

4. Design



4. Design

Detailed Design:

“the complete and precise physical description of all parts of the structure to be constructed”

Note: where one phase ends and the next phase begins can vary from project to project

Detailed Design - Introduction

- **Detailed Design Purpose** – Enabled EA to use contractors on ‘Construction Only’ Framework and agree key scheme details with landowners before they were built (no further input from designers)
- **Modular Design** – Development of suite of ‘Standard Details’ to enable re-use of template details / design drawings on future sites (e.g. DMRB, SfA etc)
- **Pre-Construction Information** – Designers Hazard Elimination and Management Record (DHEMR) and Hazard Map issued along with Client PCI information
- **Maintenance and Monitoring Plan** – Landscape Management Plan (Operation and Maintenance Manual) and Monitoring Strategy

Failure Modes – Leaking Dams



[Jeremy Repairs Dam #ClarksonsFarm - YouTube](#)



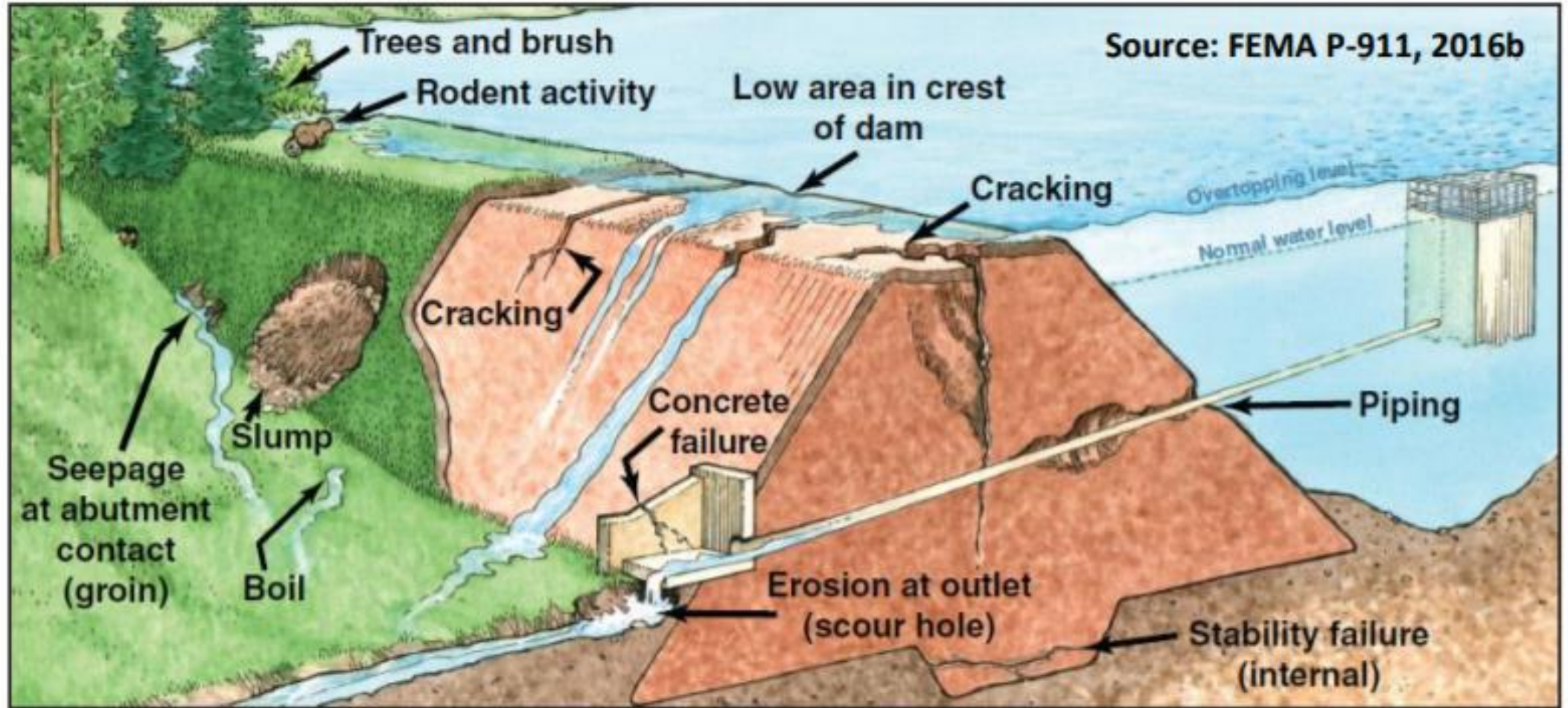
[Leaking Dam #ClarksonsFarm - YouTube](#)

Failure Modes – Earth Bunds



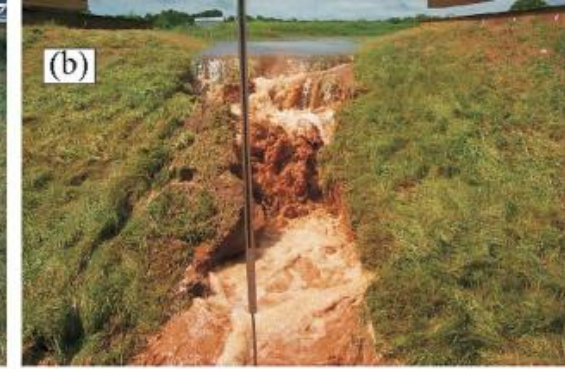
<https://youtu.be/09ANN1u0e9Q>

Failure Modes – Embankments



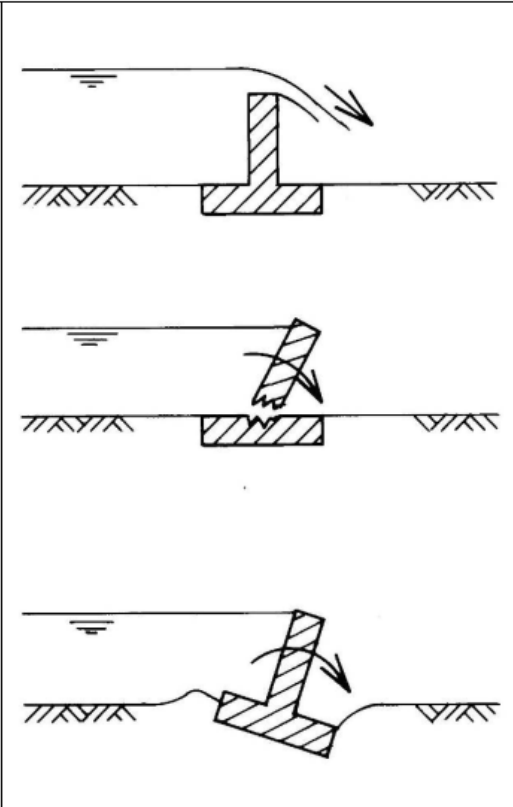
High risk: Pipes in gravel bedding through earth bunds

Failure Modes – Embankments



Failure Modes – Flood Walls

Box 9.1 Common failure modes for flood defences



Overtopping leading to failure

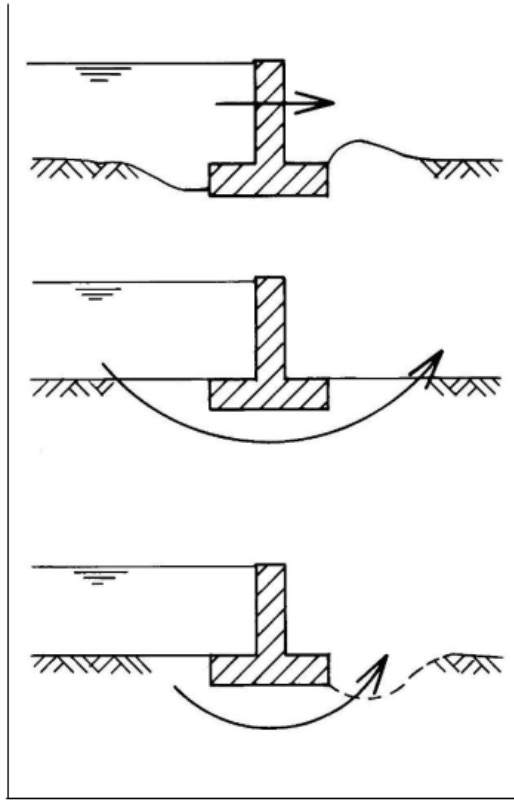
Overtopping of a defence does not necessarily result in failure – the defence may have been designed to be resilient if overtopped. However, if the defence collapses during overtopping, the consequences may be more severe than if there were no defence. Overtopping of an embankment can wash away the crest, leading to a breach.

Structural failure

In this case there is a structural failure of part of the defence, leading to loss of ability to retain water. A sudden collapse can be very dangerous, as it can lead to rapid inundation in the defended area without warning. A breach is the equivalent mode for an embankment. Collapse can also result from erosion of the riverbank if the defence is close to the river.

Rotation

Here the defence has rotated under the action of the hydrostatic load, which may include uplift under the base of the wall. A partially rotated wall may remain stable for some time, but the defence level is likely to have been compromised and there remains a risk of collapse under future loading.



Sliding

This may appear to be a 'safe' form of failure when viewed in cross section. In reality, the sliding may open up cracks between adjacent parts of the defence and the foundations may be compromised.

Seepage

If the quantity is modest, seepage under the defence can usually be dealt with by pumping. Excessive seepage can lead to local flooding and may damage the foundations (see piping below). Seepage can occur through an embankment as well as under it, often as a result of damage by burrowing animals. Local collapse of the embankment may result.

Piping

In extreme cases, seepage flow under a defence can cause the soil on the defended side to become buoyant, creating a void. This can lead to sliding or rotational failure of the wall, or a breach in an embankment. Flow through an embankment can also result in piping failure. The addition of a cutoff to lengthen the seepage path is often the most effective way to avoid piping failure.

Safety Moment

- **Your examples of NFM failure?**

Detailed Design – Scheme Summary

- **Construction seasons** - works split into 2 stages (planting and earthworks)
- **Phase 1:**
 - Hedgerow planting (120 metres)
 - Buffer Zones (3no. total area 368m²)
 - 9 no. Individual Trees
- **Phase 2:**
 - 11 no. Leaky Barriers (<10m³ each)
 - 2 no. Seasonal Habitat Ponds (<100m³ total)
- **Design Drawings:**
 - 26 Drawings issued for Construction

Phase 1 – Masterplan

Phase 1 Landscape Masterplan
1:1000@A1

Phase 1 Notes:
N1. New trees T1 to T9 to be planted in locations 1A and 1B. T1 to be *Sorbus aucuparia* (Rowan) & T2 to be *Acer campestre* (Field Maple); T3 to T9 to be a mixture of *Tilia x europaea* (Common Lime), *Fagus sylvatica* (Common Beech), *Quercus petraea* (Sessile Oak) and *Quercus robur* (Common Oak) planted 15m away from the existing dry stone wall boundaries with spacing of approximately 10m between each new tree (refer to drawing no. 'C0700_3' - Tree Planting - Areas 1A & 1B for further details).

Proposed Field Naturalised Buffer Zones

Phase 1 Notes:
N2. New buffer Zones 1C, 1D & 1E comprises a strip of naturalised grass with intermittent water tolerant shrub planting. Emorsgate EMB Meadow mixture for wetlands/ seed mix and native high moisture tolerant tree species. Fencing to be provided to exclude livestock. Existing overhanging trees to be pruned as necessary.
N3. New post and wire stock-proof fencing (no barbed wire) along indicated route of fencing.
N4. New pedestrian gate location shown in marked arrows) an alignment of fencing to allow access into enclosed areas (1C, 1D and 1E).
N5. New post and rail fencing to transition between post and wire fencing and existing boundaries e.g. dry stone walls, fences etc.

Proposed Native Hedges

Phase 1 Notes:
N6. New hedges 1F and 1G to be a mix of native species, planted in double staggered row along alignment of existing post and wire fencing.
N7. Western end of hedge 1F to terminate at existing field gate. Eastern end of hedge 1F to connect to relocated gate.
N8. Western end of hedge 1G to connect to relocated gate. Eastern end of hedge 1G to terminate at new field gate.
N9. New post and wire stock-proof fencing (no barbed wire) offset along northern and southern side of new the new hedge.
N10. New post and rail fencing at ends of hedges 1F and 1G to be secured with suitable fixings to allow removal for maintenance access.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks:

- Existing utility services: digging to be read in conjunction with utilities record plans.
- Existing steep cliff edge/leading ground: north of Area 1C.
- Existing dead tree: between Trees T1 and T2.
- Existing springs: south of Area 1C and 1E.
- Existing livestock: sheep grazing in farm fields.
- Existing septic tank: near farm house.
- Existing buried spring water pipe: between trees T3 and T4.
- Existing abandoned well: in field with 1B, 1D, 1E, 1F and 1G.
- Existing bore hole: near farm house entrance.

