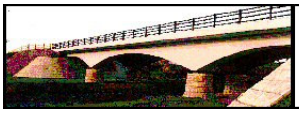
Pumping & Treatment Systems



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Fermoy Waste Water Treatment Works

DRAFT

- Design Submission -

	E.P.S.	Roadbrigde	MCOS
Approved			
Reviewed			
Date			
Rev.	DRAFT		

Table of Contents

1 Introduction

E.P.S. intend to provide a Waste Water Treatment Plant designed in accordance with BATNEEC and the Urban Waste Water Directive 1994. The treated effluent to comply with the standards shown in the following table:

Parameter	Effluent Limit
BOD	25 mg/L
COD	125 mg/L
Suspended Solids	35 mg/L
Phosphate	2 mg/L
Ammonia	3 mg/L
Total Nitrogen	25 mg/L
Sludge	18% DS or greater

Table 1 – Effluent Limits discharge

2 Plant Description

This contract forms part of the Fermoy Main Drainage Scheme. The upgraded Wastewater Treatment Works have an ultimate design flow of 7140 m^3/d at Dry Weather Flow and 673m^3/h at FFT for a Population Equivalent of 20,000.

It is proposed to upgrade the existing treatment plant by introduction of a flow splitting arrangement after the wastewater passes through the new inlet works. 40% of the flow is diverted to the existing wastewater treatment stream. The remaining 60% is directed to a proposed new treatment stream.

Each stream has an aeration phase, a respective secondary settlement phase and return activated sludge phase. Sludge is wasted separately from each stream to a common sludge blend tank, common PFT and common dewatering plant.

Provision is made within the proposed stream for biological P and N removal using an anaerobic/anoxic process.

2.1 Inlet Works

3 No. Pumps will be installed in the existing inlet pump (2Duty/1Standby). Each pump will be capable of pumping 172L/s. Forward pumping rates will be controlled by VSD.

The maximum incoming flow to the inlet works is MFW (343L./s). The inlet works comprises of 2 No. Mechanical Screens, 1 No. Manual By-pass Screen, 1 No. Grit Removal system sized for MFW (343 L/s). Provision is made for a boxed spare.

The two screens installed are capable of passing a hydraulic load of 172 L/s (FFT each screen) and the by-pass bar screen will handle the MFW.

The screens are supplied with a common screening tray with a water supply to clean and convey screenings into a disposal bin. The water supply is controlled via a solenoid valve.

All screenings are washed, separated and deposited in skips for removal off site. Grit will be removed from the base of the unit and deposited into a Grit Classifier. The Grit classifier and washer are complete with enclosed screw delivery to the disposal bin.

An ultrasonic sensor provides level measurement. The transmitter for the flow meter is mounted in the main control panel in the Control building, complete with local flow indicator.

Flows up to FFT receive full treatment. Flows in excess of FFT will overflow a storm weir and flow to the storm water storage tank. The remainder will flow to a splitter chamber which divides flows into 2No. Biological Treatment streams i.e. 60% of the flow will go to the new treatment plant and the remaining 40% will go to the existing.

Offensive odours at the inlet works are controlled by use of an air extraction system and the extracted air is passed through odour treatment system.

2.2 Biological Treatment (Proposed Stream)

E.P.S. propose the A2/O Process for the combined removal of Phosphorous and Nitrogen by Biological methods.

Each stream (Existing/New) is fed from a central channel (Splitter chamber) via an adjustable weir to existing works to new treatment stream, provision is made for a flowmeter on each line. The Biological Treatment associated with the new stream consists of three cells: Anaerobic zone, Anoxic Zone and Aeration Tank.

The Anaerobic stage is designed as a plug flow system with three compartments complete with 1 No. Mixer per compartment to provide full mixing of the contents in each compartment and to maintain a velocity sufficient to prevent solids settlement.

