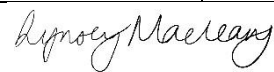


Date	28 th April 2025	Issued version	1.0
Author	Dr Lynsey MacLeary & Dr Eric Gillies, cbec eco-engineering UK Ltd		
Technical & Comm. Reviewer	Kate Comins, cbec eco-engineering UK Ltd		
To	Moya MacDonald, Cairngorms National Park Authority		
Project	Dee Valley Restoration		
Subject	DRAFT - Summary of additional modelling work undertaken at construction phase to support planning and permitting requirements		

1. INTRODUCTION

cbec eco-engineering UK Ltd (CBEC) was commissioned by the Cairngorms National Park Authority (CNPA) to produce detailed designs to restore natural river processes, reinstate channel/floodplain connectivity and improve the quality of riverine and floodplain habitat at the landscape scale through the removal of embankments along ~3.6 km of the Upper Dee, thus restoring ~135 ha of the Dee valley. Design modelling of the preferred option, undertaken in 2023, demonstrated that the design was successful in increasing floodplain connection at the study site at low flood events (i.e. the 1:1.5 year and 1:2 year events), broadly increasing inundation extents and depths on the river left floodplain and reducing those on the river right floodplain. Similar patterns were observed for the 1:5 and 1:10 year events, with differences between existing and design conditions becoming less pronounced with increasing return period. A Flood Risk Assessment carried out as part of the design development process demonstrated that the design will result in a general increase in peak flood depths within the design site but no increase in flood extents (i.e. no increase in the number of receptors affected or risk to receptors already affected). It was also demonstrated that the design is not predicted to have any impact on flooding downstream of the site, other than slight attenuation of peak flow for the 1:2 year event. In order to address some concerns raised during the Planning process and incorporate the effects of some localised changes to the design following ongoing consultation, the design model was re-run in April 2025. This technical note summarises the changes made to the design and design surface and summarises the model results for the updated April 2025 design and associated model runs and their implications for flood risk.

2. DESIGN UPDATES

Since completion of the detailed design in 2023, a number of changes have been made to the design in response to feedback from SEPA, CNPA, landowners, the local community and other stakeholders. These changes are summarised below.

- **Additional wetland scrapes.** Following feedback from the local community amid concerns about flood risk downstream, more wetland scrapes have been added to the design surface with the aim of increasing flood storage. These additional scrapes have been incorporated into the newly modelled design surface through adjustment of the surface in CAD to result in shallow floodplain scrapes with variable topography.
- **Redistribution of spoil.** Cut material will be generated primarily through the removal of the embankment and the excavation of floodplain scrapes, with additional rock generated from the removal of historical bank toe armour. This material is to be disposed of by redistributing it across the site in three ways: (i) infilling the topographic low behind the existing embankment (primarily material from bank toe armour and embankment); (ii) reuse of suitably sized boulders to ballast large wood structures; and (iii) spreading material over designated areas of the floodplain to a depth of ~5 cm. These changes have been implemented through modification of the design surface in CAD.
- **Hard bank protection removal.** Following ongoing engagement with the landowner and the wider project team, some sections of historical bank toe protection are now being retained in response to ecological or logistical constraints. Bank toe armour removal has not been modelled directly because it is not represented by a topographic change within model resolution; additionally, loss of toe armour has only a minor effect on toe friction and affects primarily the evolution of the channel rather than its hydraulic capacity, water levels and velocities. However, to ensure a conservative approach to assessment of flood risk, approximate volumes of rock to be removed have been calculated and these volumes included in the redistribution of spoil across the site. It is assumed that the rock removed will be (i) reused as ballast for the large wood structures where of appropriate size and (ii) redistributed in the deeper parts of the site (primarily behind the existing embankment) and covered by finer spoil material.
- **Large wood structures.** Large wood was represented in the model as a change to the mesh topography (i.e. an increase in height) and an increase in local friction. Following liaison with the landowners, the majority of the in-channel large wood structures have been descope, with only two in-channel structures remaining. All of the original floodplain large wood structures are retained in the design.

Design drawings reflecting the updated design can be seen in Figure 2.1 and appendix A.

