Connolly's
RED MILLS

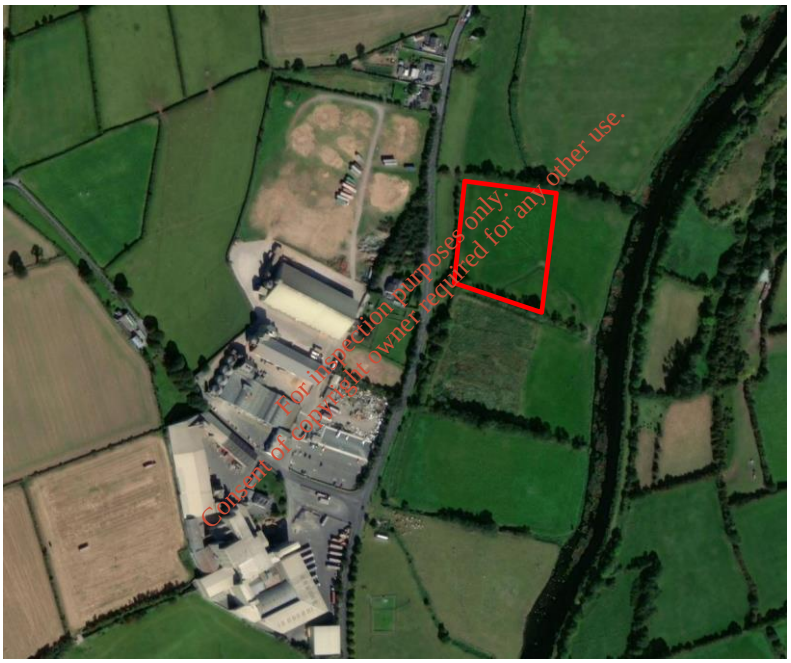
WILLIAM CONNOLLY & SONS

REDMILLS,

GORESBRIDGE, CO KILKENNY

INTEGRATED CONSTRUCTED WETLAND (ICW) SYSTEM – PHASE 2

AS-BUILT PERMEABILITY ASSESSMENT



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Client :-
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Redmills,
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Co. Kilkenny.

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1. INTRODUCTION

An assessment of the as-built permeability of the basal layer of Phase 2 of the Integrated Constructed Wetlands (ICW) system at Connolly's Redmills has been undertaken in order to assess the basal permeability prior to final planting out of the ICW system and prior to connection of the ICW system to the surface water drainage system from the area of the Redmills facility site that shall drain to the system.

An earthworks specification has been developed in respect to the construction of the basal layer and embankments of the ICW system. The earthworks specification has been development so as to ensure that the basal layer of the ICW system achieves a minimum permeability of 1 x 10^{-8} m/s in accordance with the Integrated Constructed Wetlands Guidance Document – DoEHLG, 2010. A copy of the earthworks specification is included in *Appendix A*.

The contractor has confirmed in writing that the ICW system has been constructed in accordance with the earthworks specification contained in *Appendix A*. A copy of the contractor's correspondence in this regards is contained in *Appendix B*.

2. DESCRIPTION OF PERMEBAILITY TESTING PROCEDURE

The as-built permeability of the ICW basal layer was assessed by undertaking a number of falling head permeability tests within each cell of the ICW system.

1m long, 100mm diameter uPVC test pipes (labelled as TP14, TP15, TP16, etc) were placed within each cell of the ICW system at the locations illustrated in *Figure 1* below. Each pipe was driven approximately 100mm within the 300mm thick constructed basal layer.

Following placing of pipes within each ICW cell each pipe was filled with water and allowed to stabilise for a period of 24 hours. The top of each test pipe was capped so as to ensure the water levels in each pipe were not affected by any rainfall amounts or by natural evaporation.

Figure 2 below illustrates the typical location of test pipes within Phase 2 ICW Cell 5.