The influent has a total retention time of one hour in the anaerobic zone at FFT. Activated sludge is recycled from clarifiers and mixed with the incoming influent at

a rate of between 0.5 DWF and 1 DWF (VSD controlled). Influent passes to an anaerobic zone to accommodate the combined removal of phosphorous and nitrogen from the system, where it is mixed with return activated sludge (49.6L/s).

Influent passes to an anoxic zone to accommodate the removal of nitrogen from the system, where it is mixed with recirculated mixed liquor (124 L/s).

From the anoxic zone, the mixed liquor is passed through the aeration basin.
The DO control span is operational at 0-2.5 mg/L.

Each recirculation pump is capable of variable return flow of 0-150 L/s.

Each aeration system comprises of a lattice of fine bubble air diffusers and supply networks mounted on the cell floor. Diffusers are arranged so that, with a minimum of 75% diffusers in use, they will maintain the cell contents at a dissolved oxygen level, which can be varied from 0-2.5 mg/l. Diffusers are capable of providing fine bubbles (0.5-3.0 mm. in diameter) with clog free domes capable of preventing inflow to pipe-work when not in operation.

DO probes incorporate self-cleaning mechanism, integrated electronics; handrail mounted tilting bracket and transmitter with local LCD indicator. The readings provided by dissolved oxygen meters are used to automatically control the cell modulating valves to maintain preset dissolved oxygen set-points.

The proposal Air blowers capable of supplying 1,443Nm^3/h (2,286kgO_2/d) at 550 mbar of free air. Provision is made for 2 No. Blowers (Duty/Standby), blower package to consist of positive displacement low pulse, tri-lobe rotary type incorporating high efficiency motors and low noise emission. The blower speed is controlled to maintain a constant preset air pressure in the air delivery header as air demand in the aeration basins varies. Acoustic control measures are in place to limit the operating noise to 85 dBA measured at 1 m distances in free field

conditions. Each blower includes a stainless steel wafer type non-return valve with stainless steel disc and metal seating.

From the Aeration Zone, submersible pumps, return mixed liquor to the Anoxic Zone. This is joined by returned settled activated sludge from the final settling tank into the anaerobic zone.
Sludge is wasted on a continuous basis, directly from the final settlement tank outlet by means of a submersible pump. Sludge age and MLSS is controlled directly within the system by varying the output from the sludge pumps by the use of frequency invertors linked to magnetic flow meters.

2.3 Biological Treatment (Existing Stream)

Influent is fed forward from the proposed flow splitter chamber at 33L/s.

Aeration is provided by 3 No. 7.5kW and 1 No. 11.0kW horizontal rotor-type surface aerators. Sludge recirculation pumps are capable of variable return flow of 0-33L/s.

The D.O. control span is operational at 0-2.5mg/L. The D.O. probe incorporates a self-cleaning mechanism, integrated electronics, handrail-mounted tilting bracket and transmitter with local indicator.

MLSS flows forward to the settling tank by gravity. The existing settling tanks are sized adequately to accommodate 50L/s at an upward flow velocity of 0.75$m^3/m^2/hr$. Sludge settled in the clarifier flows to the existing RAS chamber from where it is returned back to the aeration basin. WAS pumps pump excess sludge to the common blend tank.

2.4 Secondary Settlement Tank

The effluent coming form each aeration stream gravitates to its respective Secondary Settling Tank. The proposed new Settling Tank is designed for a surface loading of 539m³/m²/day, (i.e. 0.75 m/h upward flow velocity) at a hydraulic loading of FFT and a side wall of 3.0m. Tanks are equipped with a rotating half bridge sludge scraper, inlet scum and sludge draw- off pipe work, "V" notch weir plate and baffle-plate and scum collector.

Sludge settled within the secondary clarifier is scraped by means of a bridge mounted scraper which deposits settled sludge into a central sludge hopper from where it is drawn by means of a gravity pipe to the return sludge sump located adjacent to the Settlement Tank. Flows to and from the settling basins are indicated on the control panel in the Control building. The sludge return pump transfer the sludge at a rate of 1 DWF and thus returns settled sludge to the start of the process.

