Siltbuster®

Clay and Mudstone Treatment using 2-stage chemical dosing w/ CO_2, caustic soda and settlement

Process Outline, Control Philosophy & Environmental Risk Mitigation

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Date:	23rd May, 2025

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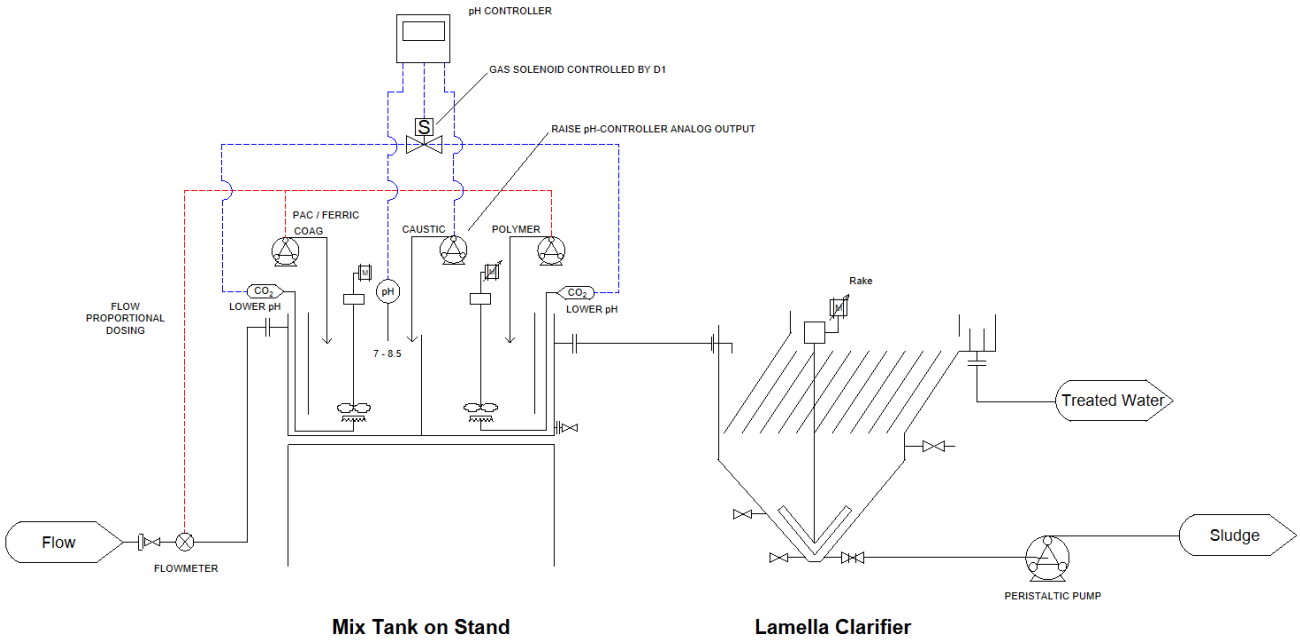
1.0 Introduction

This document details the solution outline, process control philosophy, and environmental risk mitigation for the removal of clay and mudstone from groundwater, as per request by the Robertson Group. The Robertson Construction North West division are actively engaged in a construction project involving a cut and fill operation shifting clay and mudstone, and also includes demolition and crushing operations. As such, they require details of a treatment process capable of adequately removing these solids from groundwater in order to assist with their application for a discharge permit with National Resource Wales (NRW).

2.0 Process Overview and Description

The treatment detailed below utilises a combination of a standard Siltbuster mixing tank followed by a Lamella clarifier. The extent of the process is shown below in Figure 1:

Figure 1: P&ID of 2-stage chemical dosing system using caustic soda and carbon dioxide for pH control, and lamella clarifier for settlement downstream



Incoming wastewater flows into the mixing tank where it is dosed in two stages. The first stage introduces the chosen coagulant (either ferric chloride or Poly Aluminium Chloride (PAC), whereby the dosage rate is altered in proportion to the influent flow. The coagulant works to bind small negatively charged suspended solid particles together to form larger particles known as flocs. Carbon dioxide gas and/or caustic soda are also fed into the mixing tank at this stage, to lower the pH of the alkaline influent water to an acceptable range (**between pH 7 and 8.5**). Dosage rates of both CO_2 and caustic soda are precisely controlled by a pH controller located above the tank, which is connected to the pH sensors within the vessel electronically.