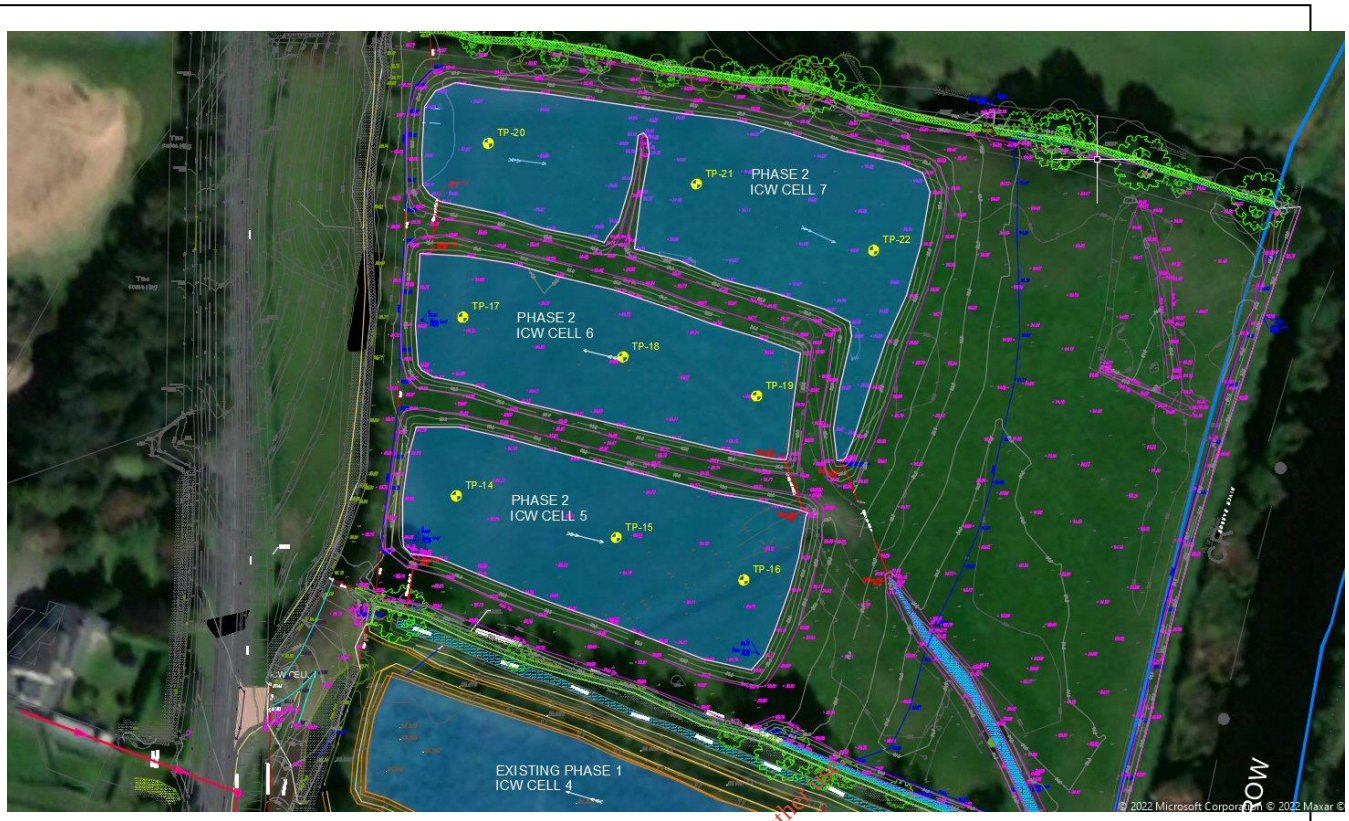


Figure 1 – ICW Cell Test Pipe Locations

Figure 2 – ICW Cell 2 Test Pipes

3. PERMEABILITY TEST RESULTS

Following the initial 24 hour stabilisation period each test pipe was filled with water where required so that a 1m head of water was applied to the basal layer at each test location.

Testing commenced at 9:30am on 24th January 2022 for a duration of 120 hours (5 days). At each 24 hour interval the water level in each test pipe was observed and any drop in water level was measured accordingly.

