CQA INTERNATIONAL LIMITED

Conceptual Design of Water Treatment System

for Proposed AD Facility at Whitwick Manor

Report prepared for:

Name of client: STL Energy Ltd

Date: 5 August 2022

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Environmental Engineers

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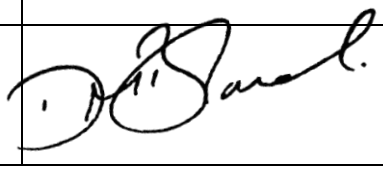
Signature	

Conceptual design of Water Treatment System for Proposed AD Facility at Whitwick Manor

Project Ref: 30550
Date: 5 August 2022

Executive Summary

STL Energy Limited is investigating an opportunity to treat chicken litter, apple pomace and other liquid waste from agricultural sources through an AD system at its Whitwick Manor Farm site in Herefordshire.

As Natural England is setting out a zero-discharge policy for phosphorous in Herefordshire, STL has asked CQA International Limited to provide a conceptual design to treat the digestate from the AD process to meet strict COD and phosphorous limits.

The conceptual design is based on two stages: a soil-based reed bed system to reduce COD and an adsorption system using specially developed clay media for removal of phosphorus.

The selected reed bed concept is to use downward vertical flow beds using a soil-based growing medium. The liquid will be applied to the surface and will infiltrate into the root zone, where the complex treatment processes occur. The total treatment area required is 3.5 hectares, with additional space for earthworks and access.

The phosphorous treatment concept will be vertical downward flow through the media at a controlled rate to ensure sufficient residence time for a high proportion of absorption. The annual quantity of media used will be 4100 tonnes/year. The media will be contained in four tanks which will be used in sequence, allowing batches to be filled, used and emptied as a continuous process. A polishing tank will be placed before the recycling lagoon inlet. The lagoon will be sized to include 5,500m^3 for storm capacity (including a climate change increase) in addition to the operational requirements.

The conceptual design is based on the preliminary data of water quantity and composition that were available, and there was a level of variation and uncertainty in these data. The concept has been based on a flow rate of up to 581 m^3/day, with COD of 28,000 mg/l and phosphorous concentration of 448 mg/l.

It will be necessary to confirm the digestate characteristics prior to detailed design, as the sizing and cost of physical, biological and mechanical elements of the treatment system will rely on these numbers.

It is likely that a treatability study will also be required to demonstrate that the final detailed design can achieve the required discharge criteria.

Contents

1. Introduction

1.1 Terms of Reference

This report has been prepared and submitted by CQA International Ltd (CQAI) for STL Energy Limited (STL).

The subject of the report is the development of a conceptual design to treat wastewater (thin fraction digestate) from STL's proposed anaerobic digestion (AD) process which will process 100,000 tonnes/year of broiler chicken manure and 16,000 tonnes/year of apple pomace and other liquid wastes. The treated water will be reused in the process or, if necessary, discharged to a surface water course, subject to consent.

The site of the proposed AD plant is located in Herefordshire, at Whitwick Manor Farm, Lower Eggleton, Newtown, Ledbury HR8 2UE.

1.2 Scope of Work

The agreed scope of work for the conceptual design study focussed on the following key issues:

- Agree inlet standards based on information provided by STL or other involved parties
- Agree treatment criteria with STL or other involved parties to enable recycling of water or discharge to a local water course.
- Determine the area of land required for a treatment system to achieve discharge standards
- Provide a schematic process layout for the treatment system
- Provide a brief environmental impact statement of the treatment system on local receptors.

The conceptual design has focussed on two key factors:

- Reduction of COD to meet discharge or recycling purposes
- Elimination of dissolved phosphorus in the discharge water from the reed bed system.

The reduction of phosphorous levels, to effectively zero, is of particular importance as a moratorium has been issued by Natural England, to prevent development in Herefordshire until phosphorous levels in the Lugg and Wye catchments are brought down to optimum levels.

The project site is located in the catchment for both rivers and so any discharges to surface water or groundwater are likely to be permitted only with zero phosphorous levels.

1.3 Outputs of Report

This report includes:

- Technical description of how the system will function
- Estimation of land requirements for the reed bed system for different volumes and concentrations of inlet wastewater from the discharge of the AD system
- General layout drawing
- An environmental statement on the potential impacts from the reed bed system

2. Technical Description of Reed Bed System

2.1 Overview and Base Data

The conceptual design is based on

- Soil-based reed bed system to reduce COD
- Specialised baked clay media to remove phosphorus

It is important to note that this study has progressed in parallel with the design of the AD plant and therefore the predictions concerning digestate volumes, COD and phosphorous levels have not yet been finalised. Various estimates have been made available during this study, and the concept has changed slightly as the data varied.

Whilst it is possible to provide a conceptual design for planning purposes using the current parameters, some minor revisions may be necessary to accommodate the final values. It is expected that the criteria for the water treatment system will be finalised prior to commencing the detailed design stage. However, we understand that STL has provided conservative parameter values which are not expected to vary to a significant degree.

2.2 Layout

Reed bed treatment systems are engineered wetlands, which are designed to meet the specific requirements for water treatment at each facility. As such each system is bespoke, and specifically designed to meet the unique treatment requirements.

Reed bed technology is based upon the treatment potential for organic and inorganic substances provided by the three main elements of the systems:

- Soil-dwelling microbes in the vicinity of the root systems
- Physical and chemical properties of the soil materials
- The root systems of the reed plants

Of these elements, the microbial flora and fauna in the vicinity of the root systems is the most important constituent.

The civil engineering surrounding a reed bed treatment zone is not complex. First, an excavated or created void is prepared and is lined to prevent seepage of process water out of the bed and into the environment.

The water may be delivered over the surface of the system, to flow vertically downward to the root zone, as shown in Figure 1.

