GLAN AGUA

Review of Kylemore Abbey Wastewater Treatment Plant Report

DOCUMENT CONTROL SHEET

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1.0 Project Background

Glan Agua carried out a review the wastewater treatment plant at Kylemore Abbey as to further understand the treatment process required to resolve the current non-compliances.

The current Emission Limit Values (ELVs) are as follows;

- Biological Oxygen Demand (BOD): 5mg/l
- Chemical Oxygen Demand (COD): 25mg/l
- Total Suspended Solids (TSS): 10mg/l
- Fats, Oils and Greases (FOG): 5mg/l
- Total Phosphorous (TP): 2mg/l
- Orthophosphate (OrthoP): 1mg/l
- Ammonia: 0.2mg/l
- Nitrate: 10mg/l
- pH: 6-9 pH units

Historical raw wastewater data and influent flows provided by Kylemore Abbey were reviewed to understand the influent composition. A jar testing regime was also completed in order to evaluate the feasibility of chemically removing phosphorus from the wastewater. Considering the maximum historical TP concentration of 11.1mg/l and a maximum mole ratio of 3.5mol Fe/mol, a dose of 627.0mg/l of $Fe_2(SO_4)_3$ 40% solution would be required.

2.0 Influent Composition

The data received "Kylemore Remote WQ Baseline Data- 01.11.2021" has been reviewed and the following observations are made:

- Whilst on the 13/05/21 alkalinity results at the inlet of the RBCs were particularly low, these have not been seen in more recent samples nor in our jar tests (even during rain events). Additionally, ALL concentrations on that day where particularly low (BOD=2mg/l, TN=5.30mg/l etc), likely indicating that there was significant ingress of surface water on that day for one reason or another. It is noted that surface water separation from the existing wastewater system is an ongoing project, and these issues are therefore expected to improve in the future.
- For the other sampling days, concentrations were generally within fairly typical ranges for municipal wastewater from a combined sewer (BOD around 200mg/l, TN around 50mg/l, TP around 5mg/l etc). Some samples were out of the typical range (either higher or lower), but this would not be too surprising if we consider that there is likely significant surface/rainwater ingress in the network, and as the samples taken were likely only grab samples and not composite. TSS are quite low with an average of around 150mg/l, likely due to the number of septic tanks on the network which would remove any settleable matter upstream of the plant.
- Whilst ammonia, nitrates and nitrites are very low at the inlet of the RBC, the TN is within typical ranges and can even be quite high. This means that most of the nitrogen getting into the plant is as organic nitrogen, which will be converted into ammonia through hydrolysis, hence the much higher nitrates concentrations on the outlet side.

3.0 Current Treatment Process

The current treatment process consists in the following:

- Multiple septic tanks on the network
- Inlet pump station (directly to primary settlement)
- 2no. precast primary settlement tanks (36,000 L ea.) directly upstream of the RBCs operating in series at the main plant.
- RBC
- Final Settlement Tank (FST)
- Sludge Return
- Phosphorous Reduction
- Polishing Lagoons (Reed Beds)

Whilst the current treatment process capacity cannot be accurately evaluated without additional information, it is fairly unlikely to be able to comply with the extremely stringent ELVs currently in place for the following reasons:

- There are numerous septic tanks on the network, which could lead to excessive retention time, septicity issues and ultimately detrimental impact on the process performances. Rationalisation of the network should be considered so that the remaining septic tanks operate within typical design parameters. This can be seen from the particularly low concentrations of solids and low BOD/TSS ratio in the influent, as well as anecdotal evidence (smell in the 2no. precast septic tanks).

- The storm water network looks to be amalgamated with the sewer network allowing introduction of high volumes of rain/storm water into the treatment system.

- BOD/COD/TSS ELVs
    - The BOD/COD/TSS ELVs are extremely stringent. Typical ELVs for an RBC treatment process based on the current influent sample results would be 25mg/l BOD, 125mg/L COD and 35mg/l TSS.

- OrthoP, TP and residual aluminium ELVs
    - For the OrthoP and TP ELVs, a chemical removal stage would be required to guarantee the ELVs. Based on the jar tests carried out which have shown the ELVs are readily achievable using chemical phosphorus removal, the system was designed assuming a Fe mole ratio of 3.5mol Fe/mol P. Assuming 29.9d storage, this would mean a coagulant storage tank of around 1000l would be required. 2no. chemical dosing pumps of 10l/h each (based on the estimated peak wastewater flow of 52.7m3/d plus 50% safety factor, i.e., daily peak flow of 79.1m^3/d and assumed peak flow of 9.9m3/h) would be required.
    - Optimisation of the chemical mole ratio through regular sampling and adjustment of the pumps will allow the process to minimise the risk of residual metal carryover. This would be further strengthened if a tertiary filtration stage was also provided as suggested above based on the BOD/COD/TSS ELVs. An iron probe could be provided; however, it should be noted that the licence does not include for an iron limit either.
    - Due to the scale of the plant, and to the high costs associated with an OrthoP online monitor, the provision of this equipment to control the chemical dosing pumps would not be considered as viable.