Refer to site hazard plan drawing for full details of site hazards.
 Designer's Risk Assessment Reference: ENV0001395C-MMD-NA-MF-RA-LD-K0500_1

Proposed Trees

Legend

- Residual Risk, refer to Safety Health and Environmental Information
- Existing overhead power line - Northern Power Grid TMV Electricity Supply
- Existing below ground water - Yorkshire Water Binch (2023rev) uPVC Raw Water Main
- Existing below ground telecable - BT Apparatus
- Existing buried spring water pipe
- Existing public right of way
- Proposed fence line and access point (Gate)
- Proposed native hedging
- Proposed field naturalised buffer zone
- Proposed tree

Notes

- No dimensions are to be scaled from this drawing.
- This drawing is to be read in conjunction with the reference drawings and together with the specifications and pre-construction information.
- Location of all existing services to be identified and marked out prior to undertaking works.
- Location of all new works to be marked out with survey stake or pegs and string line for review and approval by Land Owner prior to commencing any works.

Reference drawings

All reference drawings provided with ENV0001395C-MMD-NA-MF-DR-LD-K0500_1 - Tree Planting - Areas 1A, 1B
 C0700_4 - Buffer Zone Fencing - Areas 1C, 1D & 1E
 C0700_5 - Buffer Zone Fencing - Areas 1C, 1D & 1E
 C0700_6 - Hedge Planting - Areas 1F & 1G
 C0700_7 - Hedge Plan

Rev	Date	Drawn	Description	Checked	Appr
04	19/08/2023	MA	Published Design for Construction	PM600	JRF
03	20/07/2023	AA	Quoted for Client Review & Comment	PM600	JRF

APPROVED

Client

Leeds FAS2 NFM Marfield Farm (Earby) Pilot Site Phase 1 Landscape Masterplan

Designed	Drawn	Eng check	2nd check	Issue
J. Harvey	A.S.			Issue
C. Henson	C.S.			Issue
		Approved	3 Issues	2023

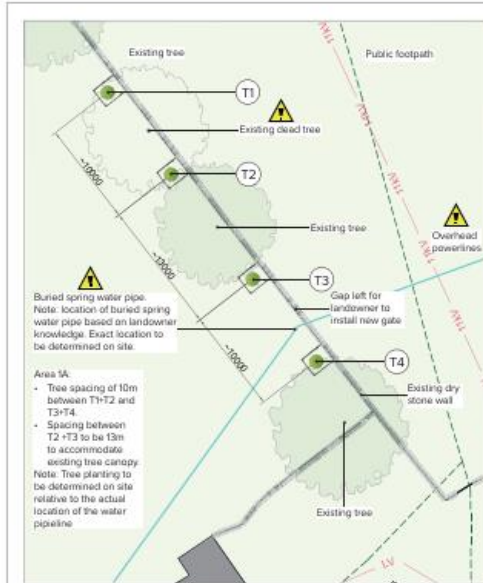
AMMD Project Number 398931 **Scale** at A1 **Security** STD

Subsidiary Description
Published Design for Construction
 Drawing Number: Project-Origination-Volume-Location-Type-Revision-Number
 ENV0001395C-MMD-NA-MF-DR-LD-C0700_2

Sub	Code	Revision	Subsidiary Part	Issue Stage	Discontinued
A4	04	C0700	EA4	LOD4	

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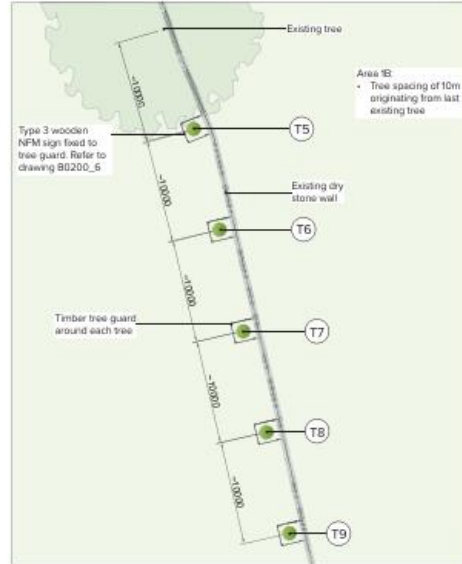
Phase 1 – Individual Trees



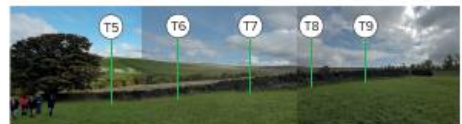
Inset Plan: Area 1A - showing Tree(s) T1 - T4
1:200@A1



1 Image 1: Existing site with indicative locations of new tree positions labelled
Not To Scale



Inset Plan: Area 1B - showing Tree(s) T5 - T9
1:200@A1



2 Image 2: Existing site with indicative locations of new tree positions labelled
Not To Scale

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks:

- Existing utility services: drawing to be read in conjunction with utilities record plans:
 - Buried spring water pipe between trees T3 and T4
 - Overhead power lines in field to north of trees T1 to T4
- Existing dead tree between trees T1 and T2
Refer to site hazard plan drawing for full details of site hazards.

Designer's Risk Assessment Reference:
ENV0001025C-MMD-HA-MF-9A-LD-K0500_1



3 Image 3: Tree guard example
Not To Scale (for reference only)

Table 1 - Tree Specification Sheet

Botanical Name	Common Name	Plant Size (cm)	Root	T1	T2	T3	T4	T5	T6	T7	T8	T9	Total
Quercus robur	Oak (common)	12-14	RB				X				X		2
Quercus petraea	Sessile Oak	12-14	RB						X				1
Tilia x europaea	Lime (common)	12-14	RB			X						X	2
Sorbus aucuparia	Rowan	12-14	RB	X									1
Acer campestre	Field Maple	12-14	RB		X								1
Fagus sylvatica	Beech (Common)	12-14	RB					X		X			2
Total:												9	

Note: RB = 'Rootball'. Estimated weight of trees is ~100kg.

Table 2 - Tree guards

Product	Quantities	Note: For tree guard specification refer to reference drawing 'B0200_4'
Type 1 tree guard	9no.	

Design Considerations

- Native species (Field Maple, Rowan, Beech, Oak and Lime)
- Timber tree guards to protect trees from grazing livestock

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Management Drawing 001 (DWG) - 2015, 1st Issue, 2015, 1:5000 00000000

Phase 1 – Individual Trees

Section A-A Plan View
Scale 1:10

Double stake and tie for standard trees
Front Elevation
Scale 1:10

Notes

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm.
- This drawing is to be read in conjunction with the relevant drawings and together with the specifications and pre-construction information.
- Trees to be planted as shown on the project drawings.
- Each tree to be secured in place with a double stake, using 8.8m long 75mm diameter machine rounded softwood (treated) tree stake posts, driven at least one-third into the ground at either side of the tree trunk and secured parallel to the tree with rubber ties. Stakes to be positioned outside of the root ball area of the plant.
- Ties shall be of a species suitable for fencing, from FSC (Forest Stewardship Council) certified sources.
- All trees shall be of local provenance and be to BS 2838 part 1, conforming to the requirements of the National Plant Specification prepared by The Horticultural Trades Association.
- Trees shall be free from pest or disease, the root ball should be free from perennial weeds and trees shall be planted within 48 hours of arriving on-site in suitable weather conditions, preferably the same day.
- Trees to be planted into pits minimum 800 x 800 x 600mm deep. On existing ground machine horizontal bases and vertical walls with no less than the minimum depth throughout. Break up pit bottom to a minimum of 300mm.
- Backfill tree pit with tree in centre with the following pre-prepared mix: 70% excavated topsoil (from the pit) / 30% Peat-free planting compost / plant fertilizer.
- Following back-filling of the tree pit match using a coarse-grade wood chip match over planting soil, to a minimum depth of 70mm. Match a circular area of approximately 1.2m diameter.
- Plastic spiral tree wrap to be fitted to all new trees. Wrap to extend a minimum of 600mm up the tree trunk from ground level to protect from rabbit damage.
- Water each tree with a minimum of 25L of water upon planting.
- The Contractor is to confirm their proposed design and the recommended installation/finishing details for their products, where different from the requirements outlined on this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work outlined on this drawing, note the following significant residual risks:

- Presence and location of any existing buried services to be established in accordance with TAC 128 before breaking ground.
- Refer to project specific safety, health and environment information.

Designer's Risk Assessment Reference:
Refer to project specific document

Key to symbols

- GL Ground Level
- Backfill
- Existing Ground
- Match layer
- Break Up Pit

Reference drawings

1:10 0 0.5m 1m

Rev	Date	By	Description	Checked	App'd
01	12/06/2019	MM	Published Design for Construction	MM	JMR
02	12/06/2019	MM	Issued for Client Review & Comment	MM	JMR
03	07/07/2019	MM	Issued for Client Review & Comment	MM	JMR

Rev: 03 Date: 07/07/2019 Description: CH/NE App'd: JMR

Client
Environment Agency
Leeds
8 City Park
Leeds
LS11 5AP

Tree
Leeds FAS 2 NFM
General
Standard Details
Tree Stake and Planting

Design	Checked	By	Eng Check	Plant Review	Plant
MM	MM	MM	MM	MM	MM

MMD Project Number: 388931
Scale: AS SHOWN
Security: STD

Published Design for Construction

Drawing Number: ENV0001395C-MMD-NA-MF-DR-LD-B0200_5

Sub. Code	Revision	Delivery Ref.	Work Stage	Development
A4	03	B0200	EA4	LOD4

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Phase 1 – Individual Trees

Detail 1 Side Elevation
1/10

Detail 2 End Elevation
1/10

Detail 3 Plan
1/10

Notes

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm. All levels shown in rAOD.
- This drawing is to be read in conjunction with the relevant drawings and together with the specifications and pre-construction information.
- The guard installation arrangements and requirements to be specified on the project drawings.
- Seam post and rail fence dimensions, general characteristics and corresponding designations are shown in BS1722-7:2006, Table 1.
- Timber components shall be of sawn timber conforming to BS 1722-7, Annex A with applicable tolerance given in BS1722-7:2006+A1:2018.
- Main posts as specified in BS1722-7:2006, Table 1 shall have a cross-section consistent throughout their length.
- Timber shall be of a species suitable for fencing from FSC (Forest Stewardship Council) certified sources.
- Timber components shall be suitably designed to avoid the collection of water at joints.
- Timber shall be treated with preservative to BS6417: Rails - class 3, posts - class 4. Any cuts or exposed untreated surfaces to be retreated with suitable preservative.
- Posts to be round, planed/peeled, smooth, 100mm long, conforming to BS 1022-2 and top-40 galvanized in accordance with BS EN ISO 1461. Washers shall conform to BS 4320. Bolts, nuts, washers and rails shall conform to BS EN ISO 1461.
- Wire to conform with BS EN 10223 or BS 4132 and be one of the following: zinc or zinc coated alloy wire (4.0mm, 4.5mm or 5.0mm Ø); zinc or zinc coated high tensile wire (2.5mm, 2.55mm or 3.15mm Ø); organically coated high tensile wire with zinc or zinc alloy coated core (3.15mm Ø, 4.0mm Ø overall).
- Fencing installed in fields containing livestock shall require a wire mesh. Wire mesh size to be specified in accordance with Table 6 of BS 1722-2:2006 (e.g. C69/30 for sheep). Mesh to be applied to timber posts and struts in accordance with section 4.6.2 of BS 1722-2:2006.
- Clearance between fence rail and dry stone wall to be maximum 100mm. Centre of line to be a minimum of 1.5m away from dry stone wall.
- A single panel of railings on the wind elevation is to be made removable for maintenance access, to be secured with latches with nuts and bolts (see note 11).
- All things shall be installed to avoid protruding elements (e.g. countersink screws and recessed nuts flush with surface) and any large timber splinters removed/banded.
- The Contractor is to confirm their proposed design and the recommended installation/filing details for their products, where different from the requirements outlined on this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the responsibilities normally associated with the type of work detailed on this drawing, the following significant medical risks are:

- Presence and location of any existing buried services to be established in accordance with PAS 126:2014 (Specification for underground utility detection, verification and location) before breaking ground.
- Refer to project specific safety, health and environmental information.