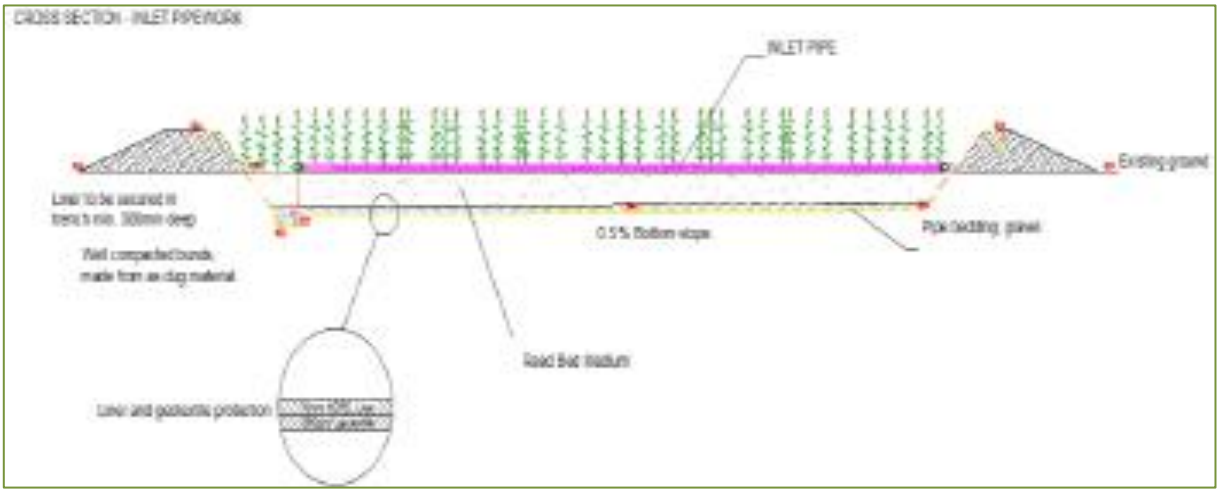


Figure 1 Vertical Reed Bed Treatment System

Alternatively, the inlet water is delivered into a feeder trench at the front end of the system to flow horizontally though the root zone, as shown in Figure 2. The choice of system depends on factors such as the nature of the inlet water and the geography of the site.

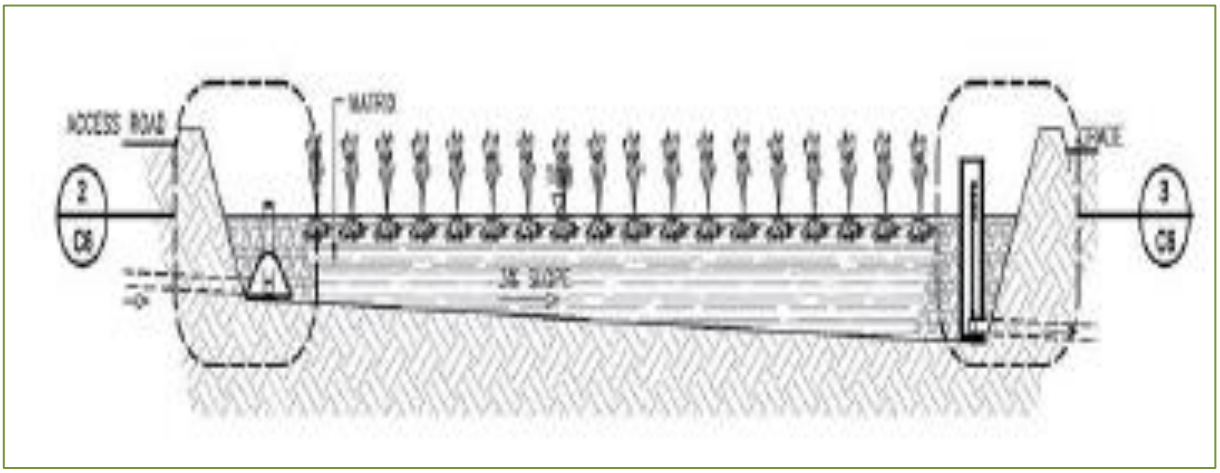


Figure 2 Horizontal Reed Bed Treatment System

As this conceptual design envisages a downward vertical flow system, a drainage system is installed in the base of the reed bed to collect the treated water after it has had sufficient residence time in the root zone. This will comprise a combination of geocomposite drainage mat and a gravel filter.

The void is then filled with an appropriate soil mixture, and the reeds are planted at a carefully selected layout distance in this growing media. Reed beds are natural systems and need time for the root zone and related microbiology to develop. Plants are usually obtained as root cuttings rather than seedlings to accelerate the development period

2.3 Treatability

Treatment in reed bed systems is undertaken principally by bacteria in the soil. Micro-organisms attach themselves to the outside of the soil particles and to the plants and plant roots. These organisms metabolise polluting chemicals, thereby degrading them and providing the treatment process.

Commonly, reed beds are used to degrade sewage effluent – partially treated or raw. However, a wide range of compounds can be treated. With adjusted designs and higher retention times even intractable compounds such as PAH, PCB, dyestuffs, amines, cyanides, thiocyanates, glycols, and other complex compounds can be treated.

The plants (reeds) have two main functions, as shown on Figure 3:

The very extensive root system creates channels for the water to pass through.

The roots introduce oxygen down into the body of soil. This creates areas near the roots where aerobic bacteria can thrive. Slightly away from the roots are oxygen deficient regions, which create an environment where anaerobic bacteria can thrive.

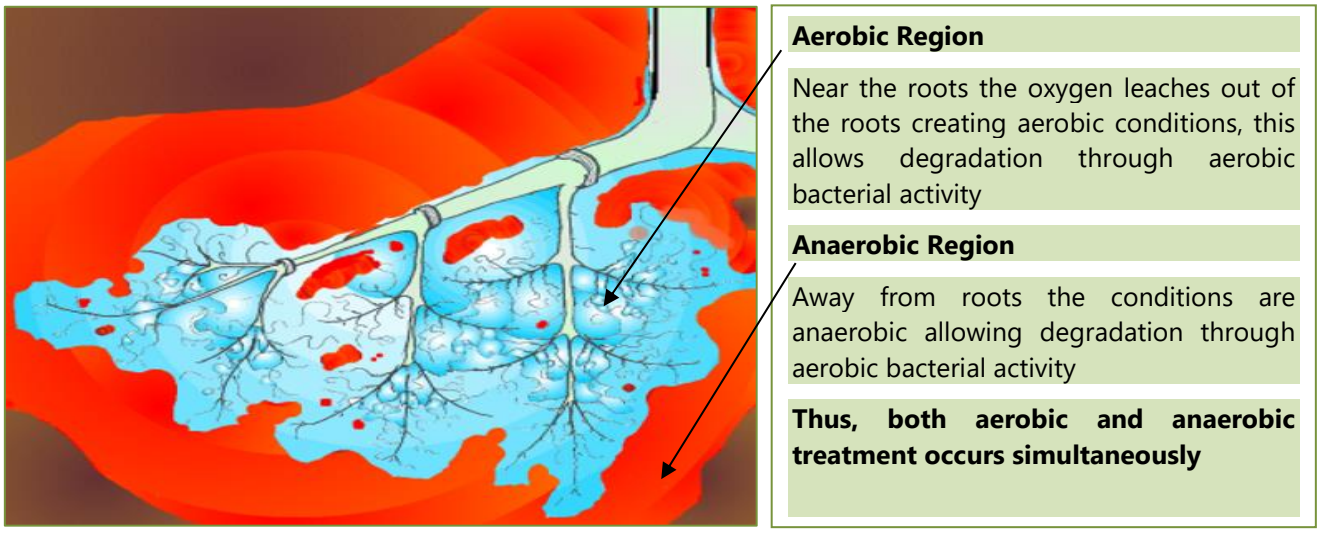


Figure 3 Gaseous pathways in the root zone

There are many pathways for pollution removal. A simplistic overview is presented in Figure 4 to illustrate the processes.

