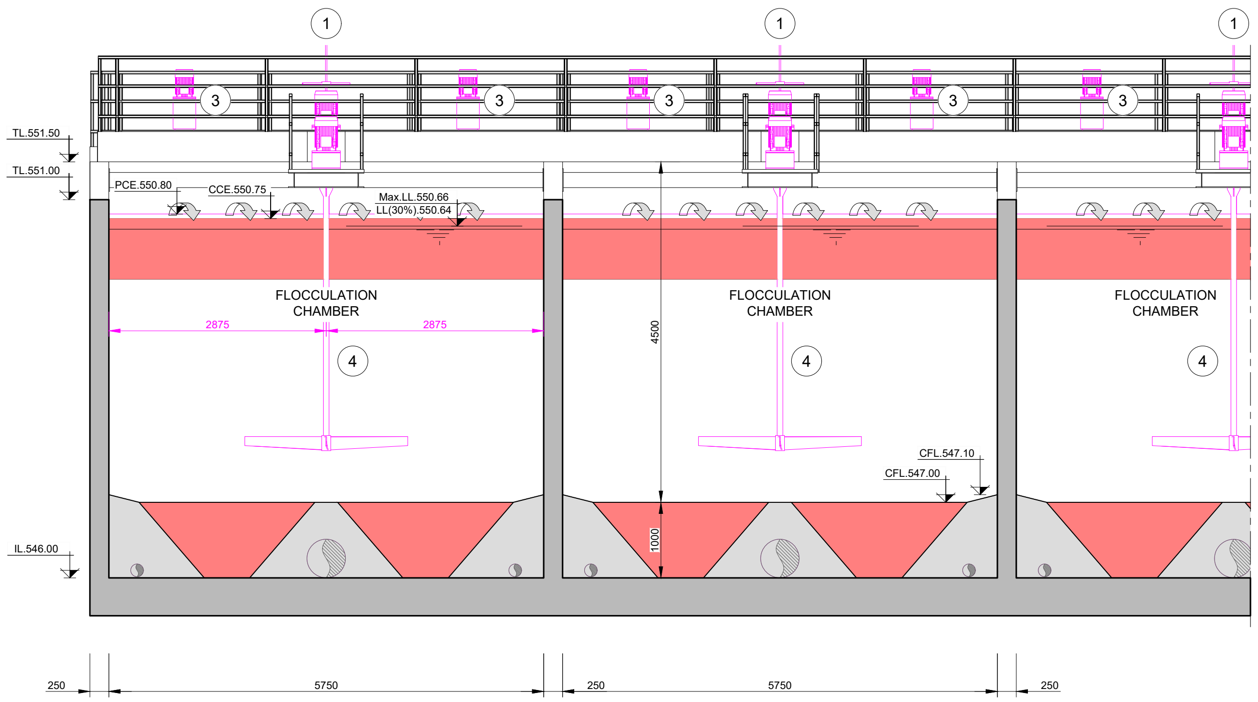
DRAWING No: GHR-DWG-ME-00-0013



SECTION C-C
SCALE 1:50



SECTION D-D
SCALE 1:50



SECTION E-E
SCALE 1:50

EQUIPMENT LEGEND

1. MANUAL INLET PENSTOCK (EXISTING)
2. SPLITTING WEIR CHANNEL (EXISTING)
3. FLASH MIXING VERTICAL MIXER
4. FLOCCULATION VERTICAL MIXER
5. LAMELLA MODULES
6. ADJUSTABLE OVERFLOW WEIR
7. COLLECTION CHANNEL
8. LAMELLA AUTOMATIC CLEANING SYSTEM
9. BAFFLE
10. MANUAL OUTLET PENSTOCK (EXISTING)