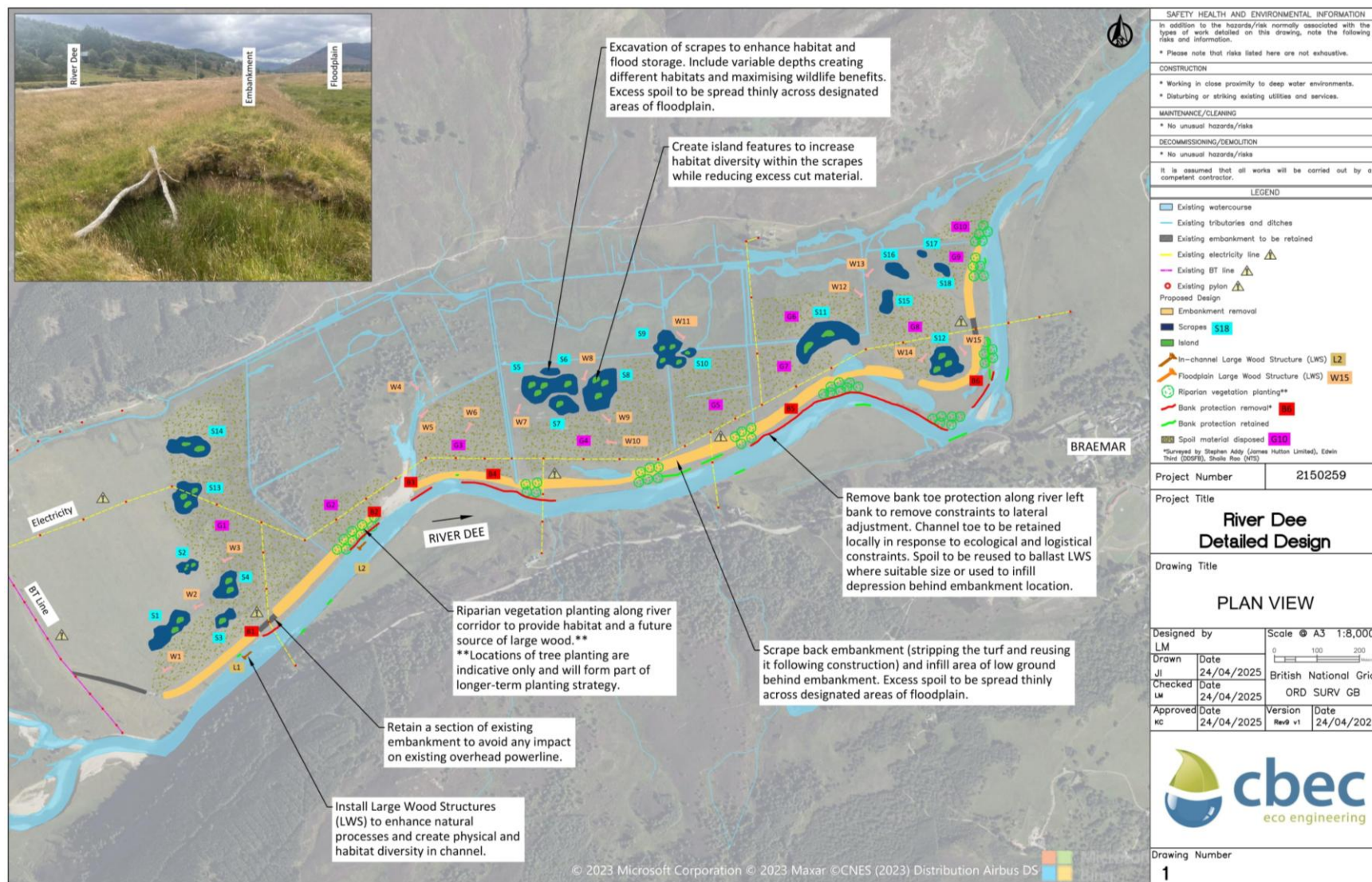


Figure 2.1. Detailed Design

3. MODEL RESULTS

3.1 MODELLING OUTPUTS

The design surface was updated to reflect the design changes detailed in Section 2. This was then re modelled using the fully 2D TUFLOW FV hydraulic model that was developed as part of the detailed design phase of work in 2023. The results of the design model for the 2023 and updated design were then compared. Full details of the model set up including model calibration and sensitivity checking are available in CBEC's Detailed Design Report (CBEC 2023). A key requirement for modelling the updated design surface was to check that the redistribution of spoil over the floodplain did not result in any significant loss in floodplain capacity and subsequently increase flood risk and pass forward flows.

Model results for the 1 in 2year, 1in 50 year, 1 in 200 year and 1 in 200 year plus climate change for existing and the updated design conditions are presented in Figure 3.1 to Figure 3.5.