Designer's Risk Assessment Reference:
Refer to project specific documents

Key to symbols

- Ground Level
- Backfill
- Concrete
- Existing Ground
- Dry Stone Wall

Reference drawings

All reference drawings provided with ENV001395C-MMD-NA-MF-DR-LD-80200_3-Standard Detail - Tree Stone and Planting

NFM Shared NFM Community Drawing

Please email comments and suggestions to: 894245@nfm.com or 894245@nfm.com

1:10 0 0.2m 1m

Rev	Date	Origin	Description	Checked	App'd
01	12/08/2019	SM	Published Design for Construction	PMMA	JW
02	25/08/2019	SM	Issued for Client Review & Comment	PMMA	JW
03	02/09/2019	SM	Issued for Client Review & Comment	PMMA	JW

Rev: Date: Origin: Description: Checked: App'd:

Status Stamp: **APPROVED**

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Client: **Environment Agency**

Env: Environment Agency
L: L1 City St
L: L1 City St
L: L1 City St

Tit: **Leeds FAS 2 NFM General Standard Details Timber Tree Guard Type 1(3 sided)**

Designated	Author	Rev	Eng Check	Paul Mott	PMMA
Drawn	Michael Henshaw	001	Co-ordinated	Paul Mott	PMMA
Check	Paul Mott	001	Approved	John Patten	JW

MMD Project Number: 398931
Scale at A1: AS SHOWN
Security: STD

Published Design for Construction
Drawing Number - Project-Originator-Volume-Location-Type-Role-Number
ENV001395C-MMD-NA-MF-DR-LD-80200_4

Sub Code	Revision	Delivery Ref	Work Stage	Development
A4	03	B0200	EA4	LOD4

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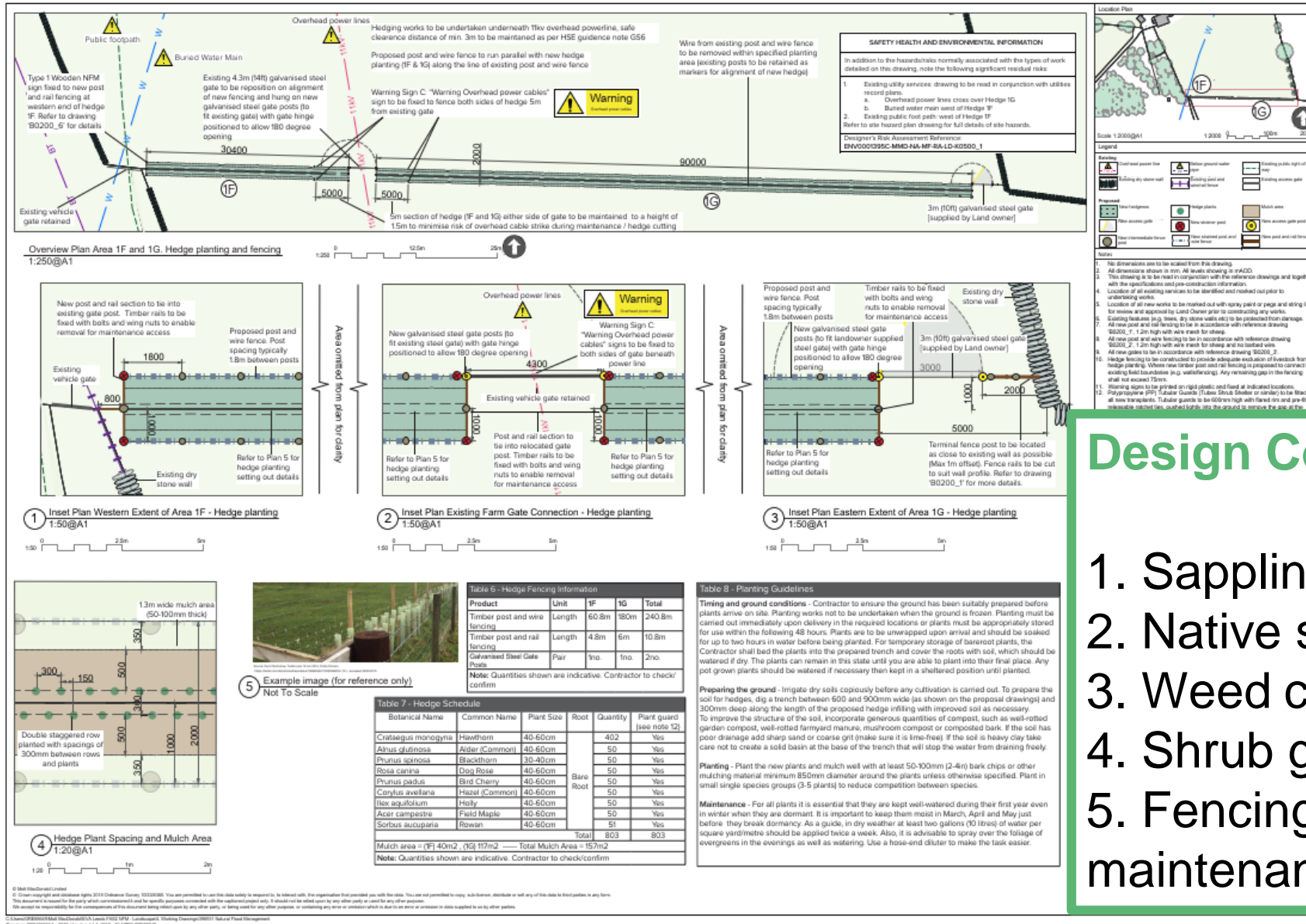
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Environment Agency
Leeds
L1 City St
L1 City St
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Leeds FAS 2 NFM
General Standard Details
Timber Tree Guard
Type 1(3 sided)

Phase 1 – Hedgerow

4. Design



- ## Design Considerations
1. Sappling spacing
 2. Native species
 3. Weed control/mulch
 4. Shrub guards
 5. Fencing: spacing and maintenance access

Phase 1 – Fencing & Gates

Post and Rail Fence - Type 1
Front Elevation

Detail A

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NFM Shared NFM Community Drawing

Leeds FAS 2 NFM General Standard Details Timber Post and Rail Fencing Type 1

388931 AS SHOWN STD

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EN0001395C-MMD-NA-MF-DR-LD-B0200-4

A4 03 B0200 EA4 LOD4

Timber Post and Wire Fence (Sawn Timber Height 2.1m Shown)
Front Elevation

Table 4 - Dimensions of Sawn timber fence posts and struts

Height (m)	Intermediate posts		Strutting posts		Struts	
	Length (m)	Base dimension (mm)	Length (mm)	Section (mm)	Length (mm)	Section (mm)
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125

Table 5 - Dimensions of Round timber fence posts and struts

Fence Height (m)	Intermediate posts		Strutting posts		Struts	
	Length (m)	Top diameter (mm)	Length (mm)	Top diameter (mm)	Length (mm)	Top diameter (mm)
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125
1.8	2.1	75	125	125	125	125

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NFM Shared NFM Community Drawing

Leeds FAS 2 NFM General Standard Details Timber Post and Wire Fencing

388931 AS SHOWN STD

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EN0001395C-MMD-NA-MF-DR-LD-B0200-2

A4 03 B0200 EA4 LOD4

Detail 1
Rear Elevation
Type 1 - Timber Field Gate

Detail 2
Rear Elevation
Type 2 - Timber Field Gate

Section A
Type 1 - Single Leaf Field Gate for Pedestrian Access (1.2m to 2.1m wide)

Section B
Type 2 - Single Leaf Field Gate for Vehicular Access (2.4m to 4.2m wide)

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NFM Shared NFM Community Drawing

Leeds FAS 2 NFM General Standard Details Timber Field Gates Type 1 and 2

388931 AS SHOWN STD

Environment Agency

Published Design for Construction

EN0001395C-MMD-NA-MF-DR-LD-B0200-3

A4 03 B0200 EA4 LOD4

Notes

- All dimensions are to be taken from this drawing.
- All dimensions shown in mm. All levels shown in m AOD.
- This drawing is to be read in conjunction with the relevant drawings and together with the specification and pre-construction information.
- The type of gate and width to be installed at a specific location shall be as indicated on the project drawings.
- The opening direction of the gate shall be as detailed on the project drawings where gates are located adjacent roads. If not shown, gates shall be as shown on the relevant sections of BS 5470.
- Where pedestrian gates are located on public footpaths, the relevant requirements of BS 5250 shall apply.
- Where emergency access is required at single leaf gates the minimum gate width shall be 2.7m. For footpaths, the minimum width between posts shall be 1.50m. Where gates are larger than 2m x 2.5m timber top rail and 125 x 75 hanging rails shall be used.
- The timber framing arrangements shown are indicative only. Alternative arrangements complying with the requirements of BS 5470 may be used.
- Gate posts shall not be used as retaining walls for kerbs.
- Timber shall be of a species suitable for fencing, from FSC (Forest Stewardship Council) certified sources.
 - Class 2
 - Class 4
- Timber shall be treated with preservative to BS 8417.
 - Class 2
 - Class 4
- Any cut ends or exposed untreated surfaces to be treated with suitable preservative.
- Design to incorporate all BS standards.
- Timber shall be installed in a standard pre-drilling pattern (i.e. construction screws and screws into flush with surface) and any large timber girths pre-drilled.
- All work shall be to BS 5470 (Specification for timber gates) and BS EN 14843 (Specification for timber gates) and the accompanying installation / fixing details where different from the requirement outlined on this drawing.

APPROVED

MOTT MACDONALD

NFM Shared NFM Community Drawing

Leeds FAS 2 NFM General Standard Details Timber Field Gates Type 1 and 2

388931 AS SHOWN STD

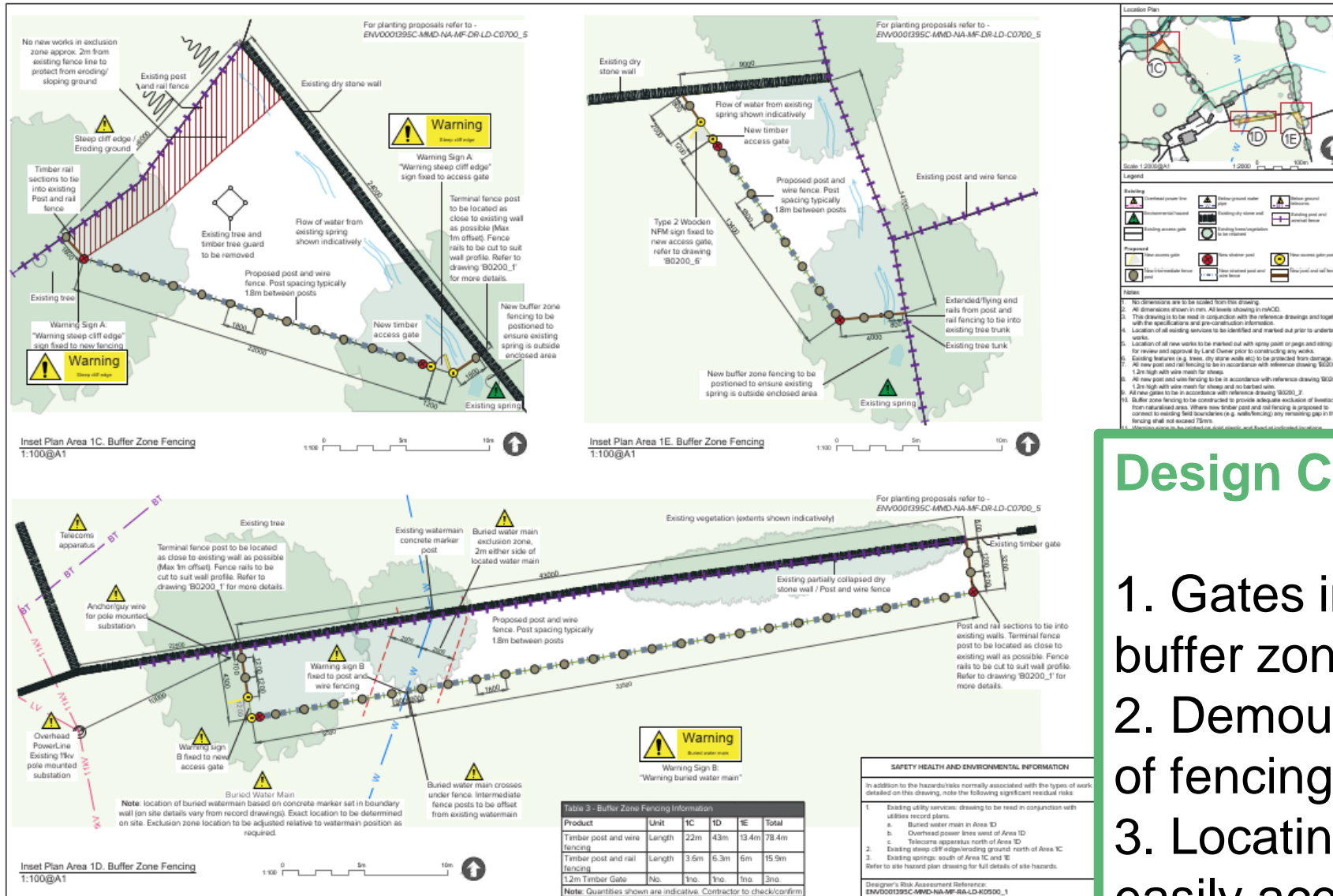
Environment Agency

Published Design for Construction

EN0001395C-MMD-NA-MF-DR-LD-B0200-3

A4 03 B0200 EA4 LOD4

Phase 1 – Buffer Zones (Fencing)