LEVELS ACRONYMS

SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

DATE: SEPTEMBER 2025

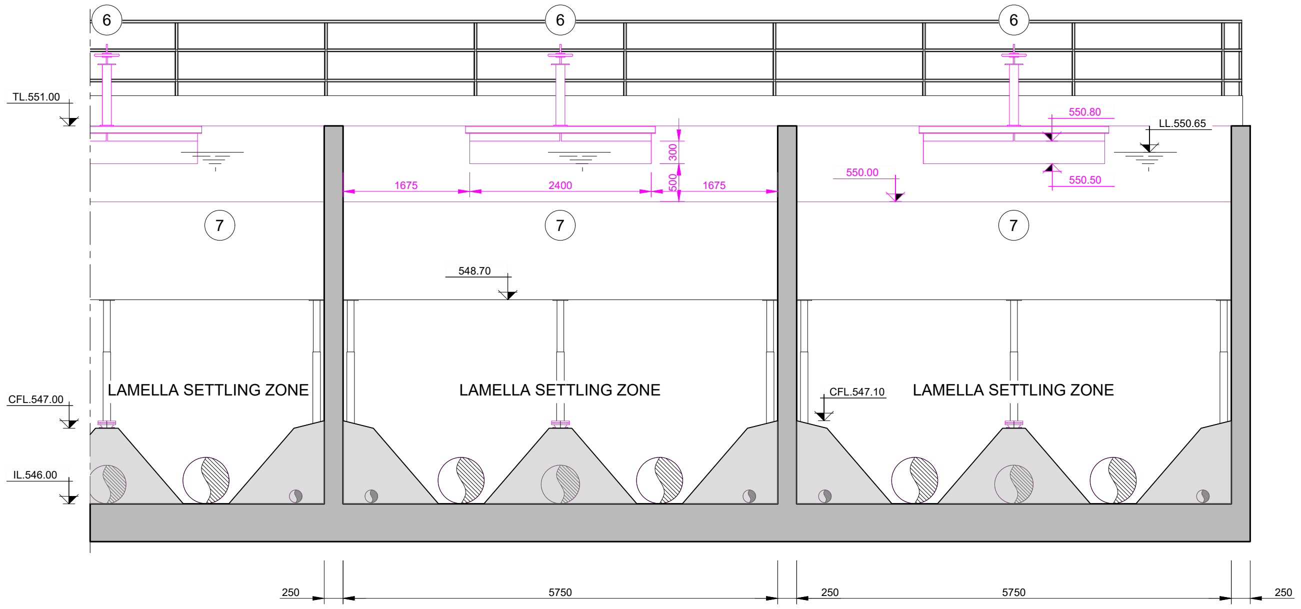
PROJECT TITLE: GHRMAGHELE DWTP SETTLEMENT EXISTING FACILITIES UPGRADING

DRAWING TITLE: EXISTING SETTLERS UPGRADED STATUS SECTIONS

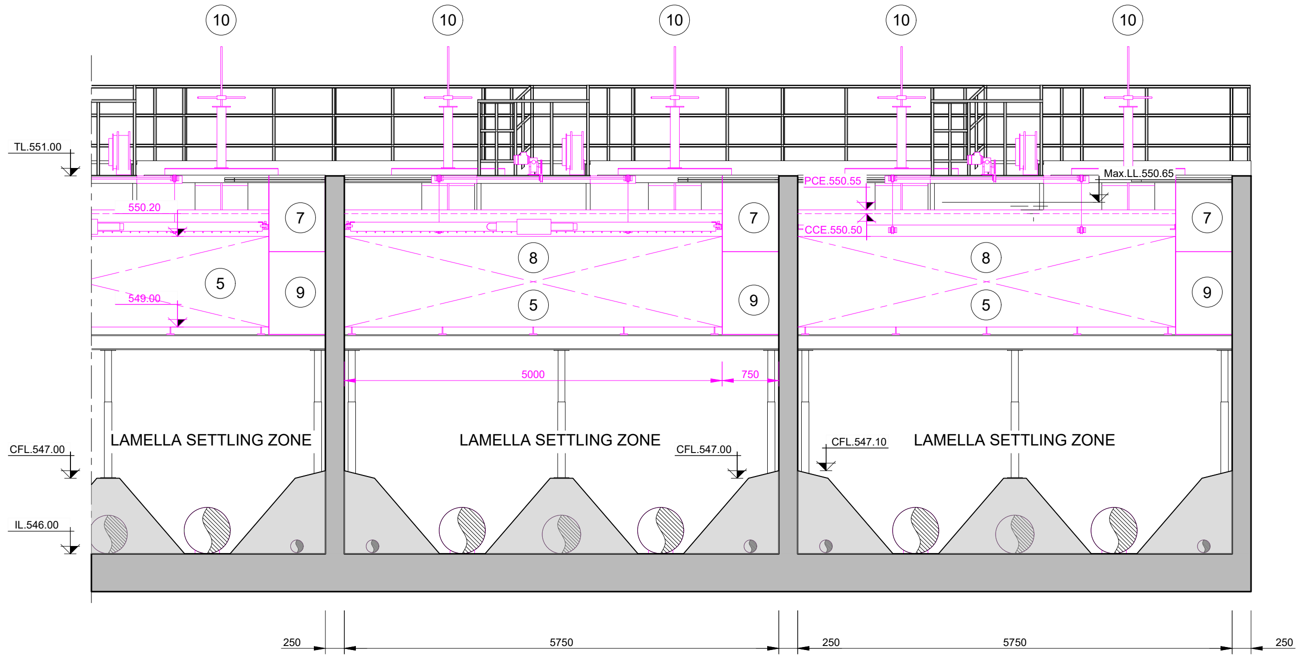
SCALE (DIN A1): 1:50

DRAWING No: GHR-DWG-ME-00-0014

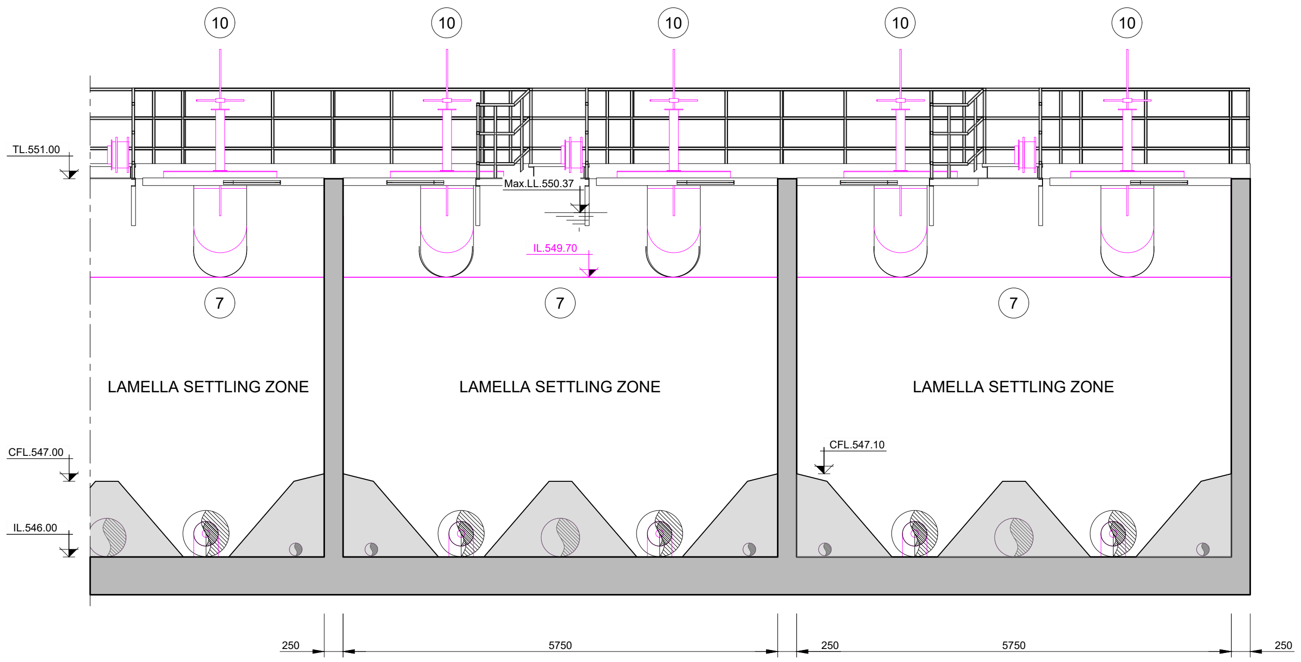
FILE: GHR-DWG-ME-00-0011 SHEET: GHR-DWG-ME-00-0014 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)



SECTION F-F
SCALE 1:50



SECTION G-G
SCALE 1:50



SECTION H-H
SCALE 1:50

EQUIPMENT LEGEND

1. MANUAL INLET PENSTOCK (EXISTING)
2. SPLITTING WEIR CHANNEL (EXISTING)
3. FLASH MIXING VERTICAL MIXER
4. FLOCCULATION VERTICAL MIXER
5. LAMELLA MODULES
6. ADJUSTABLE OVERFLOW WEIR
7. COLLECTION CHANNEL
8. LAMELLA AUTOMATIC CLEANING SYSTEM
9. BAFFLE
10. MANUAL OUTLET PENSTOCK (EXISTING)