2150729 - HYDRAULIC MODELLING RESULTS - 2Y RETURN PERIOD - DEPTH

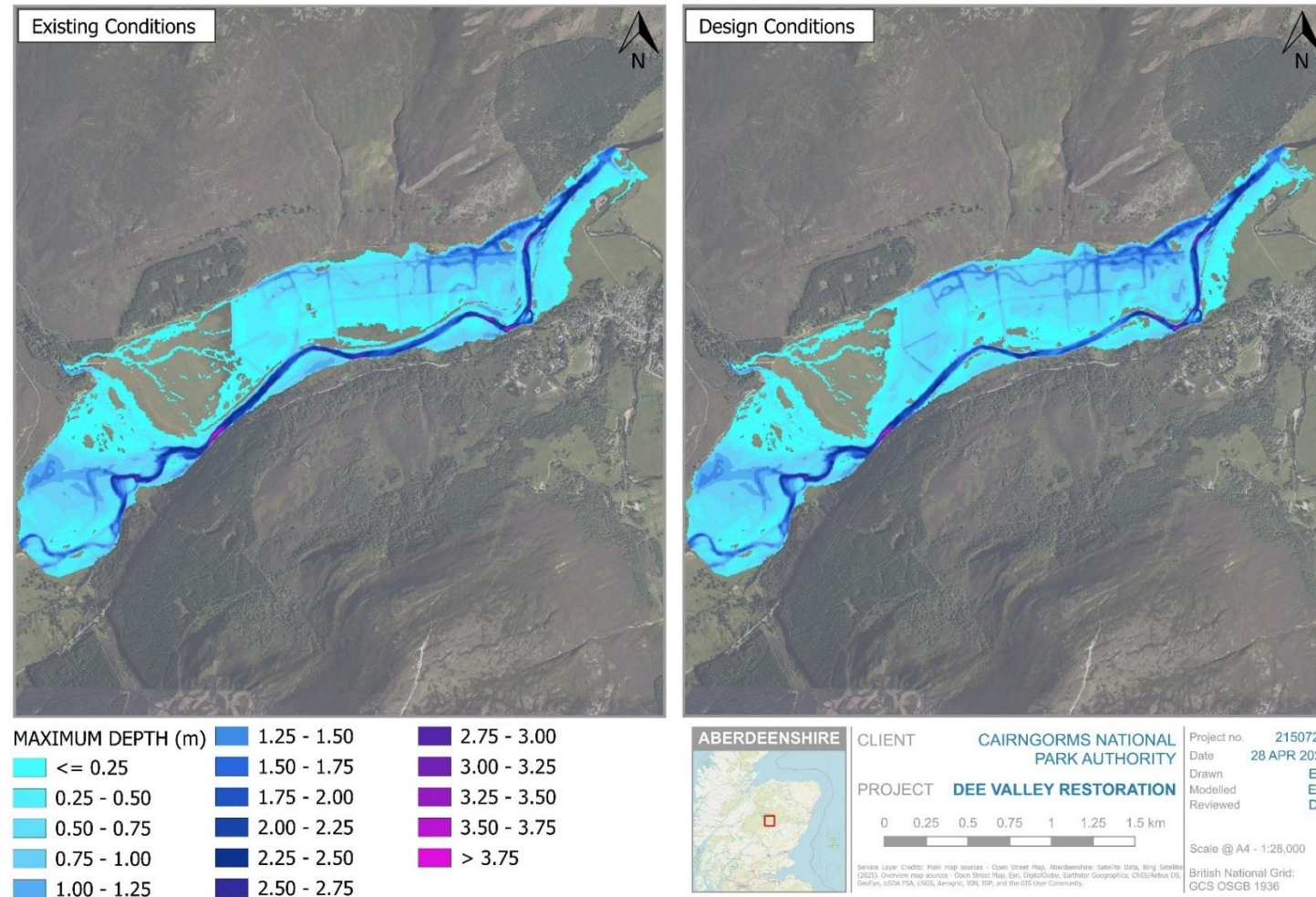


Figure 3.1. Hydraulic model results for existing and design conditions – 2yr return period

2150729 - HYDRAULIC MODELLING RESULTS - 10Y RETURN PERIOD - DEPTH

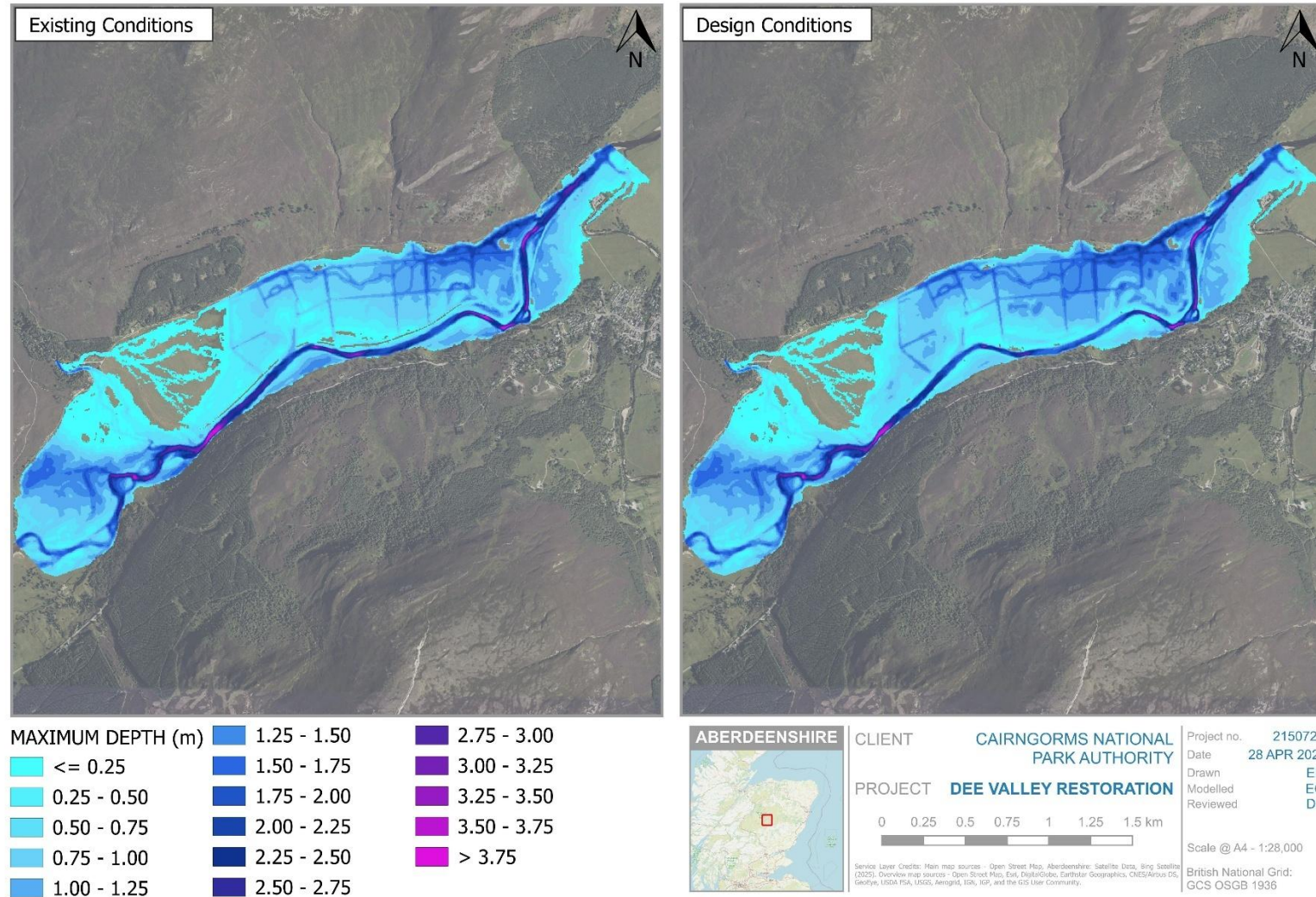


Figure 3.2. Hydraulic model results for existing and design conditions – 10yr return period