In the second stage, anionic polymer (such as AQ2084) is introduced to the wastewater to increase floc sizes and enhance settlement downstream. A pH sensor is also located in this part of the vessel, and the pH controller may allow CO_2 to be diffused into the water if the pH is deemed too high for discharge.

After the dosing process, the wastewater flows down stream into a Siltbuster Lamella clarifier for settlement. Siltbuster Hopper Bottom (HB) lamella clarifier units (**HB40R or HB50MR in this instance)** are designed to separate, and store suspended solids using lamella plate separator technology and gravity. For construction schemes, a rake unit is preferred to agitate the sludge generated in the hopper and prevent buildup of sludge on the hopper side walls.

The solids-laden wastewater enters the unit, where it encounters a series of inclined parallel plates known as lamella plates. The lamella plates in the unit reduces the footprint of the unit by approximately 90% in comparison to a conventional settlement tank, resulting in a compact treatment solution, that provides a highly effective settlement area ideal for clarification of wastewater. As the wastewater flows over these inclined plates, solid particles present in the water tend to settle onto the plate surfaces due to gravitational forces. The spacing between the plates and their inclination is carefully designed to allow the solids to slide down while clear water continues its path upward. The settled solids accumulate at the bottom of the unit and form a sludge, which can be periodically removed. Meanwhile, the clarified water rises to the top of the clarifier, where it flows out of the treated outlet.

3.0 Process Control Philosophy

3.1 Chemical Dosing

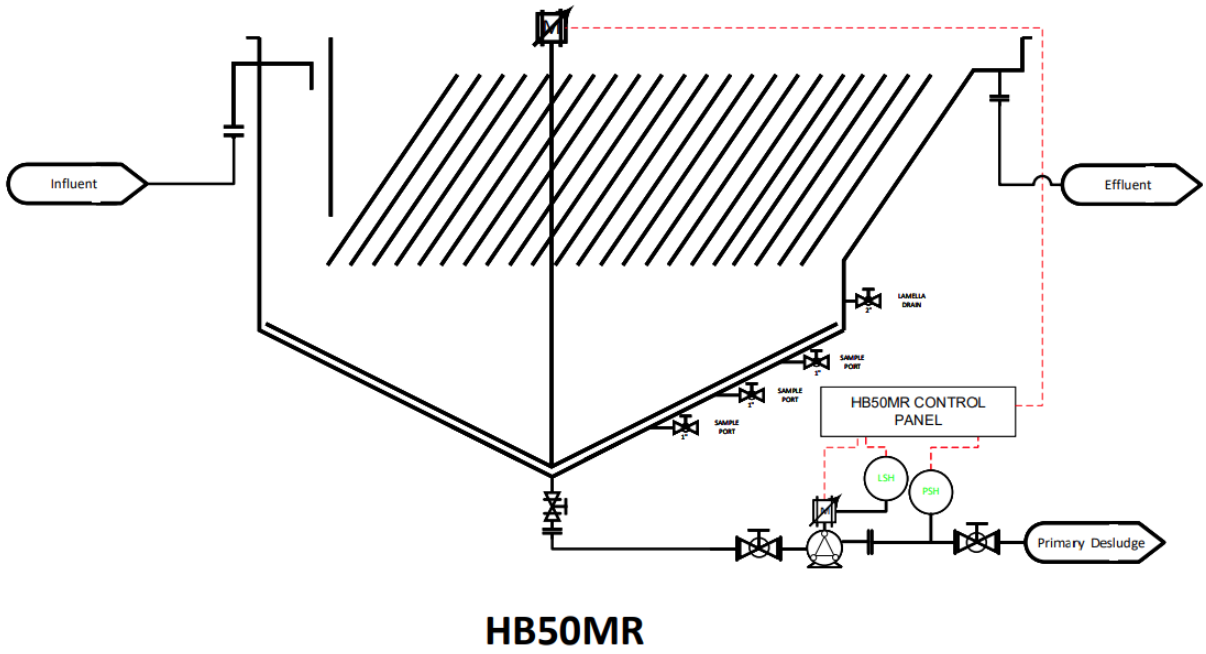
The control sequence for the 2-stage chemical dosing system is as follows:

1. **Influent Monitoring:**
   Wastewater enters the system and is measured by a flow meter. Valve located upstream of flowmeter can be used to manually adjust flowrate if required.
2. **Signal Transmission:**
   The flow meter generates a 4–20 mA analog signal proportional to the flow rate.
3. **Signal Duplication:**
   This analog signal is duplicated within the control panel for distribution to multiple dosing systems.
4. **Chemical Dosing Activation:**
   The duplicated 4–20 mA signal is transmitted to one coagulant dosing pump and one polymer solution dosing pump.
5. **Flow-Based Triggering:**
   The flow meter activates a volt-free contact (relay output) once the flow rate exceeds a predefined threshold, typically set at 1% of the system's maximum flow (Q_{max}).
6. **Dosing Pump Enablement:**
   Dosing pumps are initiated when the volt-free contact (relay signal) from the flow meter enables the remote start function.
7. **Proportional Control:**
   Pump speed (RPM) is automatically adjusted in real time, proportional to the 4–20 mA signal output from the flow meter.
8. **Process Optimization:**
   Pump RPMs are fine-tuned based on the flow signal to ensure optimal coagulation and flocculation conditions are achieved.

3.2 Lamella Hopper Bottom (HB) Settlement Tanks: Main Components

A P&ID of the HB50MR has been provided below in Figure 2 for reference:

Figure 2: P&ID of Siltbuster HB50MR Unit



Lamella Plates – Durable and resistant to corrosion, these PVC sheets feature a smooth surface. They are arranged in two cassettes, maintaining the proper spacing between them. Additionally, slotted handles at the top facilitate easy extraction.

Sludge Hopper – Situated beneath the lamella plate cassettes, the hopper collects settled solids.

Sludge Pump - The sludge pump will operate via a timer. The sludge pump will be inhibited if a sludge tank high level float switch is activated.

Lifting Points – Integrated lifting points designed to support the dry weight of the unit and with enough space to attach a range of lifting shackles.

Forklift Slots – Base of the unit, referred to as the skid. Spaced 900mm apart, accessible from two sides.

Saw-tooth Weir – Adjustable outlet weir in double central launder configuration.

Rake Drive – Motor-gearbox drives the rake assembly which continuously rotates in the sludge hopper, to prevent solids solidifying and becoming too thick to remove.

Sparge / Sample Points (Optional) – A series of air sparging points is positioned along the inclined surface to aid in the agitation of solidified sludge. These sparging points can also double as sampling points for monitoring the sludge level.

Note: Sample ports / valves are optional and not installed on all units

Auto Control:

In auto control the rake will operate continuously, the sludge pump will operate via a timer. The sludge pump will be inhibited if a sludge tank high level float switch is activated or the timer dictates that the pump shall be OFF.

Hand (Manual) Controls:

In hand mode, the sludge pump will operate until the switch is either put into “OFF” or “Auto” if the timer allows.

It will run at the speed set on the VSD, the speed can be adjusted via the potentiometer on the control panel door.

3.3 Lamella Hopper Bottom (HB) Settlement Tanks: Electrical Details

Panel Specification:

- Construction – Form 2 stainless steel.
- Control and Interface Type – Lamps, pushbuttons and switches, relay logic.
- Switchgear – Siemens LV where possible, ABB drives.
- Emergency Stop – SIL 3 on control panel door and allowance for one remote stop.
- Cable Entry – Bottom only.
- Control Supplies – 24vDC.
- External Incoming Supplies – Mains 400vAC, 3 phase +N+E.