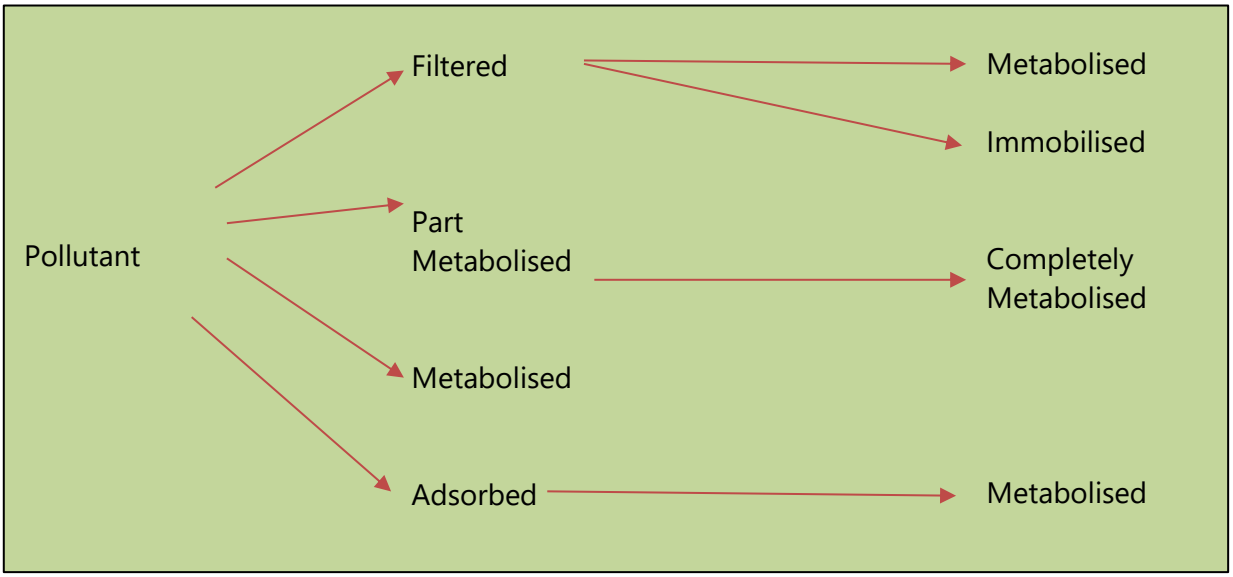


Figure 4 Illustration of Pollutant Removal Mechanisms

It should be noted that most compounds and organic contaminants are degraded, not just stored, in the reed bed. There are hundreds of metabolic pathways for contaminant degradation and the proceses are powerful enough for primary treatment of many effluents, as described below.

Organics	Organic contaminants are fully degraded to leave the end products of carbon dioxide and water. For simple organics, this is a relatively simple, microbial process, which naturally occurs during decomposition of organic matter. The design of the red bed system will create the optimum environment to enhance this natural process. Complex organic contaminants can be more difficult to break down, and degradation may occur in a sequence of processes with different microbes being responsible for different stages. Examples of this include the category of contaminants known as Persistent Organic Pollutants (POPs) which can take a long time to degrade in the environment. Reed bed systems significantly speed up this process and ensure complete breakdown of these chemicals. A specific category of organic compounds, including lignin, melanin and melanoidins, impart brown colouration to water and contribute to COD determinations, without being particularly reactive in the environment. These can be difficult to treat by any method and may need special consideration when discharge standards are determined.

Inorganics	Ammonia and nitrates: These are treated using reed bed systems, using nitrification and denitrification bacteria to breakdown ammonia and nitrates into nitrogen gas.
Phosphorous	Phosphorous compounds cannot be degraded; however, phosphorous can be trapped within a specially designed entrapment media. Typical reed bed designs would include a 'sacrificial zone,' which is a region of the treatment system dedicated to the entrapment of phosphorous. The treatment media would be selected for its phosphorous binding properties and designed for periodic replacement. In this design the phosphorous removal will be an external system after the reed beds. CQA will use an especially developed hi-alumina clay media to remove phosphorous. The media works in two ways. Firstly, it acts like a chemical sponge, it binds with species found in the aqueous environment. Thus, it can be used as a simple filter, put it in "A box" and pour the water through, clean improved water will emerge from the box filter. The design of the filter depends on the strength, flow, and nature of the contaminated water. The second way it will work is as a biological filter where a thin film of biological life is formed on the pellets, and this reduces the strength (BOD and COD) of the wastewater. There is set up within the treatment system, a two-way symbiosis, between the adsorbed chemically bound species, the bio film. It should be noted that once the media is saturated it can be applied to farmland and will have the same manorial value (NPK) as farmyard manure. (ADAS evaluation).
Metals	Removal of metals from the water is also achieved by entrapment within a sacrificial zone. Different metals require different conditions for optimal binding, so the selection of the media and system design is critical for ensuring adequate immobilisation of the relevant metals.
Salts	Salts generally pass through a reed bed unaffected, other than any dilution or concentration effects (e.g., through precipitation and evaporation). Some types of reed bed are very tolerant of salinity, meaning that they can be used to remove organic contamination from saline water, even though the resulting treated water will remain saline. Salts in this context refers to all inorganic salts, typically those comprising of calcium, magnesium, potassium, sodium, bicarbonates, chlorides, or sulphates.

3. Phosphorous Treatment System

3.1 Options and Selected System

CQAI understands that all of the wastewater shall be treated to remove COD and phosphorous for recirculation purposes. This would automatically satisfy discharge consent levels if there is surplus water. If significant residual phosphorus levels are recirculated back into the AD system, the concentration will rise with each cycle and would eventually compromise the treatment system.

The complete removal of phosphorous from effluent by chemical is difficult due to the solubility of the salts and the range of valent states. Removal by physical means is also usually difficult, as this would involve process such as reverse osmosis, which are troublesome in nutrient-rich environments, and only concentrate the phosphorous into a smaller volume of solution.

This conceptual design is based on a new physical treatment system - adsorption into a mineral-based medium.

Green Science, a company based in Leicestershire, has developed a range of water treatment media that can be applied to treating heavily polluted wastewater. All the ingredients in the media are on the DWI approved substances list making them safe to use in human drinking water treatment, and therefore environmentally safe.

The specific media which has been selected to treat the phosphorous-contaminated water is designated "GS100". This is a patented material, produced from a specific type of high-alumina clay that has high affinity for phosphorous, ammonia, and other water pollutants.