2150729 - HYDRAULIC MODELLING RESULTS - 50Y RETURN PERIOD - DEPTH

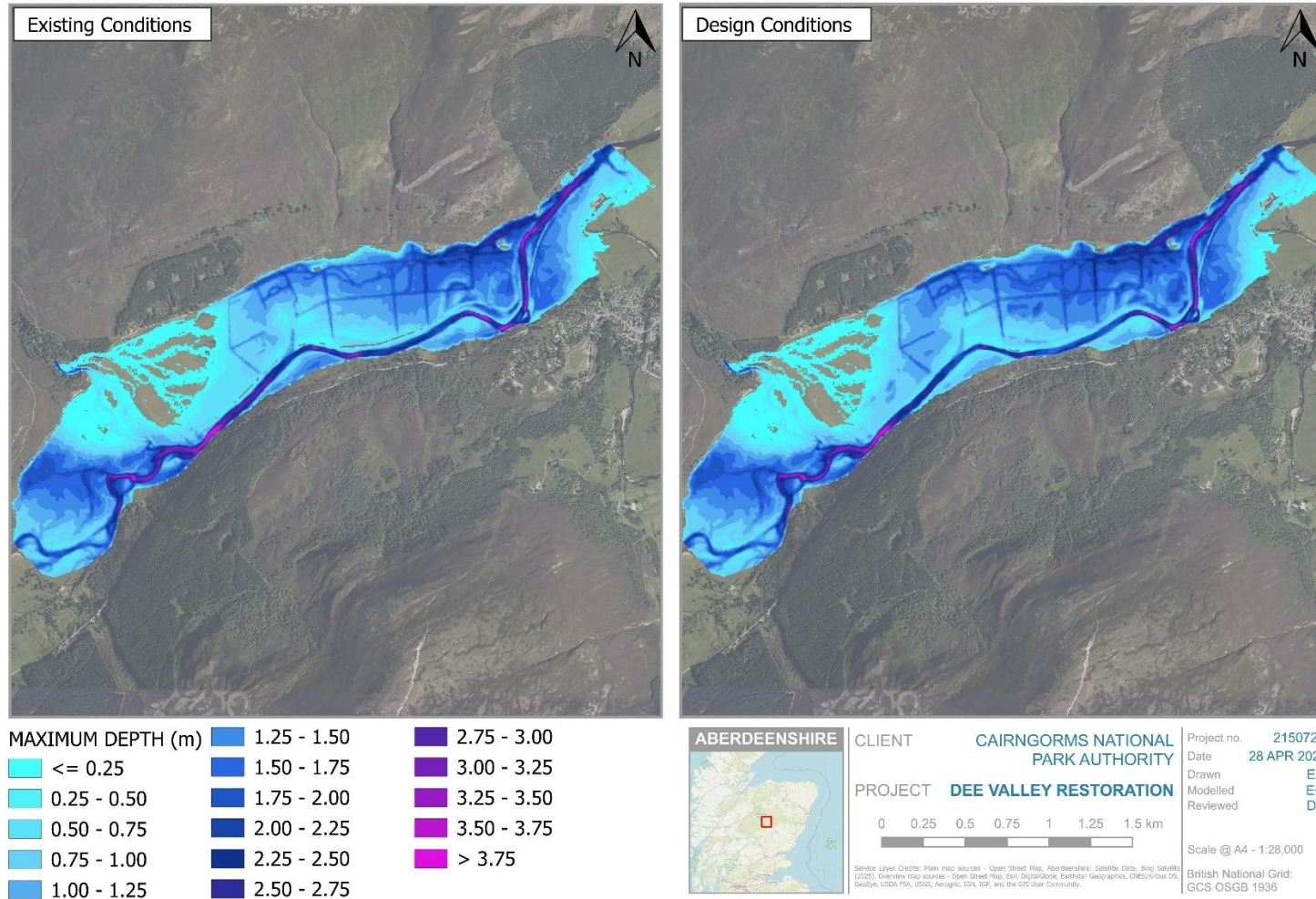


Figure 3.3. Hydraulic model results for existing and design conditions – 50yr return period