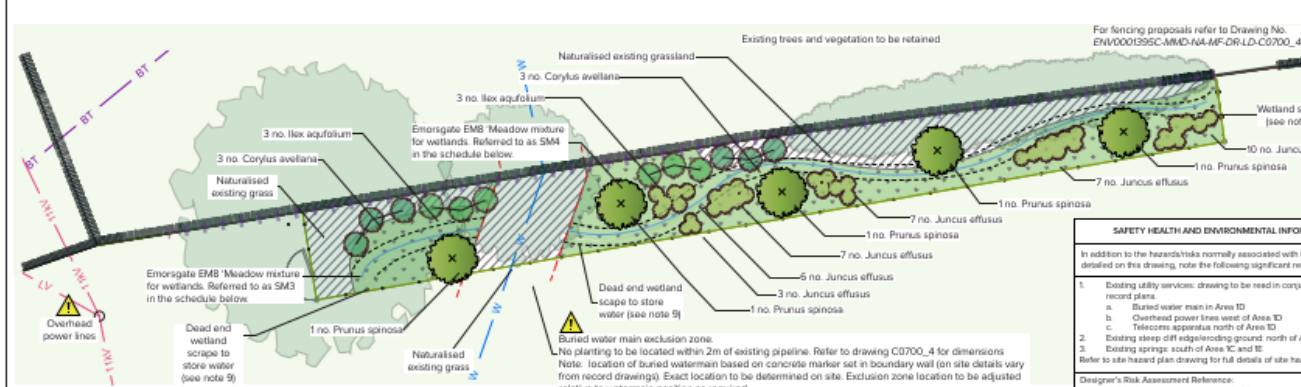
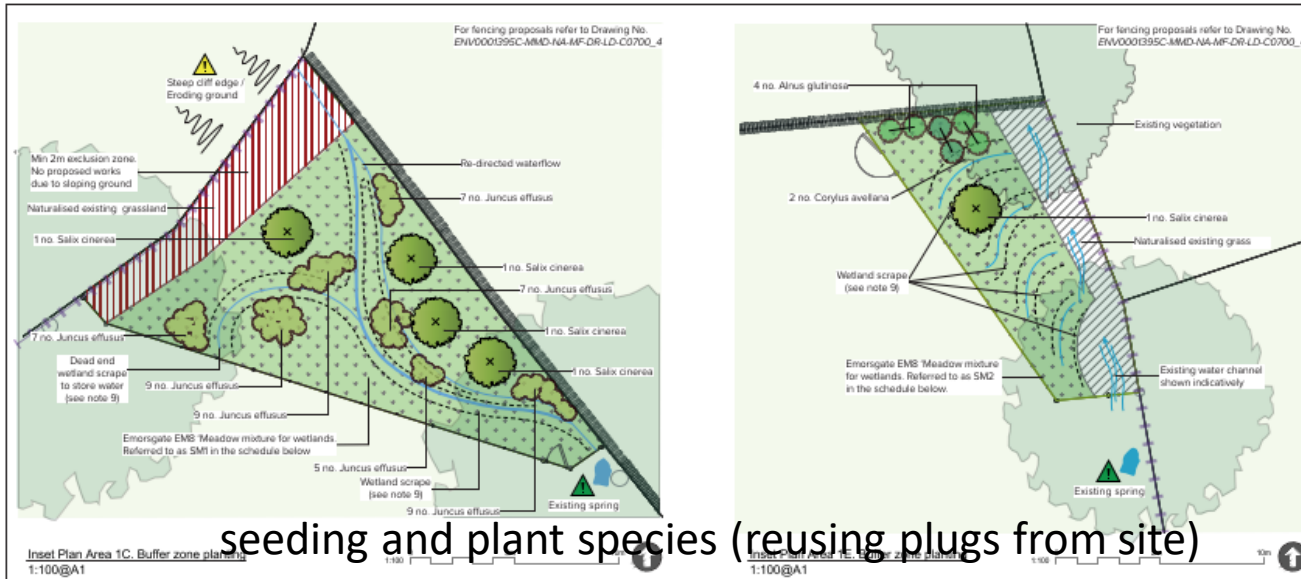


Design Considerations

1. Gates into fenced buffer zones
2. Demountable sections of fencing
3. Locating works in easily accessible areas

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 Drawing: 02/03/2019 - 01/04/2019, 01/04/2019 - 12/09/2019
 Drawing: 02/03/2019 - 01/04/2019, 01/04/2019 - 12/09/2019

Phase 1 – Buffer Zones (Planting)



Inset Plan Area 1C. Buffer zone planting
1:100@A1

Inset Plan Area 1D. Buffer zone planting
1:100@A1

Table 4 - Seed Mix

Emersgate EMB 'Meadow mixture for wetlands' (or similar) Seed	SM1	SM2	SM3	SM4	Total	Note: Quantities shown are indicative. Contractor to check/confirm.
Area (m ²)	164	102	20	82	368	
Quantity (t)	656	408	80	336	1,480	

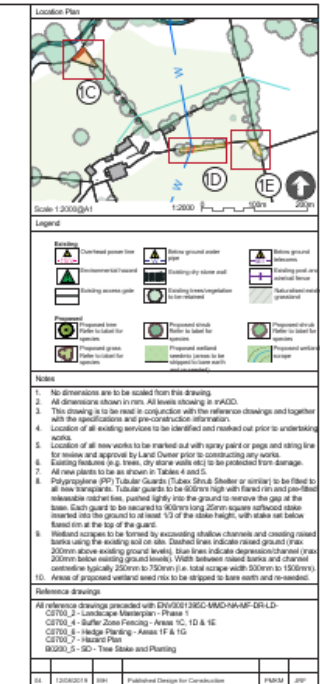
Planting Notes:

- For tree planting requirements refer to drawing 'B02000_5'
- For shrub planting refer to drawing 'C0700_5' Table 8
- For meadow mix seeding requirements refer to supplier's ground preparation, sowing and aftercare recommendations.

Table 5 - Plant schedule

Botanical Name	Common Name	Plant Area	Quantity	Total Quantity	Plant size (cm)	Root	Plant guards (see note B)
Salix cinerea	Grey Willow	4	1	5	40-60	Bare Root	Yes
Prunus spinosa	Blackthorn	5	5	10	40-60		Yes
Corylus avellana	Hazel	6	2	8	40-60		Yes
Alnus glutinosa	Alder	4	4	8	40-60		Yes
Ilex aquifolium	Holly	6	6	12	40-60		Yes
Juncus effusus	Soft Rush	-	-	28	-	-	-
		Total	33	68			

Note: Quantities shown are indicative. Contractor to check/confirm

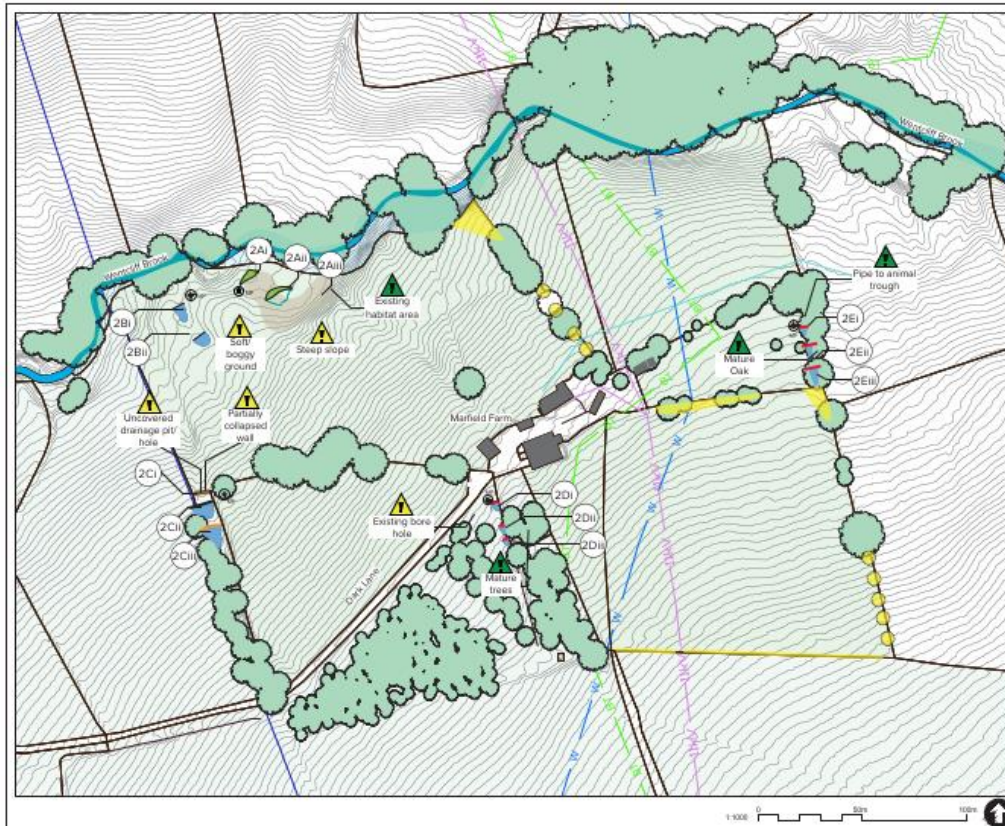


Design Considerations

1. Seeding and native shrubs/plant species
2. Reusing plugs from existing site

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Phase 2 – Masterplan



SAFETY HEALTH AND ENVIRONMENTAL INFORMATION	
1. Location of the landscape works is shown on the site plan and detailed on this drawing. Note the following significant works risks:	
1.	Existing utility services: 3 being to be read in conjunction with existing road plans.
2.	Existing habitat area adjacent to Area 2A
3.	Existing subsurface ground adjacent to Area 2A
4.	Existing steep slope south of Area 2A
5.	Existing partially collapsed wall on field boundary at Area 2C
6.	Existing uncovered drainage paths adjacent to wall in Area 2C
7.	Existing core hole near North house entrance
8.	Existing meadow areas adjacent to areas 2C and 2D
Refer to site hazard plan drawing for full details of site hazards.	
Designer's Risk Assessment Reference: ENV0001396C-MMD-NA-MF-DR-LD-00289_1	

Proposed Seasonal Habitat Ponds

Notes:

N1. New Seasonal habitat ponds to be formed in locations 2Aii and 2Aiii designed to slow and store runoff and provide enhanced wetland habitat. Two tiered ponds formed by new earth bunds comprising an dug material. The upper pond (2Aii) will be maximum 300mm deep and designed to trap and store silt and sediment, from which water will then flow into the lower pond (2A) maximum 500mm deep which includes an excavated area to form a shallow aquatic bench (max 200mm deep), designed for some wet planting (e.g. Marsh Nigella and Eriogonum EMB 'Meadow mixture for wetland' seed mix).

N2. Scrape channel (2Aii) to be formed to intercept overland run-off and direct flows towards seasonal habitat ponds.

Proposed Timber Stake Leaky Barrier

Notes:

N3. Two new timber stake leaky barriers at locations 2Bi and 2Bii to be formed to slow the flow of water in the existing field depressions.

N4. New timber stake leaky barrier at location 2Ci to be formed to slow the flow of water within existing natural drainage ditch/channel.

Proposed Dry Stone Wall Modifications

Notes:

N5. Section of existing dry stone wall at location 2Ci to be rebuilt incorporating modifications to allow passage of water through boundary wall.

Proposed Woven Hazel Leaky Barrier

Notes:

N6. New woven hazel leaky barrier to be installed at location 2Cii to act as silt/detritus trap upstream of timber stake leaky barrier at location 2Ci. Curved hazel barrier formed in the existing natural ditch to capture silt sediment and to retain woody/debris originating from the upstream wooded area.

Proposed Timber Sleeper Leaky Barriers

Notes:

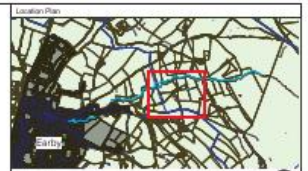
N7. Three new timber sleeper leaky barriers at locations 2Di, 2Dii and 2Diii designed to slow the flow of water in the existing wet/flowing drainage ditch with permanent spring flows. Barriers to be installed with gaps between sleepers to create leaky structure.

N8. Three new timber sleeper leaky barriers at locations 2Ei, 2Eii and 2Eiii designed to slow the flow of water in the existing wet/flowing drainage ditch with permanent spring flows. Barriers to be installed with holes drilled in lower sleepers to allow intermittent spring flows to pass through structure, with only higher flood flows restricted in a flood event.

Proposed fixed point photography monitoring posts

Notes:

N9. Timber monitoring posts to be installed adjacent to NFM features to allow consistent long term monitoring of effectiveness of NFM measures.