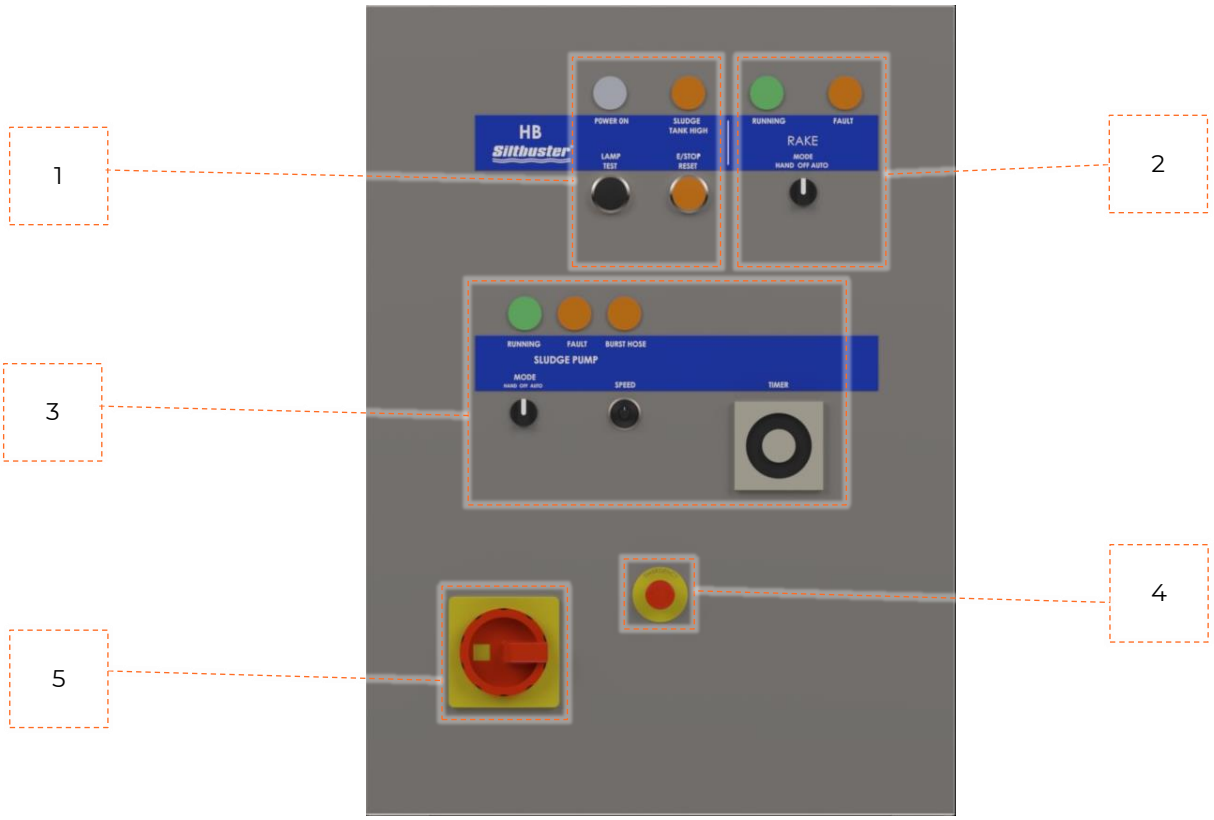


Figure 3: Lamella Clarifier Control Panel Layout

Table 1: Lamella Clarifier Control Panel Interface Breakdown

REF	§	COMPONENT	FEATURE
1		POWER ON (white)	Lamp illuminates when the correct voltage is supplied.
		E/STOP RESET (amber)	Push-button clears latched fault relay if system healthy
		Lamp Test	All Lamps illuminate when lamp test button is pressed
		Sludge Tank High Level (amber)	Lamp illuminates when sludge tank is at high level and sludge pump is inhibited
2	RAKE	RUNNING (green)	Lamp illuminates to indicate power provided to rake motor
		FAULT (amber)	Lamp illuminates when rake overload tripped
		MODE (HAND/OFF/AUTO)	Switch rake state from HAND (manual continuous), OFF, or AUTO (automatic) modes
3	SLUDGE PUMP	RUNNING (green)	Lamp illuminates to indicate power provided to sludge pump
		FAULT (amber)	Lamp illuminates when mixer overload tripped
		BURST HOSE (amber)	Lamp illuminates when burst hose sensor is activated
		MODE (HAND/OFF/AUTO)	Switch sludge pump state from HAND (manual continuous), OFF, or AUTO (automatic) mode. AUTO mode allows the pump to operate based on timed intervals set by the asymmetric timer
		SPEED	Potentiometer allows the operator to adjust the operating frequency (speed) of the mixer from 0 Hz to 50 Hz
		Asymmetric Timer	Timer allows operator to set the ON and OFF duration
4		Emergency Stop (latch/unlatch)	Mushroom-head push-button immediately deactivates all system function and control panel supply. Must be manually disengaged to release latched relay
5		Mains Isolator (ON/OFF)	Switches the control panel ON or OFF

3.4 Lamella Hopper Bottom (HB) Settlement Tanks: Electrical Instrumentation

The following instruments are part of the clarifier:

- Burst Switch
- Sludge Tank High Level Float Switch (Optional)

Burst Switch

Indicates that the hose in the peristaltic pump has burst and fluid has entered the pump head chamber. Investigate pump condition and replace hose if required.

Sludge Tank High Level Float Switch (Optional)

The optional sludge tank high level float switch will inhibit the sludge pump when the level goes above the sludge tank high level float switch.

Interlocks

Each Unit shall require the following protection devices to be interlocked with the Main Drive (MD) motor starter in all modes of operation:

- MD motor Thermal/Magnetic protection
- MD Variable Speed Drive (VSD) healthy
- Burst hose
- External fault

Each protection device shall be hard-wired in a fail-safe operation.

Motor Drives

Rake motor is Direct Online.