- Ammonia and TN
    - The existing RBCs is unlikely to be able to comply with the extremely stringent current ammonia ELV. With RBCs, the oxygen used for the nitrification reaction is only provided through diffusion from the ambient air to the wastewater when the disc is above the water, and it is therefore difficult to guarantee full nitrification. Available effluent results provided to Glan Agua for 2021 showed that the effluent from the RBCs was nonetheless generally compliant with the ammonia limit.
    - For the nitrate ELV, a denitrification zone with nitrate recirculation (so that nitrates generated in the aerobic zone can be returned where BOD availability is greater) would be required – the existing process does not have such a zone and the existing ELV therefore cannot be guaranteed. An anoxic zone would need to be provided to guarantee compliance with the ELV.
    - It should be noted that, due to alkalinity consumption by nitrification and coagulant dosing, alkalinity boosting using NaOH may be required depending on the outcome of the stormwater separation process and operational results when resuming ferric sulphate dosing.
        - Assuming no denitrification, the max. storage volume required for 27.2d storage would be around 2000l, and 2no. 9.2l/h chemical dosing pumps would be required.
        - If there was an anoxic zone provided upstream of the aeration stage with internal recirculation of nitrates, the denitrification reaction would allow for some alkalinity recovery and drop the requirement to 1500l (29.3d storage) storage and 6.4l/h chemical dosing.
    - Finally, it should be noted that the existing polishing lagoons can actually have a detrimental impact on the effluent quality, due to the risk of algae or other organic matter growing in the lagoons, decomposition of vegetation, animal contamination etc. This was not seen for "Kylemore Remote WQ Baseline Data- 01.11.2021" apart from the 19/10/21 sample where the COD concentration at the outlet of the RBC (SW7) was 29mg/l, against 47mg/l at the outlet of

the lagoon. However, it is a risk that should be considered if a larger upgrade of the WwTP besides the provision of chemical dosing was considered.

4.0 Proposed Solution to Achieve Current ELVs

In order to improve compliance with the ELVs, it is proposed that an optimisation trial be completed to ascertain the level of process guarantees that can be given based on the current process, and the extent of the required additional upgrades. The solution would comprise of two stages.

- First Stage (trial for BOD/Ammonia/Nitrate/OrthoP/TP ELVs):
  - As the RBC appear to be currently underloaded (unit designed for 220PE), the BOD and ammonia results are much better than expected. Consequently, optimisation of the existing infrastructure could be an option, as follows:
    - Convert the existing 2no. precast tanks into 1no. anoxic zone followed by 1no. settlement zone. Provide recirculation from settlement zone to anoxic zone to maintain sufficient biomass in the anoxic zone and allow the denitrification reaction to happen.
    - Provide nitrate recirculation from the manhole between the RBC and the final settlement tank to the anoxic zone, thus allowing the nitrates to be recirculated where BOD availability is greater and enabling alkalinity and oxygen recovery. Provide DO and ORP probes in the anoxic zone to control the nitrate recirculation.
    - Provide aeration stage (submersible aerator) upstream of the RBC so that the RBC operates in fully aerobic conditions and that BOD and ammonia results are optimal. Provide a DO probe at the end of the RBC to control the aeration system.
    - Provide chemical phosphorus removal as per Section 3 Current Treatment Process - OrthoP, TP and residual aluminium ELVs

- Second Stage (TSS ELV):
  - Provide filtration stage downstream of FST
  - Provide sludge tank
  - Bypass the existing lagoons

5.0 Conclusions and Recommendations

Glan Agua recommend for the following steps to be undertaken initially at Kylemore Abbey.

1. Due to the probable issues with the current septic tanks network at Kylemore Abbey as mentioned in Section 3, Glan Agua recommend for rationalisation of the network to bypass the septic tanks. This will negate the issues associated with excessive retention which will ultimately have a detrimental impact on the process performances. The bypassing works should be completed in a gradual manner, and in a reversible configuration, in order to optimise the performances of the system.
2. Due to the recommended bypassing of the septic tank network being completed this will increase the wastewater loadings entering the WwTP. Glan Agua recommend for at minimum 6 months additional laboratory analysis to be completed once the septic tanks have been bypassed. Samples should be captured at the inlet and outlet of the treatment plant to understand the wastewater loading beings received and the level of treatment being achieved by the existing WwTP.
3. Reintroduction of chemical dosing is required as no treatment process will achieve the ELV's without chemical treatment.
4. A Service Level Agreement should be put in place with a competent experienced contractor, with scheduled preventative maintenance visits and operational checks completed.

Once the above steps have been undertaken and additional laboratory analysis results have been received, it will then be possible to review the adequacy of the existing treatment process at Kylemore Abbey and identify whether any additional upgrade is required. The additional laboratory analysis will provide the relevant information for the proposed optimisation of existing infrastructure

Further detail is required as to the process design for the selection of the treatment process at Kylemore Abbey.