The media works in two ways:

- It acts like a chemical sponge, binding with compound in the effluent. Thus, it can be used as a type of filter. The design of the filter depends on the effluent strength, flow rate, and other characteristics of the contaminated water
- It acts as a biological filter where a thin biofilm forms on the pellets, and the microbial activity reduces parameters such as BOD and COD

The combination of chemical adsorption and biological treatment can provide a high level of phosphorous removal, with 95% as a minimum. The combination with reed beds to remove other organic loading will increase the efficiency of treatment.

The media have a finite capacity and need to be changed when the absorption rate drops. The used media will be saturated with nutrients and can be applied to farmland. ADAS have evaluated the used media to have the same nutrient value (NPK) as farmyard manure.

4. Conceptual Design Calculations

4.1 Reed Bed System

The land requirements for treating wastewater are based on the first-order reaction kinetics, assuming that the rate of COD removal is proportional to the quantity of COD within the system at the time.

$$A = Q_d\, k\, \ln\left(\frac{COD_{in}}{COD_{out}}\right)$$

Where A = Area requirement of the reed bed (m^2)

Q_d = Volume of water per day (m^3)

k = Kickuth Constant (see below)

COD_{in} = Biological Oxygen Demand of the effluent (mg/l)

COD_{out} = Biological Oxygen Demand required at the outlet (mg/l).

The Kickuth constant, k, is a measure of the rate at which degradation occurs, and it varies depending on the type of contamination, with higher k values applying to more persistent contaminants.

For the purposes of conceptual design and footprint for the reed bed system the wastewater parameters are set out in Table 1. These parameters are based on data provided by the client's AD manufacturer HOST. HOST has given as range for outlet COD of between 23000mg/l to 28,000 mg/l and have also stated that the daily volumes could range from 466 m^3/day to 569m^3/day. Therefore, to be conservative:

Inlet COD and flow rate/day for conceptual design and land requirements has been taken to be 28,000 mg/l and 581 m3/day, respectively

Outlet COD needs to relate to discharge consent or process requirements and has been set arbitrarily at 20 mg/l at this stage

Discussions with the Environment Agency will be required to agree the discharge levels.

The report from NRM Laboratories shows sodium concentration in the chicken manure to be 2604 mg/kg. Some of this sodium is likely to dissolve into the digestate fine fraction and this will need to be predicted in the design phase and monitored in the operational phase.

Sodium is difficult to remove from water and concentrations above 3000 mg/l could affect the reeds and the soil growing media. We understand that STL does not anticipate problems due to dilution by rainwater and other feedstocks. However, if higher levels are anticipated at a later stage, it may be necessary to carry out further study and include measures such as using salt-tolerant reeds for the project.

Table 1 Wastewater Inlet Parameters		
Contaminant	Units	Value
Chemical Oxygen Demand	mg/l	28,000
Ammonia	mg/l	Not available
Nitrates	mg/l	Not available
Sulphates	mg/l	Not available
Total Suspended Solids	mg/l	Not available
Total Dissolved Solids	mg/l	Not available
pH		7.28
Volume of Wastewater	m^3/d	581

Based on the digestate characteristics given in Table 1 the footprint for the reed bed system calculated as 3.2 hectares. Additional land will be required for the earthworks to create the required levels and gradients. Access routes are also required for maintenance and pipework. In this conceptual design the total footprint is 5 hectares, and this could be reviewed and optimised during the detailed design process.

4.2 Phosphorous Stripping System

The calculations undertaken to determine the total dissolved phosphorus in the digestate are presented in Appendix 3.

To calculate the media required to remove the phosphorus the following calculations are undertaken

1 $Pd = Q_d \; x \; Pww,$ where:

Pd = Daily total amount of Phosphorus in wastewater (mg/d)

Qd= Volume of wastewater (m^3/d)

Pww= Concentration of Phosphorus in wastewater (mg/l)

2 $Md = (\frac{1}{\frac{q}{Q_d}})$ where:

Md= Media required per day (kg/d)

q= Adsorption capacity of the media

Q_d = Volume of wastewater (m^3/d)

3 $Mp = \left((Y\ x\ 365)\ x\ Md\right)\ x\ C$, where:

Mp = Media required for project duration (kg)

Y = Lifetime of project (years)

Md = Media required per day (kg/d)

C = Contingency factor (%)

Table 3 presents the calculated basis for conceptual design of the phosphorous removal system and the quantity of media required for total removal of phosphorus from the digestate.

Table 2 Design Criteria for Phosphorus Removal		
Contaminant	Units	Value
Assumed flow of inlet water from reed beds	m^3/d	581
Average phosphorous concentration (from STL)	mg/l	448
Phosphorus loading	mg/day	60,000,000
Quantity of media required, based on supplier's performance predictions	kg/day	11357
	t/year	4145.32

The media will be contained in 4 large tanks, each containing 900 tonnes (dry weight) and a smaller tank containing 545 tonnes.

Water from the reed beds outlet will be pumped to the top of one of the large tanks and will flow down through the media. The rate of flow will be constrained by the outlet valve, such that the water level in the tank completely covers the media. The residence time of water in the tank will be approximately 6 hours at the highest anticipated flow rate.

The water will flow through the small polishing tank at a similar rate, prior to storage in the recirculate lagoon. The lagoon will be sized to include 5,500m^3 for rain storm capacity (including a climate change increase) in addition to the operational requirements.

The inlet and outlet water quality will be monitored for phosphorous on a weekly basis, or more regularly as required. As the media in the tank become fully utilised, the flow will be switched to another tank. The finished tank will be drained, and the media will be removed for possible sale or use as a nutrient source. The tank will then be refilled. The four tanks will allow for a sequence of filling, emptying and utilisation.

The water in the recirculate lagoon will be stored until needed for reuse in the AD plant. If levels exceed requirements, the surplus water will overflow into the nearby ponds, under the terms of a discharge consent. The layout is shown on the drawing in Appendix 1.

5. Other Issues

Outside of the design of the treatment system, there are several other issues that might be beneficial:

Composting of the solids from AD process

Use of solar panels to meet some process requirements

CQA has experience in these areas and would be pleased to carry out feasibility studies.

6. Environmental Assessment

A preliminary environmental assessment of the proposed treatment system was carried out using a pro-forma basis. This is reproduced in Appendix 2. Overall, there will be no significant environmental impact from the reed bed system and the phosphorous treatment facility.