The proposed surplus sludge system consists of 2 No. Surplus sludge pumps (Duty/Standby). Surplus sludge is pumped into the Sludge Blend/Holding Tank. Provision is made for flow measurement, which quantifies surplus sludge removed. The pumps are controlled via AC adjustable frequency drives using set points derived from the metered flows. Transmitters are located on the main control panel in the Control Building.

The plant incorporates a Sludge Blend/Holding Tank for the storage and mixing of all sludge produced within the plant and imported sludge at 0.5% which is delivered to site by road tankers. Imported sludge is passed through a sludge acceptance screen to the sludge acceptance sump, from here the sludge is pumped by duty/standby wet-well pump to the blend tank. These imported sludge's are mixed with the indigenous sludge in the blend tank and pumped to the Picket Fence Thickener @ 0.67% D.S.

The blended product @ 0.67% D.S. is pumped by duty/standby pumpset to the picket fence thickener. The dewatered sludge is pumped from the PFT @ 2% D.S. to the dewatering building where it is concentrated to a minimum dry solids concentration of 18% by sludge belt press. The dewatered sludge can be stored on-site for up to two weeks prior to disposal off-site.

The supernatent from the PFT overflows by gravity to the adjacent waste return sump and is pumped to the inlet works for recycle through the process.

2.5 Sludge Dewatering

Sludge dewatering equipment in the form of a Sludge Belt Press is used to dewater thickened sludge. The sludge is drawn off the PFT at approx 2% DS. The sludge is conditioned by addition of a suitable polyelectrolyte followed by flocculation and dewatering. The final dewatered sludge cake has a minimum dry solid content of 18%, and is removed off site for disposal. The Belt Press is capable of dewatering 1290 kgDS/d. The Ancillary equipment consists of Polyelectrolyte dosing, Flocculation tank, Sludge transfer pumps and a Screw conveyor.

We propose conducting a value engineering evaluation of all existing dewatering equipment prior to confirming use of new plant or refurbishment of existing plant for this application.

2.6 Final Effluent

Final effluent prior to discharge to an outfall is subject to outflow measurement and sampling. Open channel flow metering on the gravity flow common outlet main provides flow measurement. A composite flow proportional wastewater sampler provides sampling.

3 Process Design

3.1 Inlet Works

3.1.1 Inlet Pumps

3 No. Foul Pumps (2 Duty/1 Standby)

$$\text{MFW} = \frac{1235\ m^3/h}{2\ \text{pumps}} = 617.5\ m^3/h = 172\ L/s$$

Flow rate = 172 L/s each pump

No. Required:	3 No. (2 Duty/1 Standby)
Flow Rate:	172L/s
Solids Size:	100 mm

3.1.2 Inlet Screens

$$\text{MFW} = \frac{1235\ m^3/h}{2\ \text{Screen}} = 617.5\ m^3/h = 172\ L/s\ \text{each}$$

No. Required:	2 No. (Duty/Assist)
Flow Rate:	172 L/s
Screening Size:	6 mm

3.1.3 Grit Removal

$$\text{MFW} = \frac{1235\ m^3/h}{1\ \text{Grit Trap}} = 1{,}235 m^3/h = 343\ L/s$$

Flow rate = MFW = 343 L/s

No. Required:	1 No. (Duty)
Max. Flow Rate:	343 L/s

3.2 Biological Treatment (Proposed Treatment Stream– 60% Total Flow)

3.2.1 ***Anaerobic Tank***

1 DWF	4284 m^3/d = 178.5 m^3/h
Recycle Ratio from Settlement Tank	1 DWF = 178.5 m^3/h
Total Flow entering Anaerobic Zone	357 m^3/h
Anaerobic Tank Volume	357 m^3
Dimensions	5 m H x 7 m W x 10.2 L
Retention Time @ 1 DWF	1 h
Phosphorous Removal	3-5% P in wasted sludge
	70 - 90% P in Biological Treatment