Sludge pump is VSD controlled from a manually adjusted potentiometer from 0-50Hz.

4.0 Environmental Risk Mitigation for chemical dosing system

Effective environmental risk mitigation is critical when operating chemical dosing systems and settlement tanks, to ensure protection of surrounding ecosystems, personnel, and infrastructure.

A key component of Siltbuster's mitigation strategy involves the use of **bunded chemical storage**. All chemical tanks and containers are to be housed within bunds, which are secondary containment structures designed to capture spills or leaks. These bunds are sized to hold at least 110% of the volume of the largest container within them, preventing the uncontrolled release of hazardous substances into the environment.

In addition to containment, precise dosing control is also crucial to minimize chemical overuse, which can lead to unnecessary environmental loading and increased operational costs. As detailed in Section 3.1, the dosing system is equipped with flow-paced dosing pumps, automated feedback controls (inc. pH controller and CO_2 gas solenoid), and alarm systems to ensure chemicals are added at accurate rates in response to real-time influent flow data from the flowmeter. This precision reduces chemical wastage while also ensuring compliance with NRW's discharge limits.

To maintain system integrity and prevent incidents, daily operational checks are conducted by trained personnel. These inspections cover chemical levels, dosing accuracy, pump operation, bund integrity, and any signs of leaks or corrosion. Logs are to be maintained for all checks and corrective actions, ensuring traceability and continuous improvement. By integrating robust containment, accurate dosing, and consistent monitoring, the chemical dosing system upholds a high standard of environmental stewardship. Table 1 below details the recommended daily operational check procedures to ensure that the dosing system functions as required:

Table 2: General operational check schedule for chemical dosing system

Chemical Dosing System:	**Daily**	**Weekly**
Check inlet flow meter is readable and operating correctly	✓	
Check dosing pumps are operational	✓	
When in operation, check dosing pumps are rotating clockwise	✓	
Test emergency stop and safety interlocks	✓	
Check chemical level is adequate for effluent treatment (Recording level is recommended)	✓	
Check chemical lines/joints for leaks	✓	
Clean pH probes with a suitable cleaning cloth (if applicable)	✓	
Check pH probe accuracy using buffer solution		✓
Check all drives for excessive noise and vibration		✓