The results of the falling head permeability test are summarised ion *Table 1* below.

	Water Level Measurements (mm Below Top of Test Pipe)				
Test Pipe Location	24/01/22	25/01/22	26/01/22	27/01/22	28/01/22
TP-14	0.0	0.2	0.8	1.1	1.2
TP-15	0.0	0.3	0.6	1.2	1.8
TP-16	0.0	0.4	0.9	1.7	2.1
TP-17	0.0	0.1	0.5	1.3	1.9
TP-18	0.0	0.2	0.7	1.5	2.0
TP-19	0.0	0.4	0.8	1.6	2.2
TP-20	0.5	0.9	1.2	1.8	2.4
TP-21	0.6	1.0	1.4	1.6	1.8
TP-22	0.3	0.6	1.1	1.5	1.9

Table 1: Falling Head Permeability Test Results

The ICW system has been constructed to an earthworks specification in order to achieve a minimum basal permeability of 1 x 10^{-8} m/s.

In consideration of a minimum basal permeability of 1 x 10^{-8} m/s and a 1m head of test water, this equates to a maximum permitted drop in test water level of 0.864mm after 24 hours, 1.73mm after 48 hours, 2.59mm after 72 hours, 3.45mm after 96 hours and 4.32mm after 120 hours.

As presented in *Table 1* above, the results of the falling head permeability testing fall within the maximum permitted drop in test water levels as presented above.

In this regard the as-constructed basal layer of the ICW system has been constructed to the minimum required permeability of 1 x 10^{-8} m/s in accordance with the Integrated Constructed Wetlands Guidance Document – DoEHLG, 2010.

APPENDIX A

ICW Earthworks Specification

1.0 GENERAL

1.1 Scope

This specification covers the requirements for earthworks in relation to the construction of the proposed integrated constructed wetland system and pond system to provide tertiary treatment for the proposed primary and secondary wastewater treatment system at Redmills, Goresbridge, Co Kilkenny. The works shall be in general accordance with B.S. 6031 "Code of Practice for Earthworks" and in accordance with *'Integrated Constructed Wetlands – Guidance Document for Domestic Wastewater Applications – DoEHLG, November 2010'.*

1.2 *Definitions*

1.2.1 Engineer

The Engineer referred to in this specification means the Civil/Structural Engineer appointed by the Employer or the Architect for the purposes of the construction contract.

1.2.2 Contractor

The Contractor (including sub-contractors) referred to in this specification means the person or persons responsible for the physical undertaking of construction of the proposed wetlands system and pond areas.

3.0 Subsoil Liner Construction

3.1 General

It is imperative that the subsoil liner in the floor and inner bank surfaces of each wetland cell and the pond areas and the core of the embankments are thoroughly compacted. If the subsoil liner is stony or has a relatively high gravel content the proportion of these materials present shall be such that they are embedded in the dense matrix of the subsoil liner itself and do not create any air-filled porosity by bridging or result in the liner subsoil losing any of its overall plasticity. If these conditions are met the overall hydraulic conductivity will be reduced rather than increased. A 20+ tonne (at minimum) tracked excavator shall be used to construct the store and effect optimum compaction. Floors and banks shall be built in layers/lifts of 150 mm and compacted until the desired density and sealing has been achieved.

A minimum of four runs (two each in cross directions) per lift should give adequate compaction in normal conditions. On sites susceptible to groundwater pollution a minimum of six runs or its equivalent with compacting machinery shall be used. Alternative compaction plant may be used if it can be clearly demonstrated that **at least** equivalent compaction will be achieved.

3.2 Compaction of Subsoils

The design and construction of compacted subsoil liners is governed by the strength and degree of compaction required to ensure low permeability. The geotechnical component of a subsoil liner is determined by the nature of the subsoil being utilised. The base and part slopes of the wetland system shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to a permeability of 1×10^{-8} m/s over a thickness of 0.3 m. Achieving the required permeability may require compaction of a minimum thickness of subsoil resulting in a compacted subsoil liner.