LEVELS ACRONYMS

SWL	SIDEWALK LEVEL	FL	FLOOR LEVEL
PL	PAVEMENT LEVEL	SFL	STRUCTURAL FLOOR LEVEL
BL	BEDPLATE LEVEL	FFL	FINISHED FLOOR LEVEL
SBL	STRUCTURAL BEDPLATE LEVEL	BTL	BEAM TOP LEVEL
		BBL	BEAM BOTTOM LEVEL
FBL	FINISHED BEDPLATE LEVEL	FTL	FOUNDATION TOP LEVEL
TL	TOP LEVEL	GL	GROUND LEVEL
WTL	WALL TOP LEVEL	FGL	FINISHED GROUND LEVEL
LL	LIQUID LEVEL	NGL	NATURAL GROUND LEVEL
LLMax	LIQUID LEVEL (MAXIMUM)	WL	WEIR LEVEL
LLMin	LIQUID LEVEL (MINIMUM)	CCE	CONCRETE / CHANNEL CREST ELELEVATION
LLH	LIQUID LEVEL (HIGH)		
LLL	LIQUID LEVEL (LOW)	PCE	PLATE CREST ELEVATION
CFL	CONCRETE FILLING LEVEL	COP	CENTER LINE OF PIPE
SL	SLAB LEVEL	PIL	PIPE INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL	BOP	BOTTOM OF PIPE
		IL	INVERT LEVEL

REV.No	DATE	DESCRIPTION	REV.	APP.

DESING AND BUILDING: aqualia

DATE: SEPTEMBER 2025

PROJECT TITLE: GHRMAGHELE DWTP
SETTLEMENT EXISTING FACILITIES UPGRADING

DRAWING TITLE: EXISTING SETTLERS
UPGRADED STATUS
SECTIONS

SCALE (DIN A1): 1:50

DRAWING No: GHR-DWG-ME-00-0015

FILE: GHR-DWG-ME-00-0011 SHEET: GHR-DWG-ME-00-0015 SAVE DATE: 11/09/2025 RRELANOR PRINT DATE: 12/09/2025 COMPUTERIZED DRAWING (DO NOT CORRECT MANUALLY)

ANNEX IV

TECHNICAL DATA SHEETS

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLASH MIXING TANKS

Design data

- Design flow:	23.400	m³/h
- No of rows (tanks):	22	uts
- Flow per row:	1.063,64	m³/h
	295,45	l/s
- No of chambers (parallel) per row:	2	uts
- Maximum flow per chamber:	531,82	m³/h
	147,73	l/s
- Unitary dimensions:		
• Length:	2,00	m
• Width:	2,00	m
• Maximum height:	4,90 (4,50 + 0,40)	m
• Water maximum depth:	3,85	m
- Unitary useful volume:	15,60	m³
- Hydraulic Retention Time:	1,76	min
- No of mixers to be installed:	44	uts
- Fluid viscosity:	1	mPa.s
- Fluid specific gravity:	1,10	kg/m³
- Mixer position:	Centered	

Mixer main data

- Manufacturer:	DMR or equal	
- Total flow:	3.415	m³/h
- Tip speed:	4,39	m/s
- Hydraulic dissipated power:	2,00	kW
- Mixer rotation speed:	93,20	rpm

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLASH MIXING TANKS

Motor data

- Power:	3,00 kW
- Rotation speed:	1.460 rpm
- Supply voltage:	400 V III (± 5 %)
- Frequency:	50 Hz (± 2 %)
- Variable frequency drive:	No
- Frame / Protection / Mounting position:	Aluminum / IP 56 / V1
- Insulation / Heating class:	F / B

Agitation head without motor

- Connection motor / gear box:	With lantern and elastic coupling
- Gear box:	Coaxial, oil lubrication
- Gear reduction ratio:	15,66
- Mounting type:	Square shaped flange
- Flange dimensions:	500 x 500 mm
- Sealing device:	No