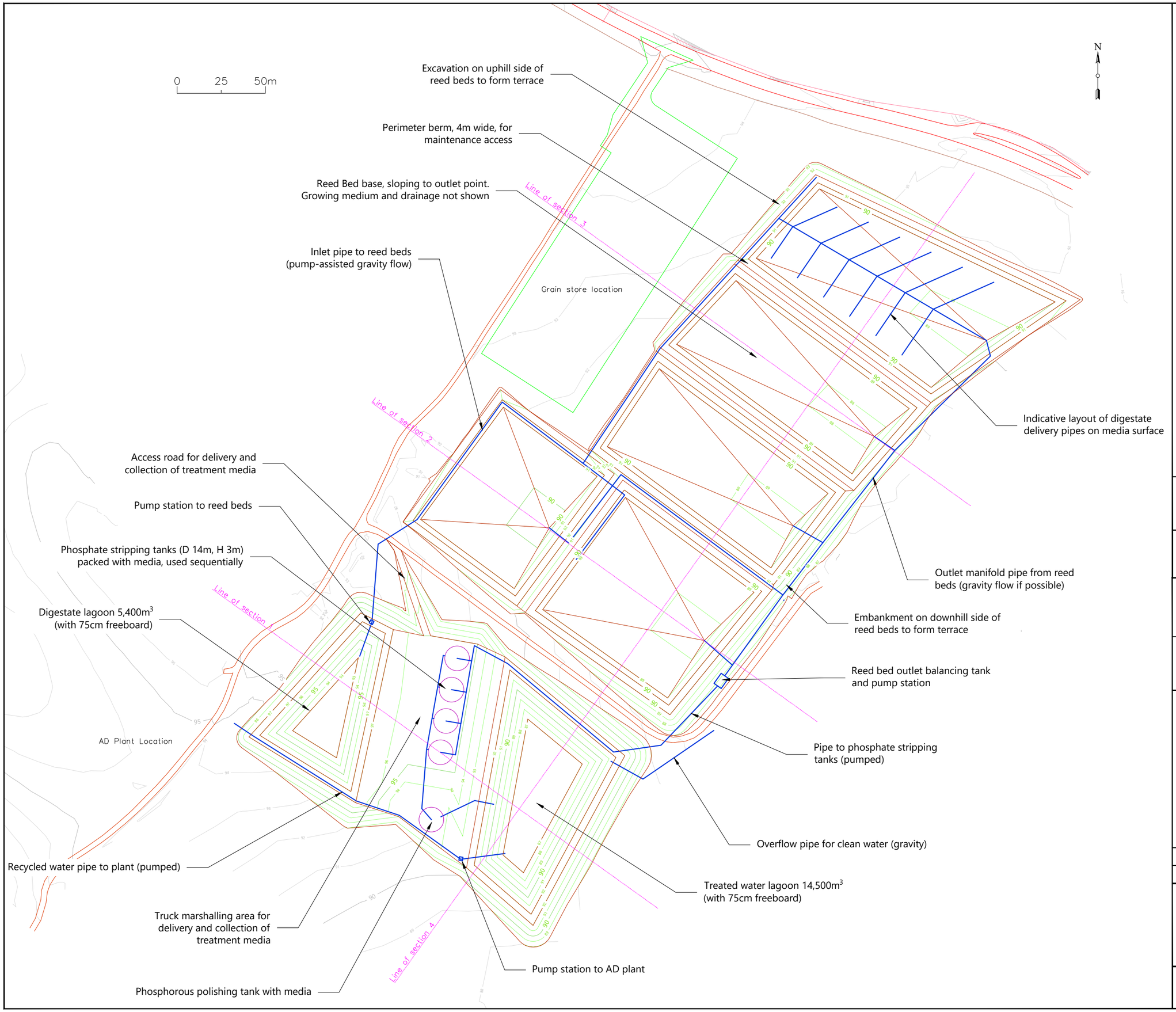
7. Conclusions and Recommendations

The wastewater treatment requirements – to provide suitable quality for reuse or discharge – can be achieved using a combination of reed beds and phosphorous stripping by a special media.

The wastewater characteristics will need to be confirmed prior to detailed design calculations. In addition to COD, phosphorous and trace contaminants, this should include melanins and melanoidins as these are particularly difficult to treat.

When the design specification is agreed, treatability studies should be undertaken to confirm treatment efficacy with analogous water, particularly with respect to phosphorous. The Environment Agency are likely to require demonstration of the viability of the treatment package prior to issuing an environmental permit or discharge consent. This would involve agreeing limits, such as a percentage reduction in COD levels, rather than a fixed target value. This will allow flexibility in the operation.

Appendix 1 General Layout Drawing of Treatment System



NOTES

Topography provided by Client, to British National Grid referenced to ETRF89-OSTN02

Reed beds are downward vertical flow units with 1-2% gradient on basal drainage system

LEGEND

Grey contours - topography

Green contours - conceptual design

Conceptual design breaklines

Blue lines - pipes and tanks

Purple circles - phosphate treatment

PROJECT

Water Treatment from AD Plant

CLIENT

STL Energy Ltd

LOCATION

Whitwick Manor Farm

TITLE

Concept Layout for Reed Bed and Phosphate Removal System

REVISIONS

Rev	Date	Chkd	Description
1	27/05/2022		Adjusted to comply with landscape constraints
0	23/05/2022		Draft for comment

DESIGNED	SB / PS	DRAWN	PS
SCALES @ A3	1:2,000	DATE	27/05/2022

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DRAWING NUMBER 30550/RBC/01L

REV 01

Appendix 2 Environmental Assessment for Red Bed and Phosphorous treatment systems

Case Details
Brief description of the reed bed system
The project is to treat chicken litter and apple pulp through an Anaerobic Digestion (AD) treatment system. The discharge water from the AD facility is being treated through bioremediation in a soil-based Reed Bed system to ensure discharge requirements. This Environmental statement pertains solely to the Reed Bed system and its potential environmental impact. The purpose of this statement is to provide the client with information for incorporation in their Environmental Impact Assessment for the Project.

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
NATURAL RESOURCES				
Will construction, operation or decommissioning of the reed bed system involve actions which will cause physical changes in the topography of the area?	YES	There will be slight changes to the topography of the site.	NO	There will be no significant effect as there will be only slight changes to the topography. There are no watercourses in the area to be developed. The area is currently used for arable agriculture.
Will construction or operation of the reed bed system use natural resources above or below ground such as land, soil, water, materials/minerals, or energy which are non-renewable or in short supply?	YES	The reed bed will utilise soil bacteria and the physical properties of soil to provide treatment to wastewaters. In constructing the system. The existing soil will be used as part of the treatment system or for landscaping the surrounding area.	NO	There will be no significant effect as the existing soil will be used in constructing the reed bed system. NO soil will be sterilised.
Are there any areas on/around the location which contain important, high quality or scarce resources which could be affected by the reed bed system or the phosphorous treatment system, e.g., forestry, agriculture, water/coastal, fisheries, minerals?	NO	Bedrock is the widespread Raglan Mudstone Formation, which is not exploited commercially in the region. There are no superficial deposits. The site has been used for arable agriculture, including silage and energy crops.		
WASTE				
Will the reed bed system or the phosphorous treatment system produce	NO	There will be only very small amounts of construction or decommissioning wastes		