3.3 Compactive Energy

Compactive energy is a function of the weight of the machine used to effect compaction, the thickness of the lift and the number of passes of the machine over each lift. Additional passes cannot be used to compensate for machines that are too light for the construction of the liner. Machine size is usually specified in terms of contact pressure exerted by the machine. For a hydraulic excavator, the contact pressure is determined based on the operating weight of the machine and the contact area of the machine on the ground. (e.g. Hydraulic excavator 20000 kg operating weight, track width 600 mm, tumbler length 2.5 m. Therefore the contact pressure = (20000/(2.5 x 2 x 0.6)) = 65.4 kPa).

Weight is important to ensure that penetration of the specified loose lift is attained. A lift thickness of 150 mm is suitable for most compaction procedures and coupled with a 20000 kg hydraulic excavator capable of exerting a ground pressure greater than 40 kPa and a minimum of four passes per lift, effective compaction should be achieved.

Table 1 below lists typical ground pressure values for various types of tracked excavators. If tracked excavators are to be used for compaction at this facility then the 'Track Length on Ground' should comply with *Table 1* below:-

Track length on ground	Track width	Machine weight	Ground pressure		
(m)	(m)	(kg)	($kg.m^{-2}$)	(kPa)	(psi)
3.00	0.6	13950	3875.0	38.0	5.5
3.27	0.6	19700	5028.1	49.3	7.2
3.28	0.6	20575	5235.4	51.3	7.4
3.37	0.6	18070	4468.3	43.8	6.4
3.37	0.6	19300	4772.5	46.8	6.8
3.37	0.6	20095	4969.1	48.7	7.1
3.37	0.6	19021	4703.5	46.1	6.7
3.45	0.6	19650	4746.4	46.5	6.8
3.66	0.6	23069	5252.5	51.5	7.5
3.66	0.6	21340	4858.8	47.6	6.9
3.83	0.6	24200	5265.4	51.6	7.5

Table 1 - Ground pressure values for a sample of hydraulic excavators

If the contractor proposes to employ a non-vibrating or vibrating roller for this facility contract he shall comply with the compaction requirements listed in *Table 2* below.

The table below is adapted from the NRA specification for roadworks and gives guidance on the required construction requirements for different types of compaction plant to ensure an impermeable compacted subsoil liner.

Type of compaction plant	Category	Max. depth of compacted layer	Minimum number of passes
		(mm)	(No.)
Smooth wheeled roller (mass per metre width of roll):	over 2100 kg to 2700 kg over 2700 kg to 5400 kg over 5400 kg	125 125 150	8 6 4
Grid roller (mass per metre width of roll):	over 2700 kg to 5400 kg over 5400 kg to 8000 kg over 8000 kg	150 150 150	10 8 4
Tamping roller (mass per metre width of roll):	over 4000 kg	225	4
Vibratory roller (mass per metre width of a vibratory roll):	less than 700 kg over 700 kg to 1300 kg over 1300 kg to 1800 kg over 1800 kg to 2300 kg over 2300 kg to 2900 kg over 2900 kg to 3600 kg over 3600 kg to 4300 kg over 4300 kg to 5000 kg over 5000 kg	100 125 150 175 200 225 250 275	Unsuitable 12 8 4 4 4 4 4 4

Table 2 – Compaction Guidance for Roller Plant

3.4 Construction of Liner to Achieve Required Impermeability

Constructed liners for the proposed wetland system and pond areas at this facility shall have, on completion, a permeability of less than 1 x 10^{-8} m/s and shall be at least 0.3 m thick, over at least 0.75m of undisturbed subsoil.

The liner on the banks and floor shall be constructed of suitable excavated dense plastic subsoil material only. It is imperative that the subsoil liner in the base of the ponds, the inner bank surfaces and the core of the banks are thoroughly compacted, as listed in this specification.