3.2.2 ***Anoxic Tank Proposed Stream***

1 DWF	178.5 m^3/h + 178.5 m^3/h (anaerb) = 357 m^3/h
Recycle Ratio from AT	3 DWF = 536 m^3/h
Total Flow entering Anoxic Zone	357 m^3/h
Anoxic Tank Volume	357 m^3
Retention Time @ 2 DWF	1 h
Dimensions	5 m H x 7 m W x 10.5 L
Ammonia-Nitrogen Removal	5% N in wasted sludge
	95% N - Biological Treatment

NH4-N influent + 20%	103.7 kg N/d
NH4-N effluent	8.1 kg N/d
BOD + 20%	864 kg BOD/d
BOD remaining	837 kg BOD/d
Sludge Yield	586 kg SAS/d
Nitrogen Removed by wasted sludge	29.3 Kg N
Total NO_3-N for nitrification	50.4 kg NO_3-N

3.2.3 *Aeration Tank Proposed Stream*

BOD Load + 20%	864 kg BOD/d
[MLSS]	3500 mg/L
F/M ratio	0.1 kg BOD/kg MLSS
Aeration Tank Volume	2518 m^3
Dimensions	5 m H x 26.5 m W x 19 L
Saturation Factor O_2	1.2
Retention Time @ 1DWF	14h
Assumed oxygen – transfer correction factor (α)	0.6
Assumed salinity – surface tension correction factor (β)	0.8
Biological oxygen requirement	(864kgBOD x 1.2)/(0.6 x 0.8) = 2160 kg O_2/d
Oxygen Requirement for nitrification	126 kg O_2/d
Total Oxygen Requirement	2286 kg O_2/d
Assumed $kgO_2/Nm_3.msd$	0.015$kgO_2/Nm_3.msd$ (95-25kgO_2/hr)/(0.015x4.4m) 1,443Nm^3/h @ 550 mbar
Benefit from denitrification	146.2 kg BOD/d
Submersible Depth	4.40m
Spec Oxygen Input	15.50gO_2/Nm^3 x Msd
Air Capacity of Diffuser	4.20Nm^3/hr x unit
Total Diffuser	336 units
Aeration Area of Diffuser	0.063 m^2
Total Surface Area of Diffusers	21.20 m^2
Diffuser Density	4.20%
Oxygen Yield	2.80 kg O2/kWhr

Blowers

Flow Rate:	1,500Nm^3 O_2/h
Absorbed Motor Power:	34kW
Installed Motor Power:	37kW
Sound Press. Level:	82 dBA
Discharge Pressure:	550mmBar

3.2.4 Aeration Tank Existing Stream

BOD load +20%	576 kg BOD/d
MLSS	3,500 mg/L
F/M Ratio	0.06 kg BOD/kg MLSS
Effective Aeration Tank Volume	2,600 m^3
Retention Time @ 1 DWF	22 hrs
Saturation Factor O_2	1.2
Assumed Oxygen-Transfer Correction Factor (α)	0.6
Assumed Gravity-surface Tension Correction Factor (β)	0.8
Biological Oxygen Requirement	(576 x 1.2) / 0.6 x 0.8
	1,440 kg O_2/day
Total NO3 – N for Nitrification	33.6 kg NO_3-N
Kg02 required per kg NO_3-N	4.2 kg02/kg NO_3-N
Total Oxygen Requirement	33.6 x 4.2 = 141 kgO_2/day
	1,440 + 141 = 1,481 kg O_2/day
Water Depth in Aeration Tank	3.7 m
Existing Aeration Equipment	3 No. 7,5 kW surface aerators
	1 No. 11 kW surface aerators
Oxygen input	1.9 kg O_2/kW input/hr (assumed)
Total Aeration Capacity	33.5 x 1.9 x 24 hrs = 1,527 kg/day
Benefit from nitrification = (BOD: NO_3-N – 1: 2.9)	97.44 kg BOD/day