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
solid wastes during construction or operation or decommissioning?		as reed beds are a natural system. The earthworks will have balanced cut and fill, so no surplus material will be produced. The wastes produced will be offcuts of plastic liner and pipe and some packaging (pallets, strops etc). Efforts will be made to reduce offcuts and reuse wastes. The phosphorous absorption media will need replacing after 6 months or annually. However, the material is fully biodegradable and can be used as fertilizer.		
POLLUTION AND NUISANCES				
Will the reed bed system or the phosphorous treatment system release pollutants or any hazardous, toxic, or noxious substances to air?	NO			
Will the reed bed system or the phosphorous treatment system cause noise and vibration or release of light, heat, energy, or electromagnetic radiation?	NO			
Will the reed bed system or the phosphorous treatment system lead to	NO	The reed bed system will be contained by a composite liner comprising clay and	NO	These is a small risk of the liner failing. This will be mitigated be construction

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
risks of contamination of land or water from releases of pollutants onto the ground or into surface waters, groundwater, coastal waters, or the sea?		geomembrane, equivalent to use in landfills. The installation of the liner will be validated by systematic quality control during installation, In addition to the lining system, there are no water courses or significant groundwater under the site. Most of the water in the reed beds will be recycled. Any discharges will be to standards required by the Environment Agency and will thus not impact surface waters.		quality assurance procedures to ensure the liner does not leak.
Are there any areas on or around the location which are already subject to pollution or environmental damage, e.g., where existing legal environmental standards are exceeded, which could be affected by the reed bed system?	YES	As phosphorous discharge or application to land is effectively banned by Natural England and EA, we assume that the area is sensitive to further phosphorous emissions.		
population and human health				
Will there be any risk of major accidents (including those caused by climate change, in accordance with scientific knowledge) during construction, operation or decommissioning?	NO	The process is passive treatment in root zone of the reeds, with flows mainly resulting from gravity. Therefore, there is almost no risk from operations.		

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
Will the reed bed system present a risk to the population (having regard to population density) and their human health during construction, operation, or decommissioning? (For example, due to water contamination or air pollution)	NO	The reed beds will be a green area, which will be on private property and fenced to prevent unauthorised access.		
WATER RESOURCES				
Are there any water resources including surface waters, e.g., rivers, lakes/ponds, coastal or underground waters on or around the location which could be affected by the reed bed system, particularly in terms of their volume and flood risk?	NO	Any discharges will be made via an existing pond, which overflows into a small stream. The water quality will be within regulatory guidelines. The area is designated as having very low risk of flooding. The small stream receiving the low-level discharge flows into the disused Hereford Canal.	NO	The canal has a medium to high flood risk downstream of the discharge point. However, the discharge rate will be only 1l/s, which is expected to be small compared to runoff in the catchment. This will be confirmed by hydrological study during the design phase.
BIODIVERSITY (SPECIES AND HABITATS)				
Are there any protected areas which are designated or classified for their terrestrial, avian and marine ecological value, or any non-designated / non-classified areas which are important or sensitive for reasons of their terrestrial, avian and marine ecological value, located on or around the location and	NO	There will be no impact from the reed bed system to any species or habitats. Experience from reed bed reed bed systems worldwide is that it increases biodiversity providing habitats to wildlife.		

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
which could be affected by the reed bed system? (e.g., wetlands, watercourses or other waterbodies, the coastal zone, mountains, forests or woodlands, undesignated nature reserves or parks. (Where designated indicate level of designation (international, national, regional, or local))).				
Could any protected, important, or sensitive species of flora or fauna which use areas on or around the site, e.g., for breeding, nesting, foraging, resting, over-wintering, or migration, be affected by the reed bed system?	NO			
LANDSCAPE AND VISUAL				
Are there any areas or features on or around the location which are protected for their landscape and scenic value, and/or any non-designated / non-classified areas or features of high landscape or scenic value on or around the location which could be affected by the reed bed system? Where designated indicate level of designation	NO			

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
(international, national, regional, or local).				
Is the reed bed system in a location where it is likely to be highly visible to many people? (If so, from where, what direction, and what distance?)	NO	Almost no houses within the sight line. The reed bed appearance will be green seasonal vegetation, similar to the current crops.		
CULTURAL HERITAGE/ARCHAEOLOGY				
Are there any areas or features which are protected for their cultural heritage or archaeological value, or any non-designated / classified areas and/or features of cultural heritage or archaeological importance on or around the location which could be affected by the reed bed system (including potential impacts on setting, and views to, from and within)? Where designated indicate level of designation (international, national, regional, or local).	NO			
TRANSPORT AND ACCESS				
Are there any routes on or around the location which are used by the public for	NO			

A Screening Criteria	B	Response to the Screening Criteria	C	Is a Significant Effect Likely?
access to recreation or other facilities, which could be affected by the reed bed system?				
Are there any transport routes on or around the location which are susceptible to congestion, or which cause environmental problems, which could be affected by the reed bed system?	NO			
LAND USE				
Are there existing land uses or community facilities on or around the location which could be affected by the reed bed system? E.g., housing, densely populated areas, industry / commerce, farm/agricultural holdings, forestry, tourism, mining, quarrying, facilities relating to health, education, places of worship, leisure /sports / recreation.	NO			
Are there any plans for future land uses on or around the location which could be affected by the reed bed system?	NO			

A Screening Criteria	B Response to the Screening Criteria		C Is a Significant Effect Likely?	
LAND STABILITY AND CLIMATE				
Is the location susceptible to earthquakes, subsidence, landslides, erosion, or extreme /adverse climatic conditions.	NO			
CUMULATIVE EFFECTS				
Could this reed bed system together with existing and/or approved development result in cumulation of impacts together during the construction/operation phase?	NO			
TRANSBOUNDARY EFFECTS				
Is the reed bed system likely to lead to transboundary effects?	NO			