Legend

- Residual Risk, refer to Safety Health and Environmental (SHE) Information
- Existing overhead power line - Northern Power Grid NVO Electricity Supply
- Existing below ground water - Yorkshire Water Branch (203mm) uPVC Raw Water Main
- Existing below ground telecons - BT Apparatus
- Environmental hazard, refer to SHE Information
- Phase 1 works (Refer to Phase 1 Masterplan)
- Proposed seasonal habitat ponds
- Proposed timber stake leaky barrier
- Proposed woven hazel leaky barrier
- Existing habitat area (Meadow grass)
- Proposed dry stone wall modifications
- Proposed timber sleeper leaky barrier
- Fixed point photography monitoring posts

Notes:

- No dimensions are to be scaled from this drawing. All dimensions shown in mm. All levels shown in m AOD.
- This drawing is to be read in conjunction with the reference drawings and together with the specifications and pre-construction information.
- Location of all existing services to be identified and marked out prior to understanding works.
- Location of all new works to be marked out with spray paint or pipe and string line to receive and approval by Land Owner prior to constructing any works.

Reference drawings

All reference drawings prepared with ENV0001396C-MMD-NA-MF-DR-LD-00289_1 - Phase 1 Landscape Masterplan

- CF00 - Hazard Plan
- CF05 - Seasonable Habitat Pond Construction
- CF06 - Seasonable Habitat Pond Planning
- CF07 - Leaky Barriers Area 2B
- CF08 - Leaky Barriers Area 2C
- CF09 - Leaky Barriers Area 2D
- CF10 - Leaky Barriers Area 2E
- CF15 - Dry Stone Wall Modifications
- BO00 - Standard Detail - Timber Stake Leaky Barrier
- BO01 - Standard Detail - Timber Sleeper Leaky Barrier
- BO02 - Standard Detail - Woven Hazel Leaky Barrier
- BO03 - Standard Detail - Dry Stone Wall Modifications
- BO04 - Standard Detail - Monitoring Post

Rev	Date	Drawn	Description	Checked	App'd
01	15/08/2018	MM	Published Design for Construction	MM	JDF
02	04/07/2018	MM	Issued for Client Review & Comment	MM	JDF

Status Stamp: **APPROVED**

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Client: **Environment Agency** (Environment Agency)
Leeds City Council (Leeds City Council)

Leeds FAS2 NFM Marfield Farm (Earby) Pilot Site Phase 2 Landscape Masterplan

Designed	Checked	Drawn	Checked	Approved	Scale
MM	MM	MM	MM	MM	1:1000
388931					STD

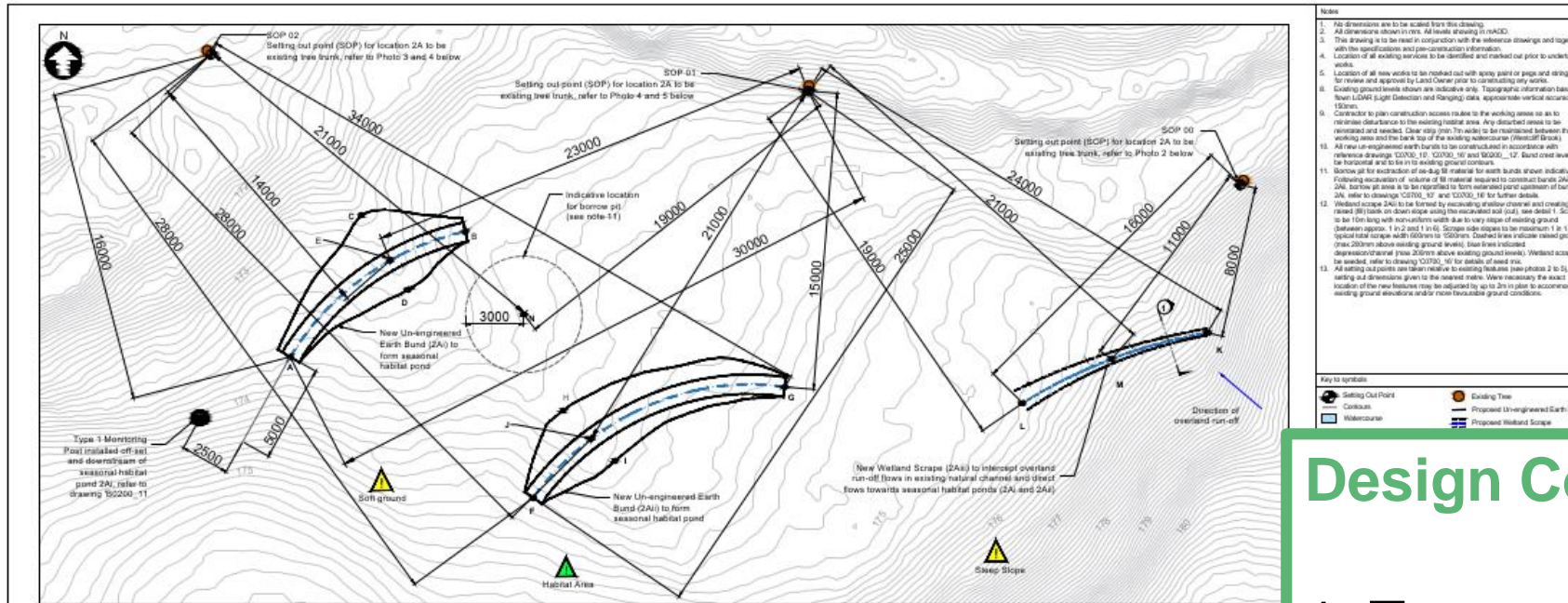
Published Design for Construction

Drawing Number: Project-Original-Volume-Location-Type-Revision
ENV0001396C-MMD-NA-MF-DR-LD-C0700_8

Rev	Code	Revised	Delivery Date	Work Stage	Development
	A4	03	C0700	E4	LOD4

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Phase 2 – Seasonal Habitat Pond



- Notes**
- All dimensions are to be scaled from this drawing.
 - All dimensions shown in red. All levels shown in black.
 - This drawing is to be read in conjunction with the reference drawings and together with the specifications and pre-construction information.
 - Location of all existing services to be identified and marked out prior to undertaking works.
 - Location of all new works to be marked out with spray paint or pipe and string line for review and approval by Land Owner prior to commencing any works.
 - Existing ground levels shown are indicative only. Topographic information based on flown LIDAR (Light Detection and Ranging) data, approximate vertical accuracy +/- 150mm.
 - Contractor to plan construction access routes to the working areas so as to not cause disturbance to the existing habitat area. Any disturbed areas to be reinstated and seeded. Clear edge zone. To note: to be maintained between the working area and the bank top of the existing watercourse (Westcott Brook).
 - All new un-engineered earth banks to be constructed in accordance with reference drawings 12/200_10, 12/200_16 and 12/200_17. Bank crest levels to be horizontal and to be in existing ground contours.
 - Borrow pit for extraction of on-site fill material for earth bunds shown. Indicative. Following excavation of volume of fill material required to construct bunds 2Ai and 2Aii, borrow pit area is to be regraded to form retained pond upstream of bund 2Ai, refer to drawings 12/200_10 and 12/200_16 for further details.
 - Wetland scrape 2Aiii to be formed by excavating gravel channel and creating raised 300mm bank on down slope using the excavated soil (see detail 1). Scrape to be 15m long with non-invertible width due to steep slope of existing ground (between approx. 1 in 2 and 1 in 4). Scrape side slopes to be maximum 1 in 1, with typical total scrape width (600mm to 1000mm). Channel to be 150mm raised ground (max 200mm above existing ground level), blue lines indicated.
 - Depression/channel (max 200mm above existing ground level). Wetland scrape to be seeded, refer to drawing 12/200_10 for details of seed mix.
 - All setting out points are relative to existing features (see phase 2) to fix with setting out dimensions given to the nearest metre. Where necessary the exact location of the new features may be adjusted by +/- 20mm to place in accessible existing ground elevations and/or more favourable ground conditions.
- Key to symbols:**
- Setting Out Point
 - Contour
 - Watercourse
 - Existing Tree
 - Proposed Un-engineered Earth Bund
 - Proposed Wetland Scrape

Seasonal Habitat Ponds (2Ai and 2Aii) and Wetland Scrape (2Aiii) - 2A: Setting Out Plan
Scale 1:100

Design Considerations

- Two earth bunds (upstream for silt trap) and interception scrape
- Setting out relative to trees (no fixed features in field)



Photo 1: Indicative layout of seasonal habitat ponds and scrape

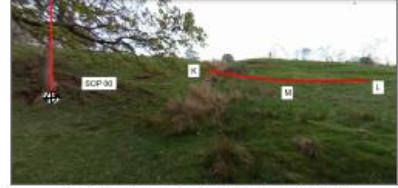
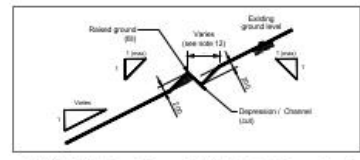


Photo 2: Scrape Setting Out Point (SOP 00)



Detail 1: Wetland Scrape 2Aiii - Typical Cross Section
Scale 1:20

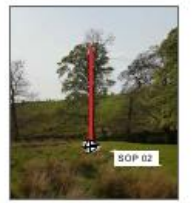


Photo 3: Area 2A (SOP 02)

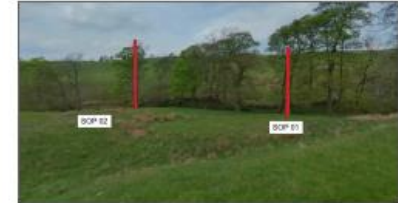


Photo 4: Seasonal Habitat Ponds Setting Out Points



Photo 5: Area 2A (SOP 01)

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION	
In addition to the hazard data normally associated with the types of work detailed on this drawing, note the following significant residual risks:	
1.	Presence and location of any existing buried services to be established in accordance with PAS 128:2014 (Specification for underground utility detection, verification and location) before breaking ground.
2.	Unknown ground conditions.
3.	Existing surface ground.
4.	Existing buried services.
Designer's Risk Assessment Reference: EMW001250C-MMD-NA-8F-SA-LD-K5596_1	

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Phase 2 – Seasonal Habitat Pond

Seasonal Habitat Ponds - 2A: Plan
Scale 1:300

Table 1 - As-dug Site Ground Conditions Guidance	
Refer to Table 1 on reference drawing 'B0200_12' for guidance on un-engineered earth bund foundations and fill material.	

Table 2 - Un-engineered Earth Bund Dimensions				
Dimension	Description	Unit	2Ai	2Aii
L ₁	Length of bund	mm	12000	15000
W ₁	Width of crest	mm	1000	1000
W ₂	Base width	mm	4500	3800
W ₃	Cut-off trench width	mm	600	600
H ₁	Upstream height of bund	mm	410	370
H ₂	Center-line height of bund	mm	550	470
H ₃	Downstream height of bund	mm	750	600
H ₄	Cut-off trench depth	mm	600	600
V ₁	Volume of earth bund above GL	m ³	7.3	8

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the Hazards/risks normally associated with the type of work detailed on this drawing, note the following significant material risks:

Presence and location of any existing buried services to be established in accordance with PAS 128:2014 (Specification for underground utility detection, verification and location) before breaking ground.

- Unknown ground conditions.
- Existing habitat area.
- Existing soft/loose ground.
- Existing deep water.

Designer's Sign: **Environmental Compliance**
DRAWN: JDFC/MMD/MF-FA-LS-LS068_1

Un-engineered Earth Bund 2Ai - Long Section A-B
Scale 1:50

Un-engineered Earth Bund 2Ai - Cross Section C-D
Scale 1:50

Un-engineered Earth Bund 2Aii - Long Section F-G
Scale 1:50

Un-engineered Earth Bund 2Aii - Cross Section H-I
Scale 1:50

Notes

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm. All levels showing in m(ACD).
- This drawing is to be read in conjunction with the reference drawings and together with the specifications and pre-construction information.
- Locations of all existing services to be identified and marked out prior to undertaking works.
- Location of all new works to be marked out with spray paint or page and string line for review and approval by Land Owner prior to commencing any works. Refer to reference drawing 'C0700_01' for marking out details.
- Existing ground levels shown are indicative only. Topographic information based on Leica LIDAR (Light Detection and Ranging) data, approximate vertical accuracy +/- 150mm.
- Two new seasonal habitat ponds (2Ai and 2Aii) to be formed using site won (penug) fill material extracted from the borrow pit identified between location 2A and 2Aii, refer to drawings 'C0700_01', 'C0700_02' for further details. Earth bunds (2Ai and 2Aii) to be constructed in accordance with reference drawing 'B0200_12' and the details in Table 2. Bund crest levels to be horizontal and to be in existing ground contours.
- Borrow pit for extraction of as-dug fill material for earth bunds shown indicatively. Size of excavation to be determined by volume of fill material required to construct earth bunds 2Ai and 2Aii (refer to details in Table 2) based on balancing cut and fill volumes on site including allowing for building of as-dug fill material and top soil. Following completion of an borrow pit area to be specified to form elevated pond upstream of bund 2Aii as shown, refer to drawings 'C0700_01' and 'C0700_02' for further details.
- No details or records of the existing ground conditions are known (other than the property name 'Marrickley Farm' indicating presence of MerCay in the vicinity of the site). Following agreement of the earth bund and borrow pit locations (see note 5 above), trial pit excavations are to be undertaken in accordance with the guidance in Table 1 of reference drawing 'B0200_12' to establish the suitability of existing site ground conditions. Where necessary the exact location of the trial features may be adjusted by up to 20m in plan to accommodate more favourable ground conditions. Should the ground conditions be fit and not to be suitable (either for the construction of the un-engineered earth bunds at the proposed location or to extract fill material from the proposed borrow pit) the works should be made safe and activities paused until further instruction is given by the Client.
- Contractor to plan construction access to site in the working areas so as to minimise disturbance to the existing habitat area. Any disturbed areas to be reinstated and seeded. Clear edge (top) to sedge to be maintained between the working areas and the bank top of the existing watercourse (Marrickley Brook).