3.2.5 *RAS/WAS Pumps*

RAS required to Anaerobic	24.7 – 50 L/s (0.5 – 1 DWF)
Internal Recycle to Anoxic Tank	100 - 150 L/s (2 – 3 DWF)
Estimated Was produced	(864 kg BOD x 0.7) = 604.8 kg DS/d
@ 1% and ρ = 1000	60.5 m^3/d

3.3 Chemical Treatment/Polishing

3.3.1 *Proposed Stream*

Phosphorous Influent + 20%	37.4 kg P/d
P Removed by A^2/O Process	70-90% P Removal
P Removed by Wasted Sludge	3-5% P Removal
Phosphorous remaining	16.4 – 1.44kg P/d
Phosphorous Effluent Limit	1.2 mg/L = 8.6 kg P/d
Chemical Treatment/Polishing	0 – 92.7L Ferric solution/day
Months storage +20%	3.11m^3

3.3.2 *Existing Treatment Stream*

Phosphorous Influent + 20%	24.96 kg P/d
P Removed by Conventional Process	10 - 25% P Removal
Phosphorous remaining	22.5 kg P/d
Phosphorous Effluent Limit	0.8 mg/L = 2.3 kg P/d
Chemical Treatment/Polishing	157 L/d of Ferric Solution
1 month storage + 20%	5.3 m^3

3.4 Chemical Treatment/Polishing

Phosphorous exists in three main forms in wastewater; ortho-phosphate, polyphosphate and organic phosphate. During aerobic treatment, the later two forms are converted to ortho-phosphate, which is the easiest form to precipitate using chemical addition.

E.P.S. propose to remove phosphorous using chemical dosing of Ferric Sulphate. The Chemical Dosing location for the chemical precipitation of phosphorous is proposed at the aeration tank i.e. simultaneous precipitation, because polyphosphates and organic phosphorous are less easily removed than orthophosphorus. Adding Iron salts after secondary treatment (where organic phosphorus and poly-phosphorus are transformed into orthophosphorus) results in the best removal.

3.5 Secondary Settlement Tank (New Proposed Stream – 60% Total Flow)

4DWF	511m³/h
Up-flow velocity @ 3 DWF	0.75 m/s
Surface area	539 m²
Volume	1212 m³
Dimensions	24mØ x 3 m
Retention Time	3h @ 4 DWF

Extra Settlement Tank for Existing Treatment Stream (40% Total Flow)

No. of Existing Settlement Tanks	2
Volume (each)	540 m^3 (∅ 13 m x 5 m)
3 DWF (each)	90 m^3/h
No. Extra Settlement Tank Required	1
3 DWF	90 m^3/h
Extra Settlement Tank surface area	120 m^3
Up-flow velocity @ 3 DWF	0.75 m/s
Extra Settlement Tank Volume	270 m^3
Dimensions	13mØ x 3 m
Retention Time @ 4 DWF	2.25 hrs

3.6 Sludge Blend/Holding Tank

3.5.1 ***Indigenous Sludge***

BOD Load + 20%	1,440 kg BOD/d
Kg DS/kg BOD	0.7
Sludge Yield @ 0.75%DS	1,008 kg Sludge/d
v = (m/ρ)	134m^3/d

Note: ρ is assumed at 1,000kg/m^3

3.5.2 *Imported Sludge*

Maximum imported per day @ 0.5% D.S.	280kg/day 280 x 100% / 0.5% = 56m³/day
Maximum volume of sludge to be accommodated per day	(134 + 56) = 190m³
Average % solids	(134m³ @ 0.75%) + (56m³ @ 0.5%) = 190m³ @ 0.67%
Volume of Blend Tank	192m³
Volume of sludge acceptance tank	45m³
Cumulative storage capacity	(192 + 45) = 237m³
Retention time available	237/190 = 30 hours

3.7 Sludge Picket Fence Thickener

Maximum volume pumped forward from sludge blend tank: 190.4 m³ @ 0.67 total solids.