2150729 - HYDRAULIC MODELLING RESULTS - 200Y RETURN PERIOD - DEPTH

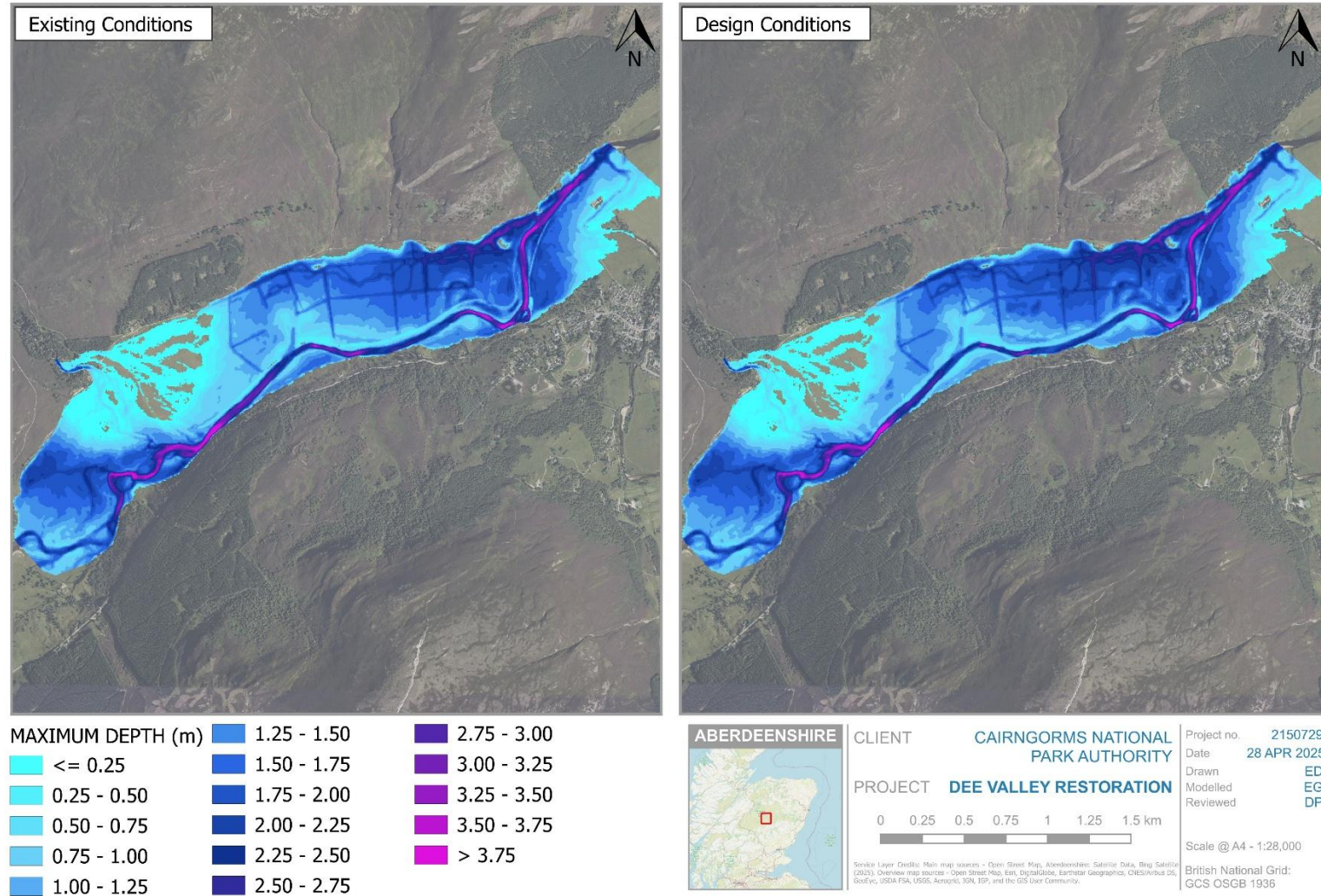


Figure 3.4. Hydraulic model results for existing and design conditions – 200yr return period

2150729 - HYDRAULIC MODELLING RESULTS - 200Y+CC RETURN PERIOD - DEPTH

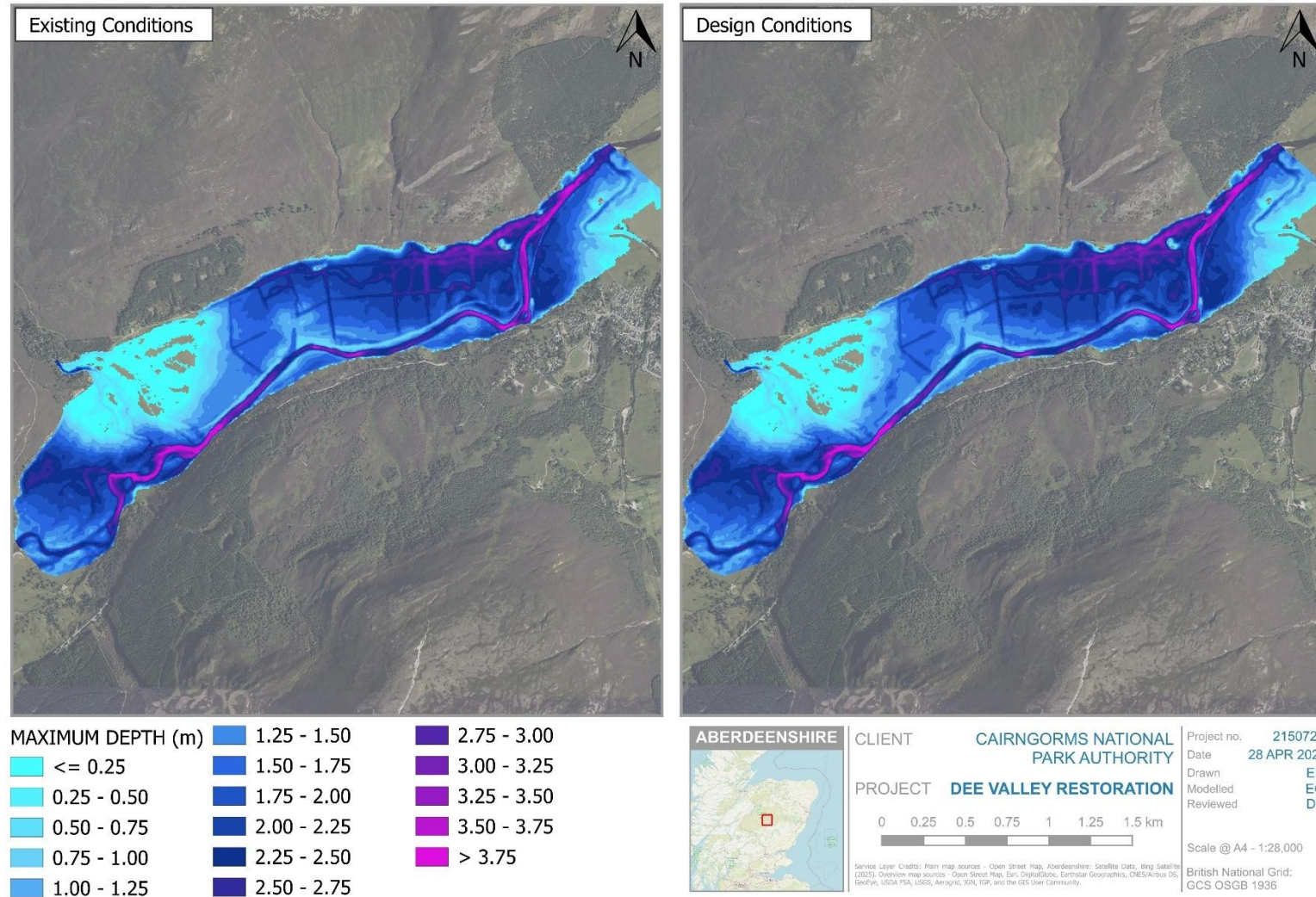


Figure 3.5. Hydraulic model results for existing and design conditions – 200yr + climate change return period

Model results show that the updated design model incorporating additional scrapes and redistribution of spoil on the floodplain has not resulted in any significant changes to the inundation extents and depths and the model results for the updated design surface are aligned with the results for proposed design of 2023 with any changes being within model tolerances.