Appendix 3 Phosphorous Level Calculation

Daily Phosphorus levels in wet matter

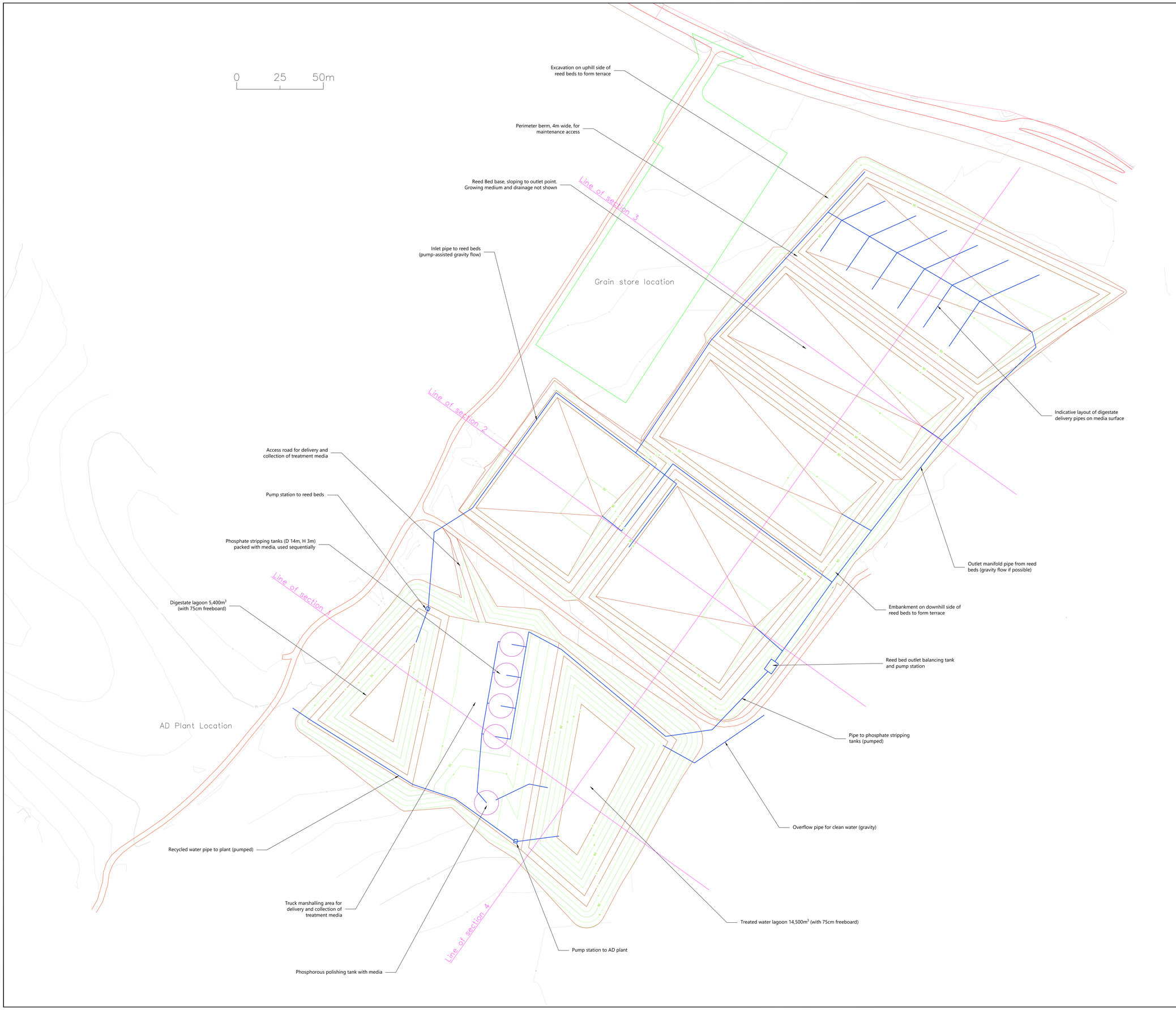
Item	Value	Units	Notes
Dry Matter in Chicken Manure	48	%	From NMR report
Phosphorus in Dry Matter	1.3	%	From HOST / input model
Phosphorus in Wet Matter	0.24	%	From STL
Fresh manure	100,000	t/year	From STL
Operating Days per year	365	days	From STL
Fresh Manure	273.91	t/day	From STL
Daily Phosphorus levels in Wet matter	1.71	t/day	

Water input to system, data from STL

Water	t/d	Solids	m^3/d	Notes
Fresh Manure	273.97	48%	71.23	Assumes 50% of residual water is free water
Apple Pomace	43.83	24%	16.65	Assumes 50% of residual water is free water
Separated digestate	95.89		95.89	
Liquid waste	68.49		68.49	
Recyclate / Rainwater	328.77		328.77	
	810.96		**581.04**	

Phosphorus Concentration

Item	Value	Unit	Notes
Inorganic Phosphorus	85	%	Insoluble
Organic Phosphorus	15	%	Soluble. % Solubility from HOST
Dissolved Phosphorus	0.30	t/day	
Water Input	581.04	m^3	
P Dissolved	0.000448	t/m3	
P Dissolved for design	448	mg/l	



NOTES

Topography provided by Client, to British National Grid referenced to ETRF89-OSTN02

Reed beds are downward vertical flow units with 1-2% gradient on basal drainage system