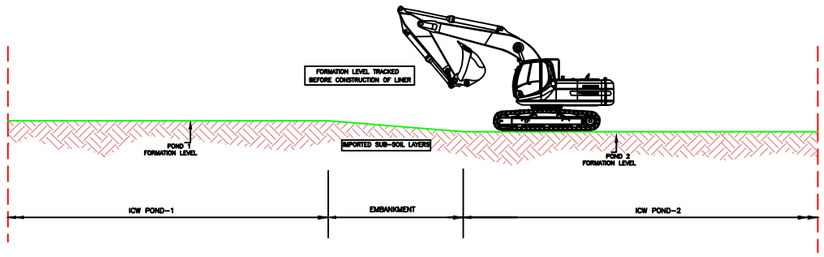
The liner on the pond base and banks shall be built in layers/lifts of 150 mm and each layer/lift compacted until the desired permeability has been achieved. The excavator shall make a minimum of 4 passes per lift (two each in cross directions) over the liner soil so as to compact the material for 0.3 m thick liners. Each layer comprising the compacted subsoil liner shall be fully compacted prior to placement of the next layer.

Once the full depth of liner has been constructed, the inside floor and bank slopes shall be smoothed off and compacted (plastered) with the track machine using a remoulded subsoil. This is particularly necessary when the liner is constructed in dry conditions.

Compaction shall be effected by means of a hydraulic excavator with a minimum weight of 20 tonne capable of exerting a ground pressure of at least 40 kPa (40 kN.m^{-2}) (e.g. a 20 tonne excavator with tumbler length 3.7 m and track width 0.6 m shall exert a ground pressure of 44.17 kPa). Alternative suitable compaction plant may be used if it can be demonstrated that ***at least*** equivalent compaction can be effected.

4.0 Construction of Embankments

Embankments should be constructed from firm sub-soil material with at least a 10-13% clay content. An impermeable liner should be provided to embankments for a minimum face height of 0.45m on the pond side only. The liner should be constructed as per *Section 3.0* above. Top-soil material can be used to landscape the embankments prior to any seeding.



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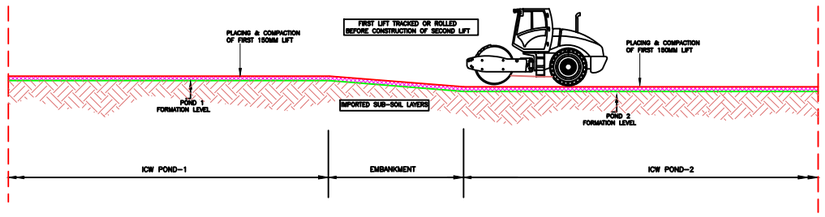

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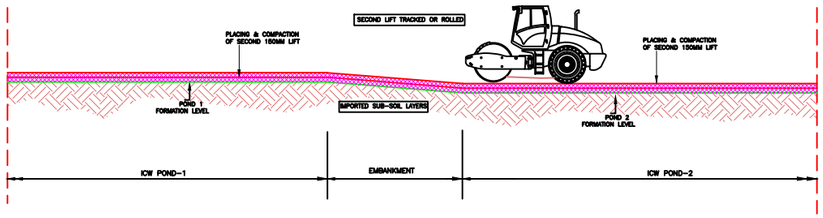

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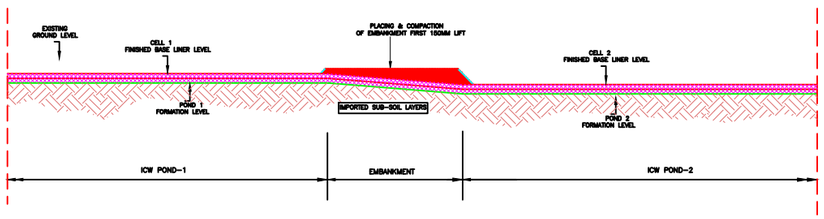