Target % solids for sludge exiting PFT: 2.1%

PFT dewatering capability over 24 hours:

Feed: 190.4 m³ @ 0.67%

Increasing % D.S. to 1.34% reduces sludge volume to 95.2 m³

Increasing % D.S. to 2.0% reduces sludge volume to 63.7 m³

The existing PFT has a volumetric capacity of 97m³

Retention time: 12h

Feed from PFT to belt press: 63.7m³ @ 2.0% D.S.

Return liquors to head of works: 190 – 48.51 = 141.49m³/day

3.8 Belt Presses

Maximum feed per day from PFT: 63.7m³ @ 2.0% D.S.

Mass dry solids	63.7 @ 2%
Dry solids loading	1,274kg/day
Design loading for belt press	1,290kg/day
No. required:	2
Expected feed solids concentration	2%
Hydraulic loading	7.96m³/hr (based on 8hr day)
Sludge cake concentration	18% D.S. minimum
Polyelectrolyte consumption	5-7g/kg D.S.
Washwater consumption	1m³/hr
Air consumption	0.7Nm³/hr
Return liquors to head of works	(63.7 – 7.16) = 56.54m³/day

3.9 Polymer Preparation and Make-Up Unit

System offered consists of:

Water consumption: 54L/min @ 3.5 Bar

1 No. Vacuum conveyor for filling the powder hopper from 25kg bags
1 No. 30L capacity powder hopper
1 No. Double screen feeder system
1 No Wetting cone
1 No. Make-up water arrangement
1 No. 300L maturing tank
1 No. 300L dosing tank

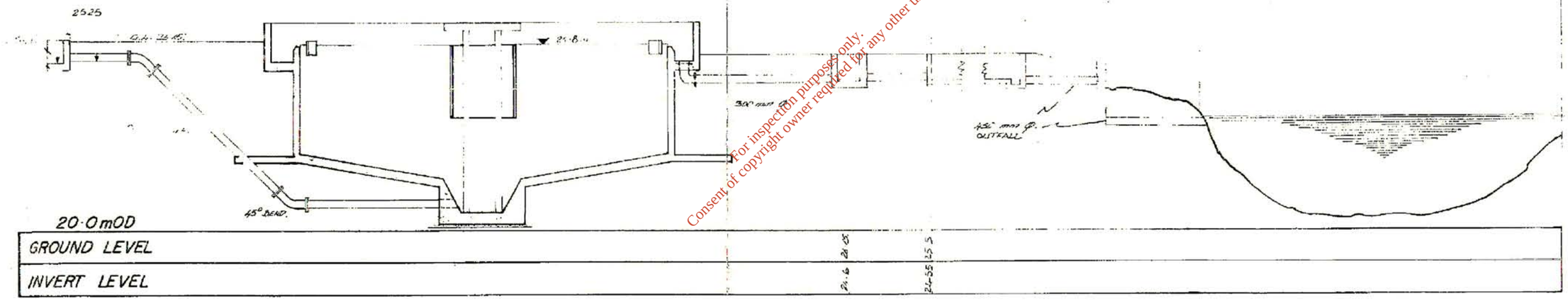
HYDRAULIC SECTION THROUGH WORKS

F.S.T. INLET
SLUDGE
CHAMBER

FINAL SETTLING TANK

MANHOLE MEASURING CHAMBER

RIVER BLACKWATER



AMENDMENT DETAILS	DATE
[redacted]	

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PROJECT: FERMOY WWTP EPA – DISCHARGE LICENCE APPLICATION

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: ATT. C.1 – FINAL EFFLUENT OUTFALL

SCALE: N.A.	JOB NO: 2778	DRAWING NO: FERMOY 09
DATE: NOV'07	DRAWN BY: BE	