LEGEND

Grey contours - topography

Green contours - conceptual design

Conceptual design breaklines

Blue lines - pipes and tanks

Purple circles - phosphate treatment

PROJECT TITLE

Water treatment from AD Plant

PROJECT NUMBER

30550

CLIENT

STL Energy Ltd

LOCATION

Whitwick Manor Farm

DRAWING TITLE

Concept Layout of Reed Bed and Phosphorous Removal System

REVISIONS

Rev	Date	Chkd	Description
0	7/06/2022	SB	First issue

DESIGNED	SB / PS	DRAWN	PS
SCALES @ A1	1:1,000	DATE	7/06/2022

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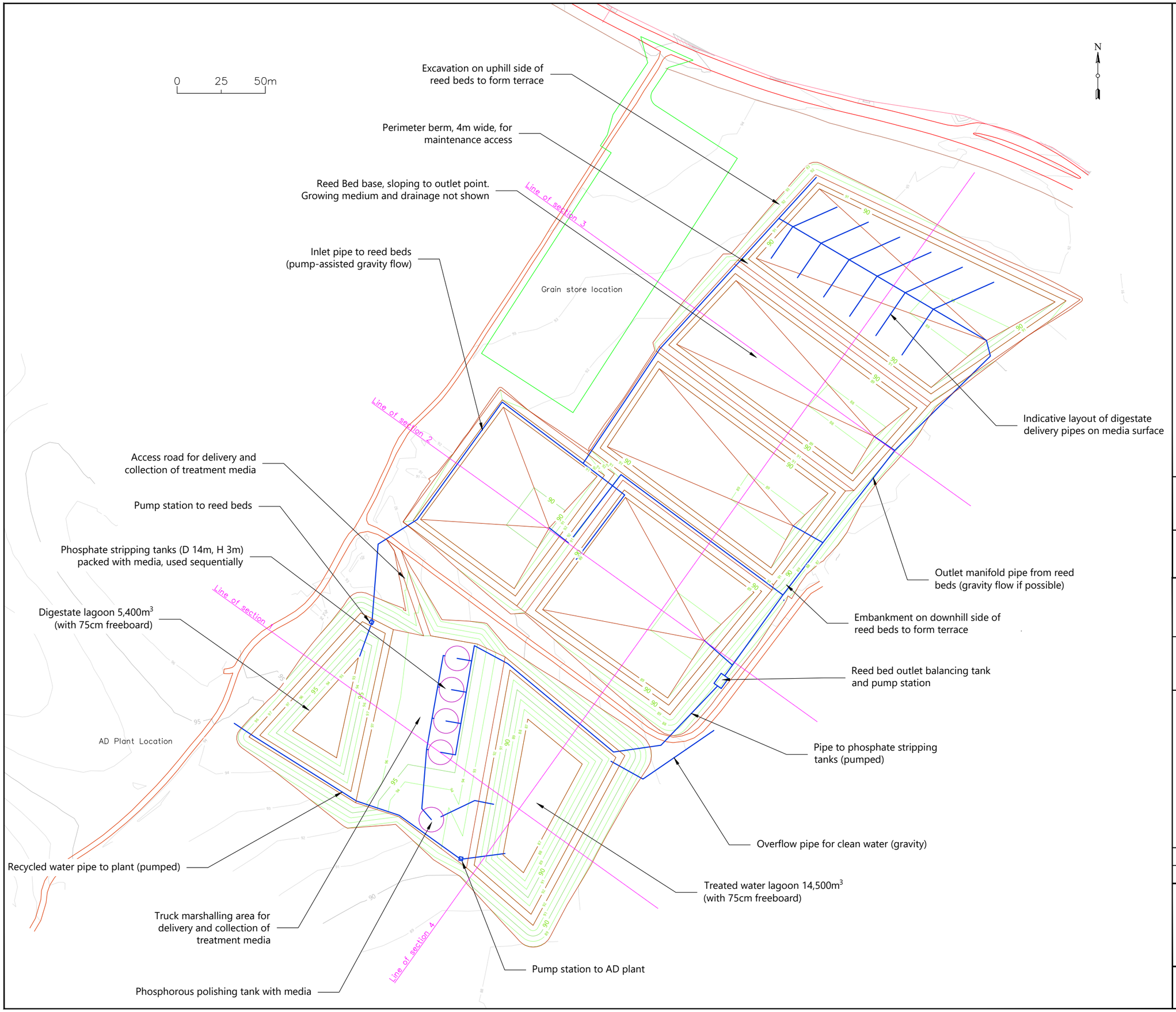
DRAWING NUMBER 30550/RBC/01L

REV 00



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PROJECT

Water Treatment from AD Plant

CLIENT

STL Energy Ltd

LOCATION

Whitwick Manor Farm

TITLE

Concept Layout for Reed Bed and Phosphate Removal System

REVISIONS

Rev	Date	Chkd	Description
1	27/05/2022		Adjusted to comply with landscape constraints
0	23/05/2022		Draft for comment

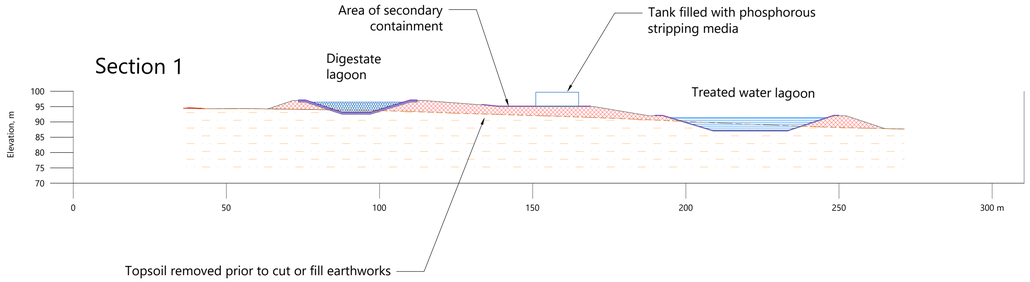
DESIGNED	SB / PS	DRAWN	PS
SCALES @ A3	1:2,000	DATE	27/05/2022

CQA INTERNATIONAL LTD

DRAWING NUMBER 30550/RBC/01L

REV 01

Section 1



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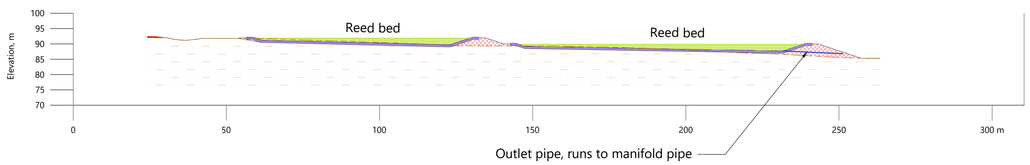

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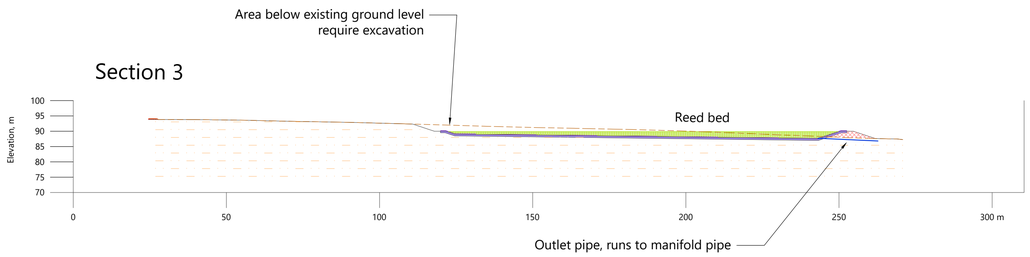

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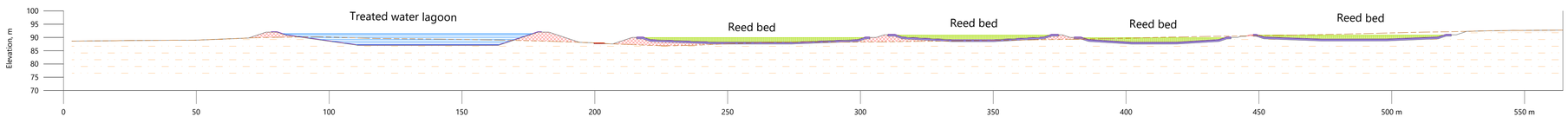

Legend

- Treated water
- Digestate
- Reed bed growing medium
- Geosynthetic liner system
- Engineered clay liner
- Ground to be raised by filling
- Tracks
- Existing ground level
- Bedrock

NOTES

Section lines shown on plan 30550/RBC/01

PROJECT TITLE

Water treatment from AD Plant

PROJECT NUMBER

30550

CLIENT

STL Energy Ltd

LOCATION

Whitwick Manor Farm

DRAWING TITLE

Concept Sections of Reed Bed and Phosphorous Removal System

REVISIONS

Rev	Date	Chkd	Description
0	7/06/2022	SB	First issue

DESIGNED	SB / PS	DRAWN	PS
SCALES @ A1	1:1,000	DATE	7/06/2022

CQA INTERNATIONAL LTD

DRAWING NUMBER 30550/RBC/02

REV 00