Key to symbols:

- 100mm Contours
- 1m Contours
- ▣ Existing Top Soil Layer
- ▤ Re-worked Top Soil
- ▥ Formation Level
- ▧ Excavation Extents

Reference drawings:

All reference drawings provided with ENV001395C-MMD-MF-FA-LS-DR-1D:

C0700_01 - Hazard Plan
 C0700_02 - Phase 2 Masterplan
 C0700_03 - Seasonal Habitat Ponds - Earthworks (1 of 2)
 C0700_04 - Seasonal Habitat Ponds - Planting
 B0200_12 - Standard Detail - Un-engineered Earth Bund

1:300 0 5m 10m

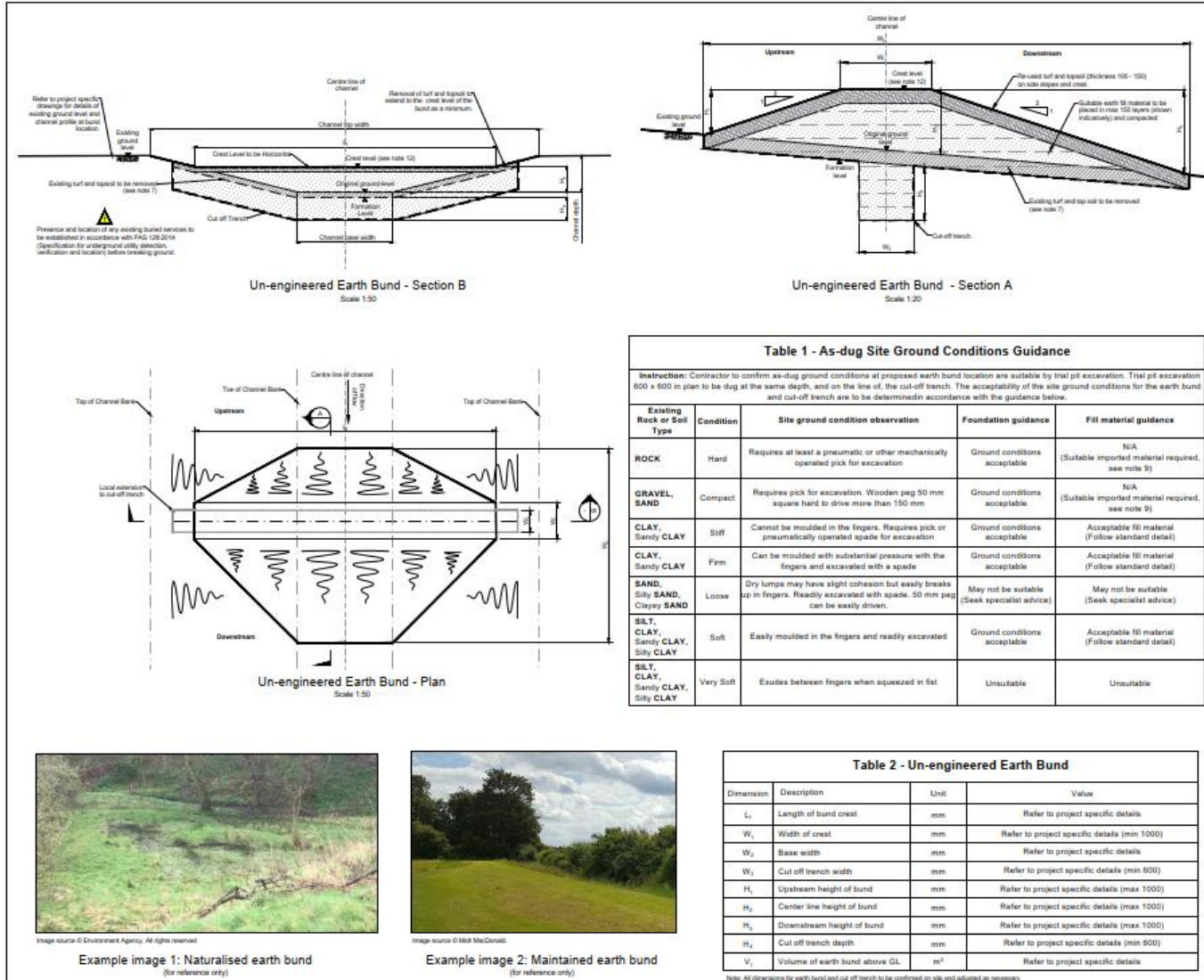
01 20/06/2019 M11 Published Design for Construction PMS01 2/19

Design Considerations

1. Cross-sections and long sections of 2 bunds
2. Profiling for 'borrow pit' excavations

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Phase 2 – Seasonal Habitat Pond



Design Considerations

1. Unknown ground conditions (Guidance box) placed in 150mm layers
2. Cut and fill volume / balance uncertainty
3. Gradient of slopes and berm width
4. Grass cover - topsoil strip / turf reuse
5. Cut-off trench, stability key and increases path length for seepage flows

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Phase 2 – Seasonal Habitat Pond

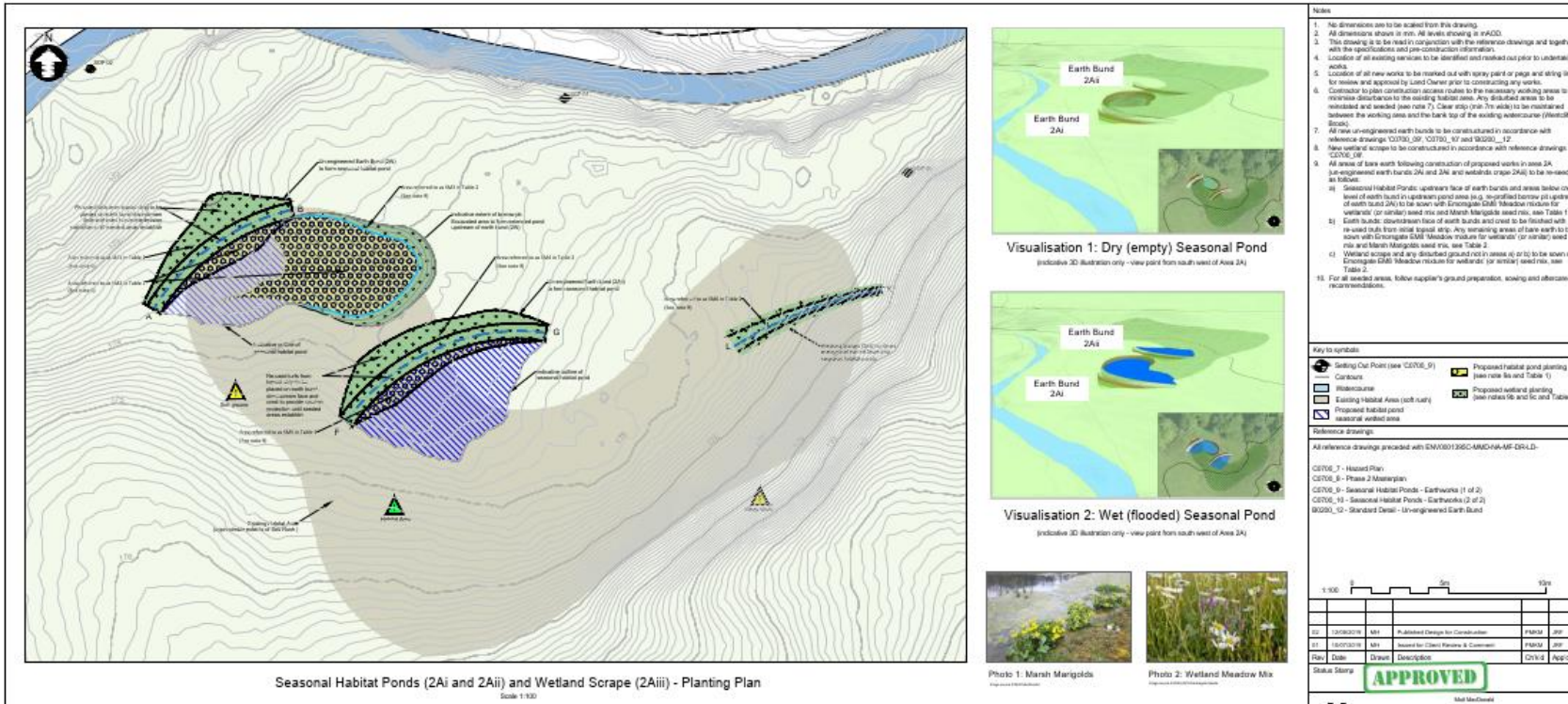


Table 1 - Habitat Pond Seed Mix

Calitha palustris – Marsh Marigold (sown at 1g/m²)

Key	SM2	SM5	Total	Note: Areas and quantities shown are indicative. Contractor to check / confirm
Area (m ²)	55	9	64	
Quantity (g)	55	9	64	

Emongate EMB 'Meadow mixture for wetlands' (or similar) (4g/m²)

Key	SM2	SM5	Total	Note: Areas and quantities shown are indicative. Contractor to check / confirm
Area (m ²)	55	9	64	
Quantity (g)	220	36	256	

Table 2 - Wetland Seed Mix

Emongate EMB 'Meadow mixture for wetlands' (or similar) (4g/m²)

Key	SM1	SM3	SM4	SM6	Total	Note: Areas and quantities shown are indicative. Contractor to check / confirm
Area (m ²)	26	13	31	13	83	
Quantity (g)	104	52	124	52	332	

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards normally associated with the type of work related to this drawing, note the following significant health risks:

- Presence and location of any existing buried services to be established in accordance with PAS 120:2014 (Specification for underground utility detection, verification and location) before breaking ground.
- Shovel ground conditions.
- Excavating habitat areas.
- Excavating wetland ground.
- Excavating deep ditches.

Designer's Risk Assessment Reference: ENV001250-AMD-NA-WF-RA-LD-90300_1

Design Considerations

1. Wetland meadow seeding mixes
2. Marsh Marigolds

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 License: ENV001250-AMD-NA-WF-RA-LD-90300_12 - Standard Detail - Live-engineered Earth Bund - Planning/ Aug 19 2019 11:30AM/01/2019
 Reference: ENV001250-AMD-NA-WF-RA-LD-90300_12 - Standard Detail - Live-engineered Earth Bund - Planning/ Aug 19 2019 11:30AM/01/2019

Phase 2 – Leaky Barriers

Location 2E - Plan
Scale 1:100

Section A - Timber Stake Leaky Barriers 2E₁ (Downstream Elevation)
Scale 1:25

Section B - Timber Stake Leaky Barriers 2E₂ (Downstream Elevation)
Scale 1:25

Section C - Timber Stake Leaky Barriers 2E₃ (Downstream Elevation)
Scale 1:25

Table 1 - Timber Sleeper Leaky Barrier Dimensions

Dimension	Description	Unit	2E ₁	2E ₂	2E ₃
W ₁	Total width of leaky barrier	mm	3000	3200	4000
W ₂	Width of crest in channel	mm	2800	3000	3800
W ₃	Width of notch weir	mm	300	300	300
S ₁	Spacing between inner face of central stakes	mm	1000	1000	1000
S ₂	Spacing between outer stakes	mm	500	500	500
D ₁	Diameter of timber stake	mm	100	100	100
N ₁	Number of timber stakes	No.	8	8	12
H ₁	Maximum stake length	mm	1800	1800	1800
H ₂	Maximum stake height above ground	mm	800	800	800
G ₁	Gap between timber sleepers	mm	20	20	20
E ₁	Embedment depth of bottom sleeper	mm	90	90	90
O ₁	Orifice / drain down hole diameter	mm	100	100	100

Notes:

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm. All levels shown in m AOD.
- This drawing is to be read in conjunction with the reference drawings and together with the specifications and pre-construction information.
- Location of all existing services to be identified and marked out prior to undertaking works.
- Location of all new works to be marked out with spray paint or pipe and string line 50 metres and extended by 500m down prior to commencing works.
- All new timber sleeper leaky barriers to be in accordance with reference drawing B0200_8 and the details in Table 1.
- Orientation of leaky barriers to be constructed perpendicular to direction of existing ground edge/ward flow route.
- Existing ground levels shown are indicative only. Topographic information based on Brown's LIDAR (Light Detection and Ranging) data, approximate vertical accuracy ±100mm.
- Existing tree locations are indicative only.
- Monitoring post to be positioned to enable viewing of leaky barrier 2E₁, 2E₂ and 2E₃ from a safe/evacuated position.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks:

- Presence and location of any existing local services to be established in accordance with PAS 128:2014 (Specification for underground utility detection, verification and location) before breaking ground.
- Unknown ground conditions.
- Refer to project specific safety, health and environment information.