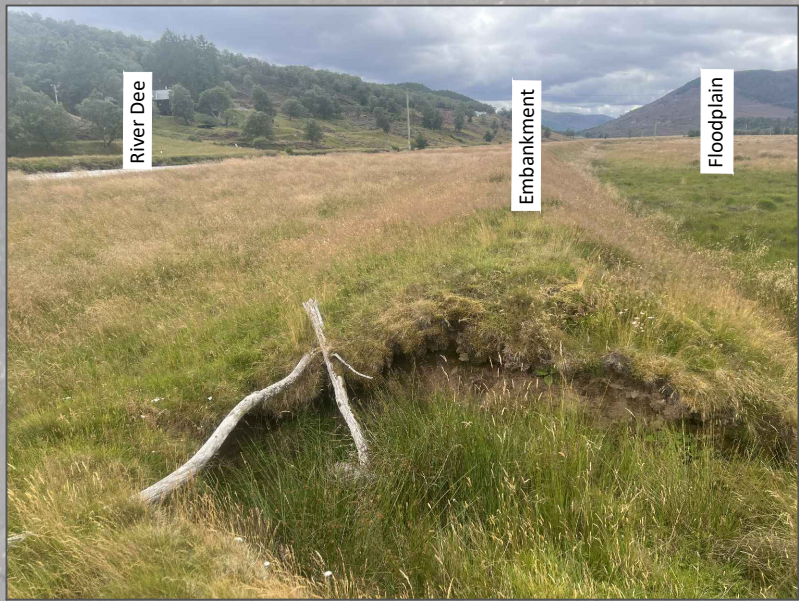
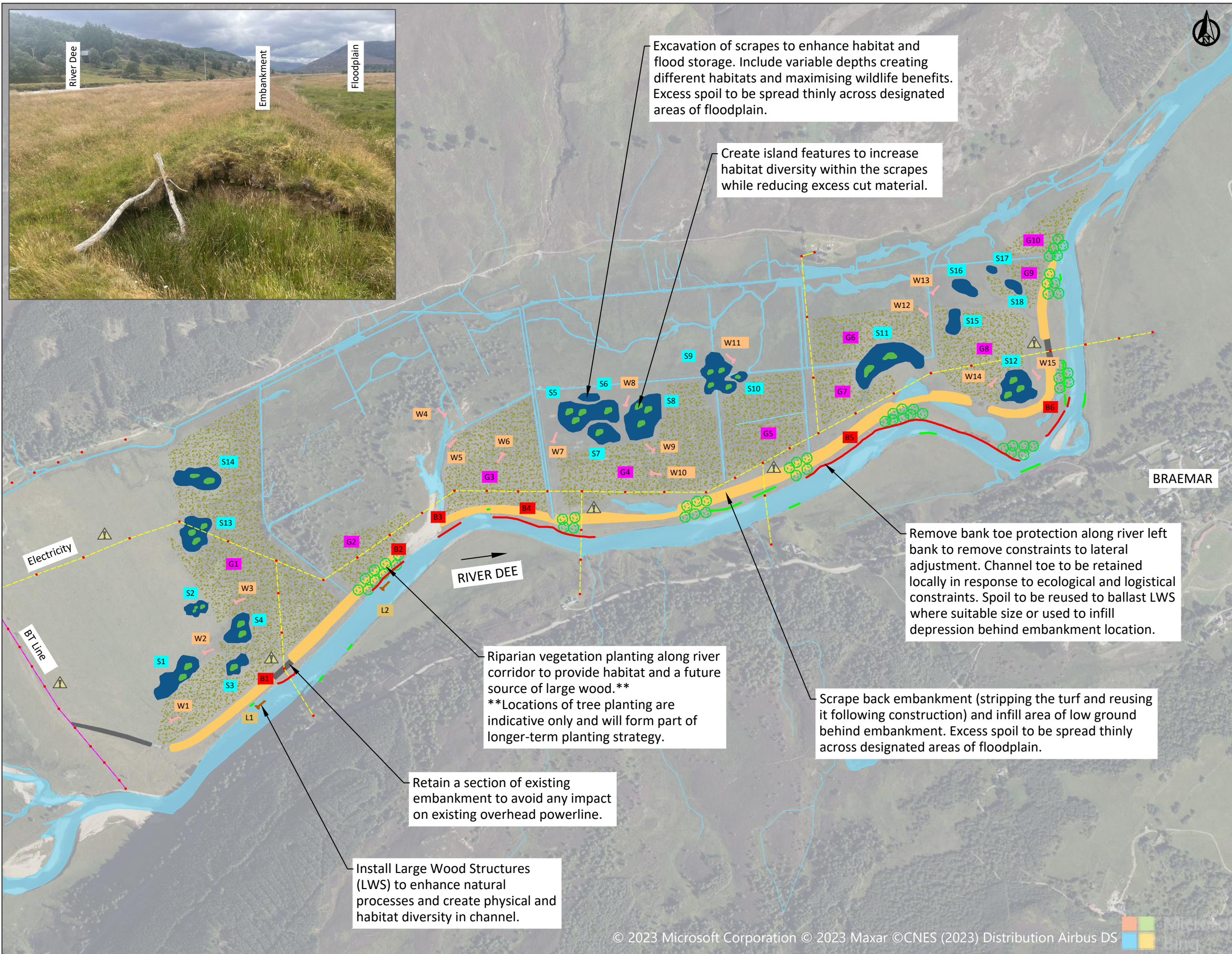
3.2 FLOOD RISK QUERIES

A Flood Risk Assessment was undertaken as part of the 2023 phase of work (CBEC 2023). This demonstrated that the design would result in a general increase in peak flood depths within the floodplain but no increase in flood extents (i.e. no increase in the number of receptors affected, or any increase in risk to receptors already affected).