Wetted parts

- Coupling between driving shaft / mixer shaft:	Removable coupling
- Mixer shaft:	Tubular
- Length between base level / imp. leading edge	4.100 mm
- Mobiles	
• Quantity of mobiles:	2
• Type of mobile:	HXP
• Diameter of mobile:	900 mm
- Mixer shaft and impeller material:	1.4404 (316 L)
- Coating:	Without

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLOCCULATION CHAMBER – 1st COMPARTMENT

Design data

- Design flow:	23.400	m³/h
- No of rows (tanks):	22	uts
- Flow per row:	1.063,64	m³/h
	295,45	l/s
- No of chambers per row:	1	ut
- Maximum flow per chamber:	1.063,64	m³/h
	295,45	l/s
- No of compartment (series) per chamber:	2	uts
- Maximum flow per chamber:	1.063,64	m³/h
	295,45	l/s
- Unitary dimensions:		
• Length:	5,75	m
• Width:	5,75	m
• Maximum height:	4,90 (4,50 + 0,40)	m
• Water maximum depth:	3,90	m
- Unitary useful volume:	128,94	m³
- Hydraulic Retention Time:	7,27	min
- No of mixers to be installed:	22	uts
- Fluid viscosity:	1	mPa.s
- Fluid specific gravity:	1,10	kg/m³
- Mixer position:	Centered	

Mixer main data

- Manufacturer:	DMR or equal	
- Total flow:	8.237	m³/h
- Tip speed:	1,72	m/s
- Hydraulic dissipated power:	0,46	kW
- Mixer rotation speed:	13,10	rpm

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLOCCULATION CHAMBER – 1st COMPARTMENT

Motor data

- Power:	0,75 kW
- Rotation speed:	1.450 rpm
- Supply voltage:	400 V III (± 5 %)
- Frequency:	50 Hz (± 2 %)
- Variable frequency drive:	Yes
- Frame / Protection / Mounting position:	Aluminum / IP 56 / V1
- Insulation / Heating class:	F / B

Agitation head without motor

- Connection motor / gear box:	With lantern and elastic coupling
- Gear box:	Coaxial, oil lubrication
- Gear reduction ratio:	110,57
- Mounting type:	Square shaped flange
- Flange dimensions:	500 x 500 mm
- Sealing device:	No

Wetted parts

- Coupling between driving shaft / mixer shaft:	Removable coupling
- Mixer shaft:	Tubular
- Length between base level / imp. leading edge	3.700 mm
- Mobiles	
• Quantity of mobiles:	1
• Type of mobile:	HXP
• Diameter of mobile:	2.500 mm
- Mixer shaft and impeller material:	1.4404 (316 L)
- Coating:	Without

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLOCCULATION CHAMBER – 2nd COMPARTMENT

Design data

- Design flow:	23.400	m³/h
- No of rows (tanks):	22	uts
- Flow per row:	1.063,64	m³/h
	295,45	l/s
- No of chambers per row:	1	ut
- Maximum flow per chamber:	1.063,64	m³/h
	295,45	l/s
- No of compartment (series) per chamber:	2	uts
- Maximum flow per chamber:	1.063,64	m³/h
	295,45	l/s
- Unitary dimensions:		
• Length:	5,75	m
• Width:	5,75	m
• Maximum height:	4,40 (4,00 + 0,40)	m
• Water maximum depth:	3,66	m
- Unitary useful volume:	121,01	m³
- Hydraulic Retention Time:	6,83	min
- No of mixers to be installed:	22	uts
- Fluid viscosity:	1	mPa.s
- Fluid specific gravity:	1,10	kg/m³
- Mixer position:	Centered	

Mixer main data

- Manufacturer:	DMR or equal	
- Total flow:	8.237	m³/h
- Tip speed:	1,72	m/s
- Hydraulic dissipated power:	0,46	kW
- Mixer rotation speed:	13,10	rpm

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	VERTICAL SHAFT MIXER
SERVICE	FLOCCULATION CHAMBER – 2nd COMPARTMENT

Motor data

- Power:	0,75	kW
- Rotation speed:	1.450	rpm
- Supply voltage:	400 V III (± 5 %)	
- Frequency:	50 Hz (± 2 %)	
- Variable frequency drive:	Yes	
- Frame / Protection / Mounting position:	Aluminum / IP 56 / V1	
- Insulation / Heating class:	F / B	