Company Risk Assessment Reference:
ENW801355C-MMD-NA-MF-RA-LD-43558_1

References:
All reference drawings preceded with ENW801355C-MMD-NA-MF-DR-LD-02780_7 - Hazard Plan.

Photo 1: Leaky Barrier 2E₁, Indicative Crest Line
Image source © Matt MacDonald

Photo 2: Leaky Barrier 2E₂, Indicative Crest Line
Image source © Matt MacDonald

Photo 3: Leaky Barrier 2E₃, Indicative Crest Line
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Design Considerations

1. Setting out details relative to field boundaries (to avoid existing trees/roots)
2. Dimensions for each structure (referencing standard detail)

Phase 2 – Leaky Barriers

Section A - Timber Stake Leaky Barrier 2Bii (Downstream Elevation)

Section B - Timber Stake Leaky Barrier 2Bii (Downstream Elevation)

Dimension	Description	Unit	2B	2C
W _L	Total width of leaky barrier	mm	6000	10000
W _C	Width of crest in channel	mm	3000	10000
D _L	Diameter of timber stakes	mm	100	100
G _L	Spacing between timber stakes	mm	50	50
N _L	Number of timber stakes	No.	50	200
M _L	Maximum stake length	mm	1800	1800
H _L	Maximum stake height above ground	mm	600	600
F _L	Freeboard above crest level	mm	400	400

Table 1 - Timber Stake Leaky Barrier Dimensions

Section A - Timber Stake Leaky Barrier 2Cii (Downstream Elevation)

Section B - Woven Hazel Leaky Barrier 2Ciii (Downstream Elevation)

Dimension	Description	Unit	2C _i
W _L	Total width of leaky barrier	mm	10700
W _C	Width of crest in channel	mm	10000
D _L	Diameter of timber stakes	mm	100
G _L	Gap between timber stakes	mm	0-5
N _L	Number of timber stakes	No.	107
M _L	Maximum stake length	mm	1800
H _L	Maximum stake height above ground	mm	600
F _L	Freeboard above crest level	mm	200 (approx.)

Table 1 - Timber Stake Leaky Barrier Dimensions

Table 2 - Woven Hazel Leaky Barrier Dimensions

Dimension	Description	Unit	2C _i
W _L	Total width of leaky barrier	mm	10300
W _C	Width of crest in channel	mm	9700
L _L	Length of leaky barrier	mm	1500
D _L	Diameter of hazel stakes	mm	100
S _L	Spacing between hazel stakes	mm	500
N _L	Number of hazel stakes	No.	22
M _L	Maximum stake length	mm	1200
H _L	Maximum stake height above ground	mm	600
F _L	Freeboard above crest level	mm	650 (approx.)
T _L	Diameter of hazel poles	mm	20

Leeds FAS 2 NFM Marfield Farm (Earby) Pilot Site Phase 2 Proposed Details Leaky Barriers - Area 2B

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A4 02 C0700 E44 LOD4

Section A - Timber Sleeper Leaky Barriers 2Di (Downstream Elevation)

Section B - Timber Sleeper Leaky Barriers 2Di (Downstream Elevation)

Section C - Timber Sleeper Leaky Barriers 2Di (Downstream Elevation)

Dimension	Description	Unit	2B	2C	2D
M _L	Maximum stake length	mm	2000	2000	2000
H _L	Maximum stake height	mm	2000	2000	2000
F _L	Freeboard above crest level	mm	500	500	500
D _L	Diameter of timber stakes	mm	100	100	100
N _L	Number of timber stakes	No.	3	3	3
M _L	Maximum stake length	mm	1000	1000	1000
H _L	Maximum stake height above ground	mm	400	400	400
F _L	Freeboard above crest level	mm	500	500	500
S _L	Spacing between sleepers	mm	100	100	100
G _L	Extension depth of sleepers	mm	50	50	50

Table 1 - Timber Sleeper Leaky Barrier Dimensions

Leeds FAS 2 NFM Marfield Farm (Earby) Pilot Site Phase 2 Proposed Details Leaky Barriers - Area 2D

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EN/0001396C-MMD-NAM-NF-DR-LOD-C0700_13

A4 02 C0700 E44 LOD4

Section A - Timber Stake Leaky Barriers 2Cii (Downstream Elevation)

Section B - Woven Hazel Leaky Barrier 2Ciii (Downstream Elevation)

Dimension	Description	Unit	2C _i
W _L	Total width of leaky barrier	mm	10700
W _C	Width of crest in channel	mm	10000
D _L	Diameter of timber stakes	mm	100
G _L	Gap between timber stakes	mm	0-5
N _L	Number of timber stakes	No.	107
M _L	Maximum stake length	mm	1800
H _L	Maximum stake height above ground	mm	600
F _L	Freeboard above crest level	mm	200 (approx.)

Table 2 - Woven Hazel Leaky Barrier Dimensions

Dimension	Description	Unit	2C _i
W _L	Total width of leaky barrier	mm	10300
W _C	Width of crest in channel	mm	9700
L _L	Length of leaky barrier	mm	1500
D _L	Diameter of hazel stakes	mm	100
S _L	Spacing between hazel stakes	mm	500
N _L	Number of hazel stakes	No.	22
M _L	Maximum stake length	mm	1200
H _L	Maximum stake height above ground	mm	600
F _L	Freeboard above crest level	mm	650 (approx.)
T _L	Diameter of hazel poles	mm	20

Leeds FAS 2 NFM Marfield Farm (Earby) Pilot Site Phase 2 Proposed Details Leaky Barriers - Area 2C

398931 AS SHOWN STD

Published Design for Construction

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Phase 2 – Leaky Barrier: Timber Stake

Timber Stake Leaky Barrier - Downstream Elevation
Scale 1:20

Timber Stake Leaky Barrier - Plan
Scale 1:20

Section A-A
Scale 1:10

Detail A - Rail and Waling Connection Detail
Scale 1:5

Long Section of Leaky Barriers
Scale 1:50

Table 1 - Timber Stake Leaky Barrier Dimensions

Dimension	Description	Unit	Value
W_1	Total width of leaky barrier	mm	Refer to project specific details
W_2	Width of crest in channel	mm	Refer to project specific details
D_1	Diameter of timber stake	mm	Refer to project specific details
G_1	Gap between timber stakes	mm	Refer to project specific details
N_1	Number of timber stakes	No.	Refer to project specific details
H_1	Maximum stake length	mm	Refer to project specific details
H_2	Maximum stake height above ground	mm	Refer to project specific details
H_3	Freeboard above crest level (if known)	mm	Refer to project specific details

Note: All dimensions for leaky barriers to be confirmed on site and adjusted as necessary.

Notes:

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm. All levels shown in MADC.
- This drawing is to be read in conjunction with the relevant drawings and together with the specifications and pre-construction information.
- Timber stake leaky barrier installation arrangements and requirements to be as specified on the project drawings, constructed in accordance with the referenced dimensions in Table 1.
- Timber shall be of a species suitable for fencing with minimum 25 year design life.
- Timber components shall be suitably constructed to avoid the collection of water at joints.
- Timber shall be treated with preservative to BS8417:17: H4/3/17: class 3.
- All elements to be cut to full on site. Any cut ends or exposed untreated surfaces to be as treated with suitable preservative.
- Timber stake leaky barriers to be formed from machine rounded timber stakes driven into the channel base and secured in place typically 4-below ground line above ground. Each stake to be installed as close as possible to the adjacent stake for each a barrier in a straight line.
- Timber waling to be 50mm x 100mm fixed in horizontal position on downstream face of barrier in conjunction with preparation as shown. Waling secured to every other post with nails or screws (see note 12).
- Top of stakes to be level and half round timber rail fixed to top timber stakes with nails or screws at 500mm centres (see note 12).
- Nails to be round, plain-headed, 40mm x 100mm long, conforming to BS 1203-1. Screws to be 6 x 150mm long self tapping. All fixings hot-dip galvanized in accordance with BS EN ISO 1461.
- Where ground conditions prevent installation of stakes to required depth, stakes to be driven until refusal and details recorded on as-built record drawings. Where more than 3 adjacent stakes cannot be installed to required depth (see note 10), additional walings to be added to downstream side of barrier and span min 5 stakes each side.
- The Contractor is to confirm their proposed design and the recommended manufacturing details for their products, where different from the requirements outlined on this drawing.

Design Considerations

- 2/3rd Rule
- Bracing to provide additional stability to individual posts
- topper to shed rain
- Notch in centre
- Treated timber (20+ design life)



Example images
(for reference only)
Not to Scale

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3.0/PM/AC/2024/00

Phase 2 – Leaky Barrier: Timber Sleeper

Timber Sleeper Leaky Barrier - Downstream Elevation
Scale 1:20

Section A-A
Scale 1:10

Timber Sleeper Leaky Barrier - Plan
Scale 1:20

Detail A - Downstream Elevation
Scale 1:10

Detail A - Sleeper Joint Detail
Scale 1:10

Long Section of Leaky Barriers
Scale 1:50

Dimension	Description	Unit	Value
W_1	Total width of leaky barrier	mm	Refer to project specific details
W_2	Width of creast in channel	mm	Refer to project specific details
W_3	Width of notch weir	mm	Refer to project specific details
S_1	Spacing between central stakes	mm	Refer to project specific details
S_2	Spacing between outer stakes	mm	Refer to project specific details
D_1	Diameter of timber stake	mm	Refer to project specific details
N_1	Number of timber stakes	No.	Refer to project specific details
H_1	Maximum stake length	mm	Refer to project specific details
H_2	Maximum stake height above ground	mm	Refer to project specific details
H_3	Freeboard above crest level (if known)	mm	Refer to project specific details
G_1	Gap between timber sleepers	mm	Refer to project specific details
E_1	Embedment depth of bottom sleeper	mm	Refer to project specific details
O_1	Optional orifice / drain down hole dia.	mm	Refer to project specific details

Table 1 - Timber Sleeper Leaky Barrier Dimensions

Example images
(for reference only)
Not to Scale

Notes:

- No dimensions are to be scaled from this drawing.
- All dimensions shown in mm. All views shown in metric.
- This drawing is to be read in conjunction with the relevant drawings and together with the specifications and pre-construction information.
- Timber sleeper leaky barrier installation arrangements and requirements to be as specified on the project drawings, constructed in accordance with the referenced specifications in Table 1.
- Timber shall be of a species suitable for fencing with minimum 25 year design life. Timber components shall be constructed to avoid the collection of water at joints.
- Timber shall be treated with preservative to BS8417: Sleepers - class 3, sawnjoists - class 4.
- All timbers to be cut to suit on site. Any cut ends or exposed untreated surfaces to be treated with suitable preservative.
- Timber sleeper leaky barriers to be formed from timber sleepers keyed into the channel sides fixed to machine rounded timber stakes driven into the channel base until securely in place (typically 200 below ground for 1:0 above ground). Each stake to be secured to each adjoining sleeper with 150mm long nails or screws (see note 12).
- Timber sleepers to be 100mm wide 200mm high (typically available in lengths of 2.4m for 3.6m and 4.8m where available), where barrier span (N_1) is greater than sleeper length two or more sleepers are to be joined using a half lap joint as shown in Detail A. No joints in sleepers are to be located in the section of the barrier between the two central facing stakes/points. Joints to be made in 'on-rearing' (i.e. self-repairing to resist being blown from exposed sides).
- Top of stakes to be sawn level and half round timber rail fixed to top timber sleepers with 100mm long nails or screws at 500mm centres (see note 12).
- Nails to be round, plain-headed, 4mm x specified length, conforming to BS 1252-1. Screws to be of a specified length self tapping. All lengths hold up galvanneal in accordance with BS EN ISO 1481.
- Where ground conditions prevent installation of stakes to required depth, stakes to be driven until refusal and details recorded on as built record drawings.
- Optional orifice (O_1) to be drilled through centre of bottom timber sleeper, to allow drain down following flood event. Sleeper to be installed on level of drain down hole in level with the existing channel base.
- Sawnjack span plate (N_1) long, 60 x 100mm wide and min 50mm thick to be located immediately downstream of leaky barrier to minimise erosion of channel. The Contractor is to confirm their proposed design and the recommended installation details for their products, where different from the requirements outlined on this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant residual risks:

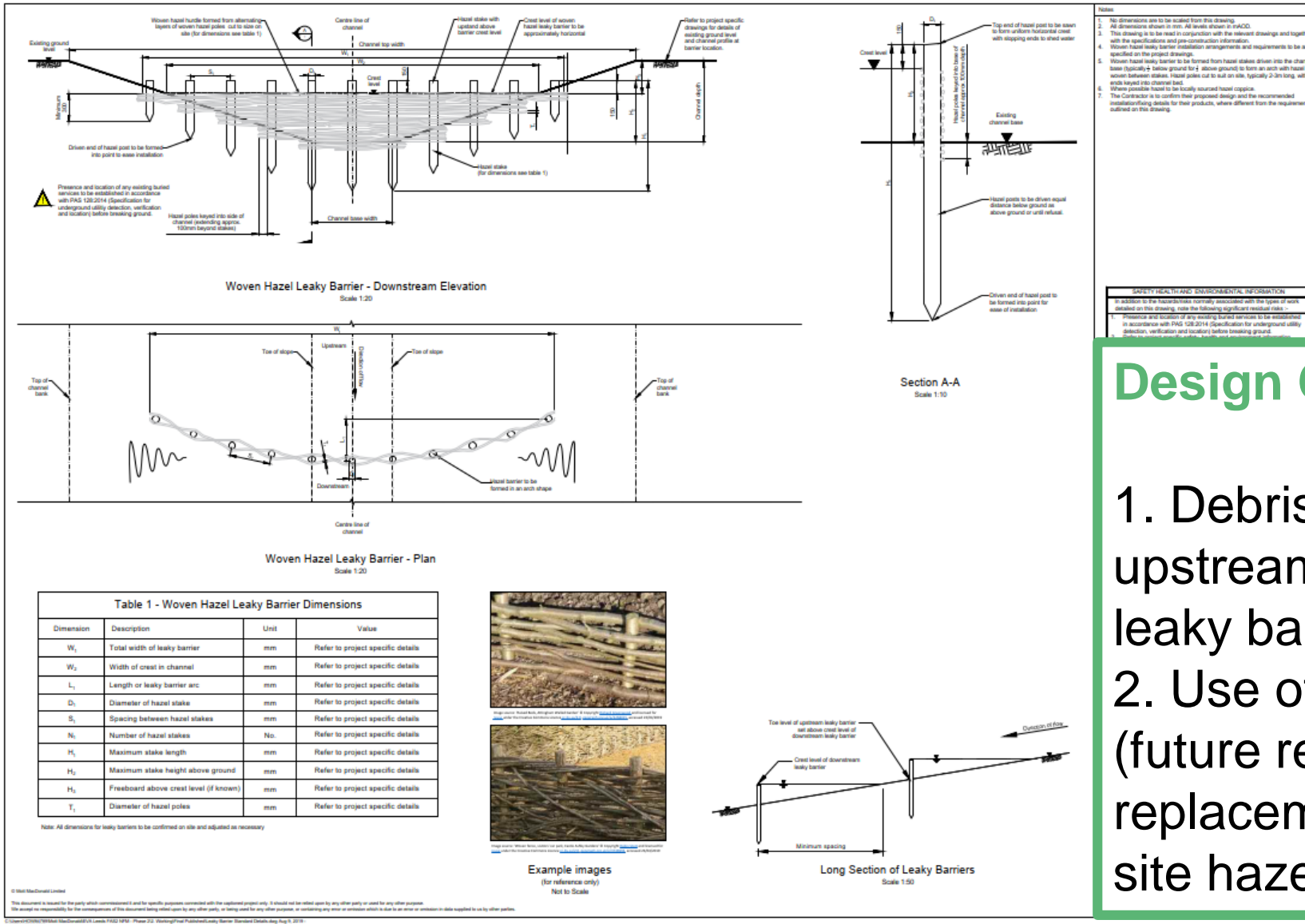
- Presence and location of any existing buried services to be established in accordance with PAS 128:2014 (Specification for underground utility detection, verification and location) before breaking ground.
- Barriers constructed in channels with flowing water to incorporate measures to control risk of water pollution.
- Barrier design to be selected to avoid blockage of fish passage.
- Refer to project specific safety, health and environmental information.

Designer's Risk Assessment Reference:
Refer to project specific document

Design Considerations

1. Timbers dug into existing channel bank
2. Stakes to provide additional stability
3. 'Splash stones' erosion protection

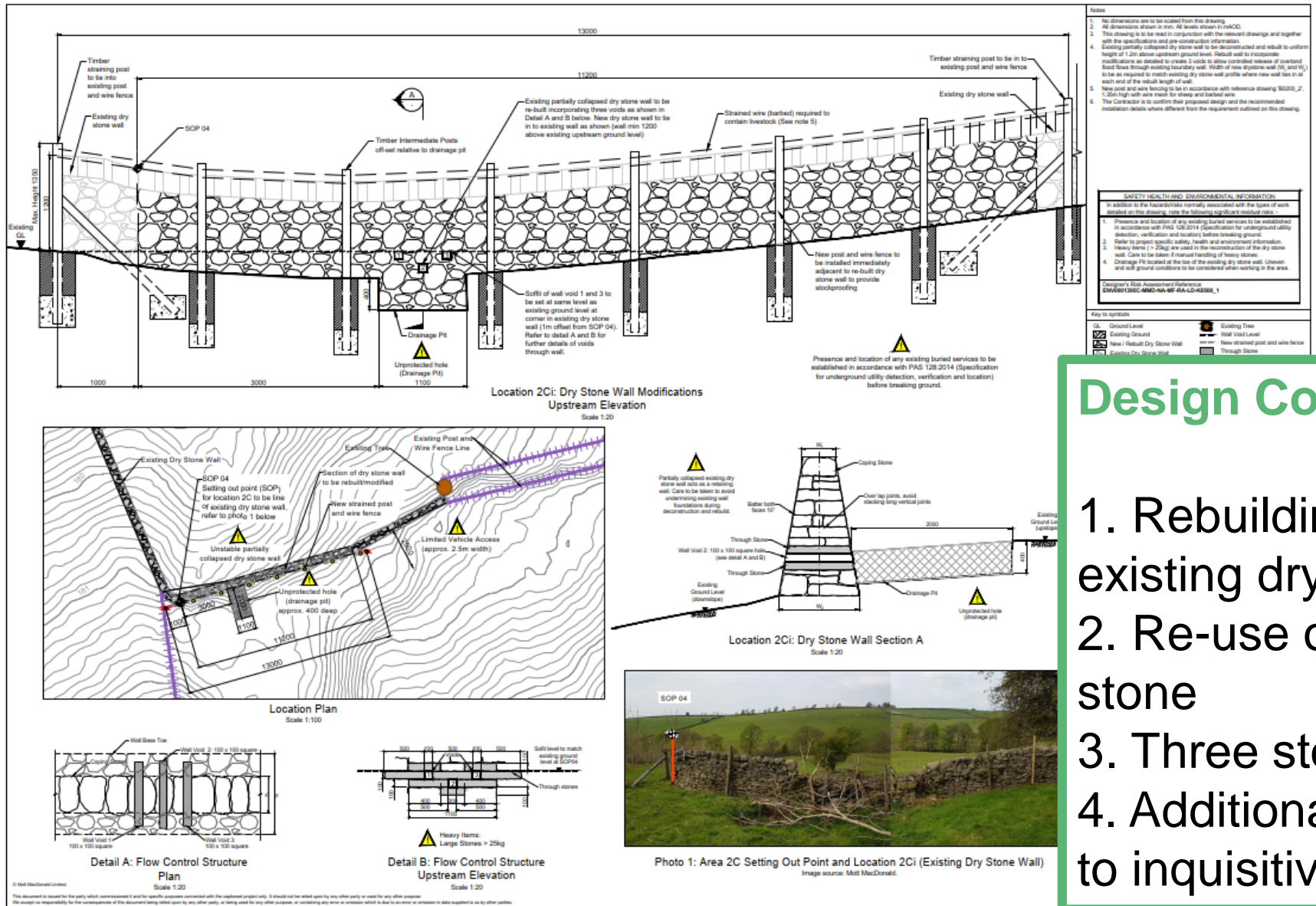
Phase 2 – Leaky Barrier: Woven Hazel



Design Considerations

1. Debris Collector upstream of 'storage' leaky barriers
2. Use of hazel coppice (future repair / replacement using on site hazel planting)

Phase 1 – Leaky Dry Stone Wall



Design Considerations

1. Rebuilding/repairing existing dry stone wall
2. Re-use of available stone
3. Three stone 'pipes'
4. Additional fencing sue to inquisitive sheep

Lessons Learned

- **EA CDM Process** – EA sign-off for no GPR (Ground Penetrating Radar) to confirm location of below ground services (Risk to be managed by Contractor).
- **‘Light Touch’ site surveys** – No Topographic survey (used LiDAR and OS Mastermap only) and no Ground Investigations (unknown ground conditions for earth bund)
- **Limited design guidance** – Lack of single source of knowledge/peer reviewed guidance for design criteria/considerations (Pre CIRIA NFM Guide). Led on to developing ‘project specific’ guidance summarising suitable and unsuitable locations for NFM



1. Summary
 Swales are defined as long shallow grass covered channels which are excavated across or along surface water flow pathways throughout the catchment.
 Swales constructed within a catchment aim to intercept or convey surface water runoff, slow flows and encourage infiltration into the ground, to reduce peak flow downstream locally during small flood events. They usually function best as part of a network of runoff pathway management features within the landscape.
 For the purposes of the Leeds FA22 NFM project this guidance is focussed upon the key considerations involved in locating swales for natural flood management. It does not consider swales for purposes other than flood management.
 Swales are typically constructed along contours to intercept and convey surface water runoff. They can also be constructed on gentle slopes in conjunction with overflow flow barriers (also called 'check dams') at intervals to slow flows. Surface water entering the swale may be retained or conveyed (downward) into a storage feature (e.g. earth bund or overflow flow barrier). Swales can be designed with wet or dry bases and can be used in locations with permeable or impermeable soils.
 Whilst swales should aim to replicate and enhance the natural processes within a catchment by intercepting overland flow pathways and allowing flows, long or large swales can hold a significant volume of water. Therefore, any swales should be located, designed and constructed with care.
 This guidance note summarises the key considerations for identifying sites which are suitable for siting swales. Exact location of individual features should be decided at a later stage of development (e.g. during detailed design). The guidance is aimed at landowners, land managers and those involved in stakeholder engagement. It covers site selection, but not design.



2. Optimum locations
 Swales should be located:
 1. In areas open to flooding (following conditions).
 2. Along routes where it is possible to create a swale with relatively flat slope (ideally with a gradient less than 1 in 20 (5%).
 3. Along routes that allow a continuous, gradual fall along the length of the swale.
 4. Alongside field boundaries, tracks, paths or landscaping.
 5. Where the swale can be as long as is reasonably practicable and can be straight.
 6. In combination with other runoff pathway management measures that need an outlet/overflow or transfer mechanism.
 7. In areas with suitable ground properties for excavation.
 8. Where the existing habitat and its functions can be protected, retained, improved or beneficially enhanced by creating wetter and drier areas using swales.
 9. In areas which are relatively unproductive and able to be temporarily flooded without causing damage to property or risk to life.
 10. In areas that are readily and safely accessible by people (and vehicles, where necessary).
 11. In locations, and of a shape and scale, to suit the existing landscape.
3. Locate with care
 Swales may be located with care:
 1. Along routes where the swale slope will be steeper than 1 in 20 (5%), or overflow flow barriers (also called check dams) may be required.
 2. Along routes where there are abrupt changes in vertical or horizontal alignment.
 3. Near public rights of way, publicly accessible open spaces and roads.
 4. In or near areas of invasive non-native plant species, where the species can be trapped/removed from the site before planting starts (otherwise have a buffer of at least 7 metres from each plant).
4. Specific constraints
 Swales should not be located:
 1. At sites with:
 a. Risks of excess fertilizer or weed killer application.
 b. Fences, or walls, land contamination.
 c. Evidence shade due to trees or overhead structures that could limit growth of grass (or other vegetation).
 d. Greater or sandy soils.
 e. Contaminated soil or unstable ground.
 2. Within 15 metres of utility assets or 50 metres of SABC high pressure gas pipeline.
 3. Where any excavation would be needed directly underneath tree canopy, or within 1m of a tree trunk, whichever is the greater.
 3. In areas where it could adversely affect designated or important natural conservation, heritage and landscape sites, protected and important habitats, and protected species and their habitats.
 4. In locations with known or suspected peat soils.
5. How to identify suitable locations
 1. Landowner / land manager knowledge.
 2. Wet and non-wet weather walkovers.
 3. Mapping in the 'Wet Walk' platform:
 a. 1.3 Monthly 15m Grid (major index polygons).
 b. 1.2 Historical NFM potential mapping: all maps.
 c. 1.2 Site Potential: NFM constant mapping: all maps.
 4. Topo-oriental imagery and historic mapping.
 Reference Guidance and Useful Information
 The Leeds Manual: CDM, <https://www.leeds.gov.uk/sites/default/files/2016/06/Leeds-Manual-CDM.pdf>
 CD 5.2 Integrated drainage solutions for highways, highways England, <https://www.leeds.gov.uk/sites/default/files/2016/06/CD5.2-Eng.pdf>