Outputs from the updated design model run were used to check and compare design flood levels and in particular any increases to flood risk at the Allanmore property, (the only property shown to come close to the functional floodplain, other than the farm buildings at Allanquoich which are unaffected by the design). The 2023 design model results found an increase of 7mm from existing to design conditions for design water levels, which is well below model tolerances. For the updated design surface this figure was found to increase by 1mm meaning design water levels at the Allanmore property were predicted to increase by 8mm as opposed to 7mm with the updated design surface. This 1mm increase in design water levels between the most recent design and the 2023 design would suggest that with the updated design surface including all the elements of the proposed design does not result in a significant increase to flood risk at the Allanmore property. The design changes also show no difference to pass forward flows relative to the 2023 results. Together this demonstrates that the original model interpretation still stands.

The FRA will be updated to reflect the latest design model results.

APPENDIX A
Detailed Design Drawings



SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risk normally associated with the types of work detailed on this drawing, note the following risks and information.

- * Please note that risks listed here are not exhaustive.

CONSTRUCTION

- * Working in close proximity to deep water environments.
- * Disturbing or striking existing utilities and services.

MAINTENANCE/CLEANING

- * No unusual hazards/risks

DECOMMISSIONING/DEMOLITION

- * No unusual hazards/risks

It is assumed that all works will be carried out by a competent contractor.

LEGEND

- Existing watercourse
- Existing tributaries and ditches
- Existing embankment to be retained
- Existing electricity line
- Existing BT line
- Existing pylon
- Proposed Design**
- Embankment removal
- Scrapes
- Island
- In-channel Large Wood Structure (LWS)
- Floodplain Large Wood Structure (LWS)
- Riparian vegetation planting**
- Bank protection removal*
- Bank protection retained
- Spoil material disposed

*Surveyed by Stephen Addy (James Hutton Limited), Edwin Third (DDSF), Shaila Rao (NTS)

Project Number	2150259
Project Title	
River Dee Detailed Design	
Drawing Title	
PLAN VIEW	
Designed by LM	Scale @ A3 1:8,000
Drawn JI	Date 24/04/2025
Checked LM	Date 24/04/2025
Approved KC	Date 24/04/2025
Version Rev9 v1	Date 24/04/2025

Drawing Number

1

Embankment removal

Section 2A / NO 12423 90796 to NO 12646 90950 / 930m3
Section 2B / NO 12685 90988 to NO 12912 91216 / 1,320m3
Section 3 / NO 13011 91285 to NO 13251 91292 / 650m3
Section 4 / NO 13251 91292 to NO 13847 91438 / 3,150m3
Section 5 / NO 13847 91438 to NO 14158 91547 / 1,360m3
Section 6A / NO 14196 91533 to NO 14332 91633 / 810m3
Section 6B / NO 14322 91686 to NO 14343 91854 / 490m3

Scrapes

Scrape 1 / NO 12437 90953 / 1,170m3
Scrape 2 / NO 12481 91103 / 310m3
Scrape 3 / NO 12567 90982 / 410m3
Scrape 4 / NO 12572 91056 / 770m3
Scrape 5 / NO 13333 91528 / 1,960m3
Scrape 6 / NO 13332 91560 / 175m3
Scrape 7 / NO 13358 91483 / 575m3
Scrape 8 / NO 13448 91515 / 1,430m3
Scrape 9 / NO 13605 91607 / 1,130m3
Scrape 10 / NO 13659 91606 / 150m3
Scrape 11 / NO 13967 91645 / 1,070m3
Scrape 12 / NO 14261 91582 / 1,250m3

Scrapes

Scrape 13 / NO 12476 91263 / 1,220m3
Scrape 14 / NO 12487 91382 / 1,100m3
Scrape 15 / NO 14121 91721 / 500m3
Scrape 16 / NO 14146 91056 / 470m3
Scrape 17 / NO 14205 91836 / 90m3
Scrape 18 / NO 14248 91799 / 230m3

In-Channel LWS

L1 / NO 12647 90892
L2 / NO 12889 91141

Excavation of scrapes to enhance habitat and flood storage. Include variable depths creating different habitats and maximising wildlife benefits. Excess spoil to be spread thinly across designated areas of floodplain.

Create island features to increase habitat diversity within the scrapes while reducing excess cut material.

Remove bank toe protection along river left bank to remove constraints to lateral adjustment. Channel toe to be retained locally in response to ecological and logistical constraints. Spoil to be reused to ballast LWS where suitable size or used to infill depression behind embankment location.

Scrape back embankment (stripping the turf and reusing it following construction) and infill area of low ground behind embankment. Excess spoil to be spread thinly across designated areas of floodplain.

Riparian vegetation planting along river corridor to provide habitat and a future source of large wood. **Locations of tree planting are indicative only and will form part of longer-term planting strategy.

Retain a section of existing embankment to avoid any impact on existing overhead powerline.

Install Large Wood Structures (LWS) to enhance natural processes and create physical and habitat diversity in channel.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

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* Disturbing or striking existing utilities and services.

MAINTENANCE/CLEANING

* No unusual hazards/risks

DECOMMISSIONING/DEMOLITION

* No unusual hazards/risks

It is assumed that all works will be carried out by a competent contractor.