Agitation head without motor

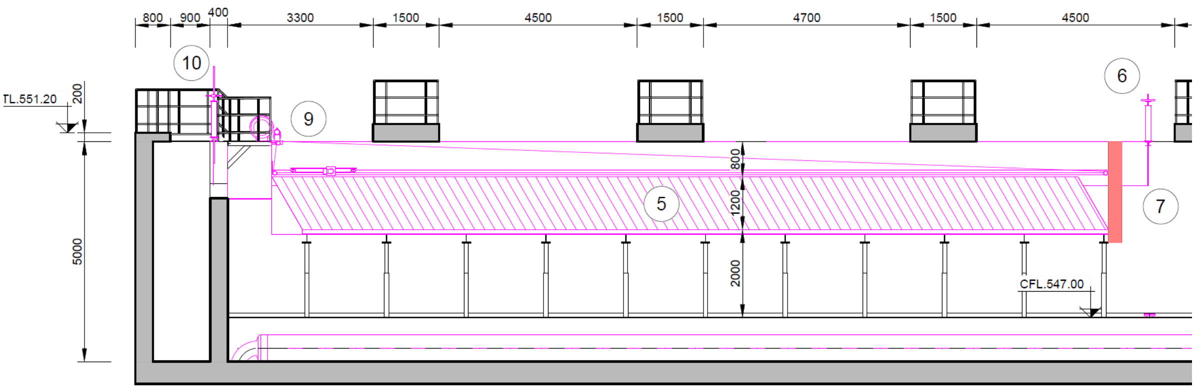
- Connection motor / gear box:	With lantern and elastic coupling	
- Gear box:	Coaxial, oil lubrication	
- Gear reduction ratio:	110,57	
- Mounting type:	Square shaped flange	
- Flange dimensions:	500 x 500	mm
- Sealing device:	No	

Wetted parts

- Coupling between driving shaft / mixer shaft:	Removable coupling
- Mixer shaft:	Tubular
- Length between base level / imp. leading edge	3.700 mm
- Mobiles	
• Quantity of mobiles:	1
• Type of mobile:	HXP
• Diameter of mobile:	2.500 mm
- Mixer shaft and impeller material:	1.4404 (316 L)
- Coating:	Without

TECHNICAL DATA SHEET	
PROJECT	GHRMAGHELE D.W.T.P. UPGRADING
EQUIPMENT	LAMELLA PACKAGE
SERVICE	LAMELLAR SETTLEMENT

- Manufacturer: Wss Dynamics or equal
- Model: 40-12-HV
- Flow homogenization system: Included
- Assembly: Internal bolted frame with SS rods
- Anti-flotation system: Bottom anchoring, no top profile
- Lamella spacing: 40 mm
- Vertical settling distance (DVD): 80 mm
- Module height: 1.200 mm
- Module volume: 1,20 m^3
- Lamella channel length: 1.370 mm
- Inclination: 60°
- Projected surface: 12,50 m^2/m^3
- Total projected surface per module: 15,00 m^2/m^3
- Material: Virgin PP
- Manufacturing process: Injection
- Surface finish: Mirror-polished
- Colour: White (RAL 9010)
- Weight: 65 kg/m^3
- Max operating temperature: 40 °C
- Losses due to internal frame: 0,60 %
- Losses due to support structures: 0
- Losses due to anti-flotation structure: 0



Lamella Settling Zone – Longitudinal Section

ANNEX V

BUDGET

GHRMAGHELE D.W.T.P. UPGRADING – BUDGET SUMMARY

MECHANICAL EQUIPMENT ***3.841.814,44 €***

- FLASH MIXING 154.792,00 €
- FLOCCULATION CHAMBERS 227,276,50 €
- SETTLEMENT 3.459.750,54 €

ELECTRICAL EQUIPMENT ***848.541,29 €***

- MAIN DISTRIBUTION BOARD´s (MDB´s) 495.510,33 €
- MCC OUTGOING LINES TO MOTORS 201.532,40 €
- CONTROL AND INSTRUMENTATION 151.498,56 €
  - UPS 8.251,26 €
  - CONTROL HARDWARE & SOFTWARE 123.220,00 €
  - DATA NETWORK 4.017,46 €
  - CABLING FOR INSTRUMENTATION 12.379,84 €
  - SUPPORTS FOR INSTRUMENTATION 3.630,00 €

TOTAL BUDGET ***4.690.355,73 €***