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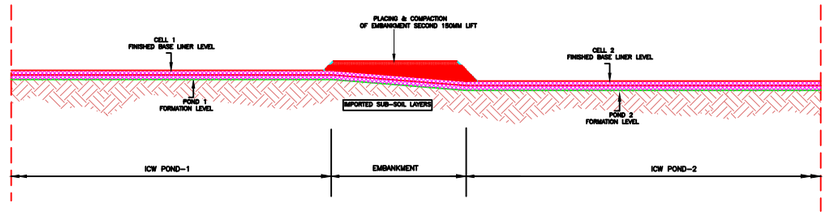

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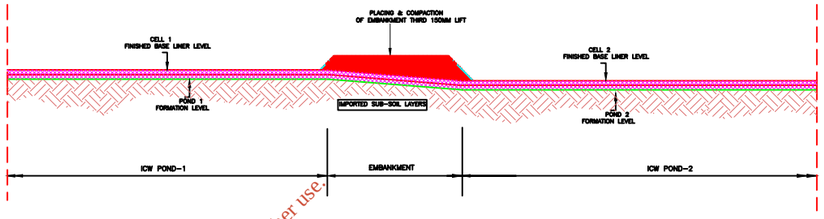

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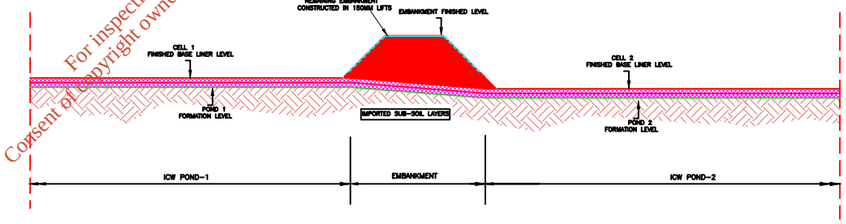

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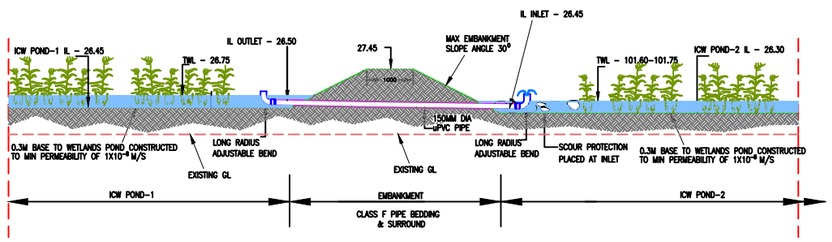

SEQUENCE OF LINER & EMBANKMENT CONSTRUCTION
TYPICAL SECTIONAL ELEVATION DETAILS
SCALE - NTS @ A3

NOTES:-

1. DO NOT SCALE FROM THIS DRAWING

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A	06.03.13	ISSUED FOR PLANNING	TP	PMS

Connolly's RED MILLS

WILLIAM CONNOLLY & SONS
LOWER GRANGE, GORESBRIDGE, CO KILKENNY

PROPOSED INTEGRATED CONSTRUCTED WETLANDS (ICW) SYSTEM

SEQUENCE OF LINER & EMBANKMENT CONSTRUCTION

TYPICAL SECTIONAL ELEVATION DETAILS

IE CONSULTING
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INNOVATION CENTRE
GREEN ROAD
CARLOW
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DRAWING STATUS: PLANNING		SCALE:	AS_SHOWN A3
		DATUM:	ORDNANCE
		DRAWN:	LM
DRAWING NUMBER: IE771-004	REV A	CHECKED:	PMS
		APPROVED:	-
		DATE:	11.02.13

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AND BE PLOTTED USING THE FOLLOWING CTB FILE :- N:\IE539-001.CTB

APPENDIX B

Contractors Correspondence

Ger Murphy Plant Hire
& Civil Engineering Works

Contact Ger – 087 2523407

13/01/2022

To Whom it may concern,

Phase 2 of the Integrated Constructed wetlands constructed at Red Mills is in line with the IE Consultants specifications.

Regards,

Julianna Dunne,

Gerard Murphy Plant Hire Ltd.