LEGEND

- Existing watercourse
- Existing tributaries and ditches
- Existing embankment to be retained
- Existing electricity line
- Existing BT line
- Existing pylon
- Proposed Design
 - Embankment removal
 - Scrapes
 - Island
 - In-channel Large Wood Structure (LWS)
 - Floodplain Large Wood Structure (LWS)
 - Riparian vegetation planting**
 - Bank protection removal*
 - Bank protection retained
 - Spoil material disposed

*Surveyed by Stephen Addy (James Hutton Limited), Edwin Thirid (DDSF), Shaila Rao (NTS)

Project Number 2150259

Project Title
**River Dee
Detailed Design**

Drawing Title
CUT FILL ANALYSIS

Designed by LM	Date 24/04/2025	Scale @ A3 1:8,000	
Drawn JL	Date 24/04/2025	British National Grid	
Checked LM	Date 24/04/2025	ORD SURV GB	
Approved KC	Date 24/04/2025	Version Rev9 v1	Date 24/04/2025



Drawing Number

2

CUT FILL ANALYSIS

- 2m to -1m
- 1m to -0.5m
- 0.5m to -0.25m
- 0.25m to 0
- 0 to 0.5m

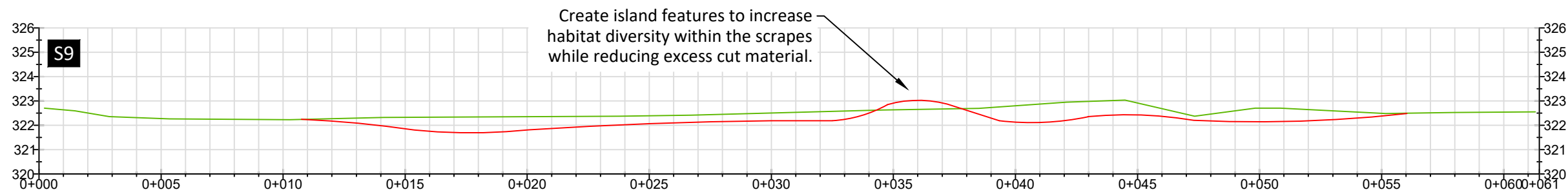
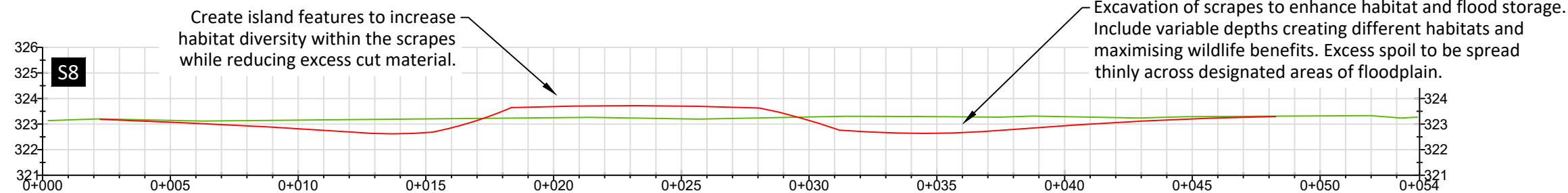
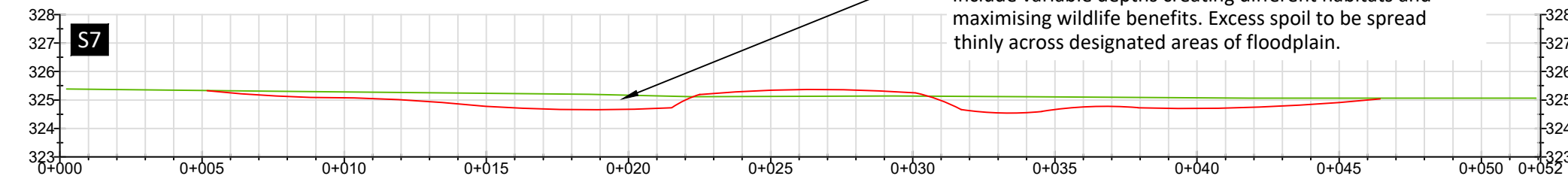
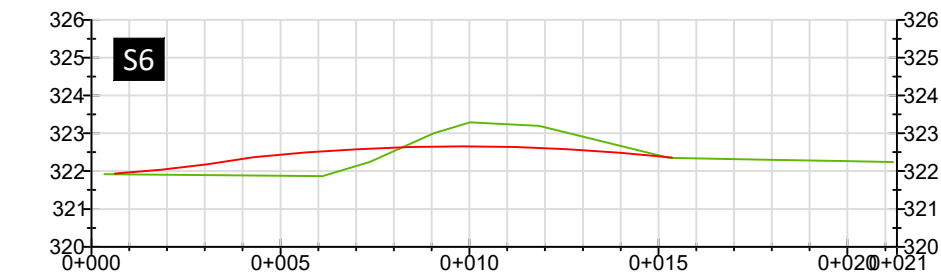
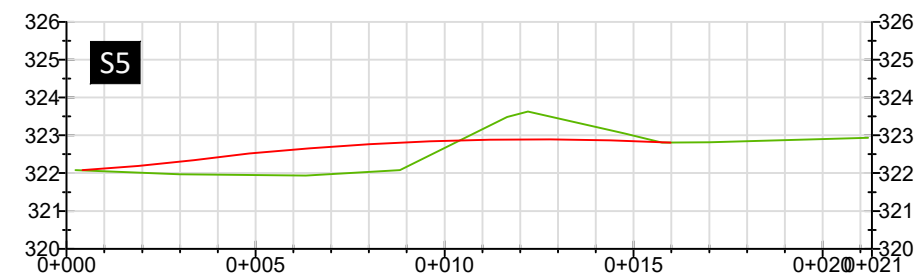
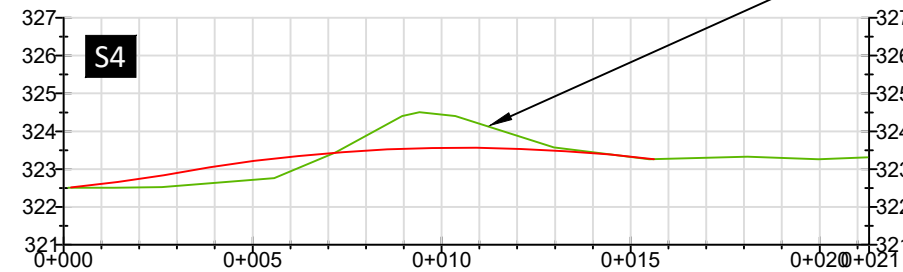
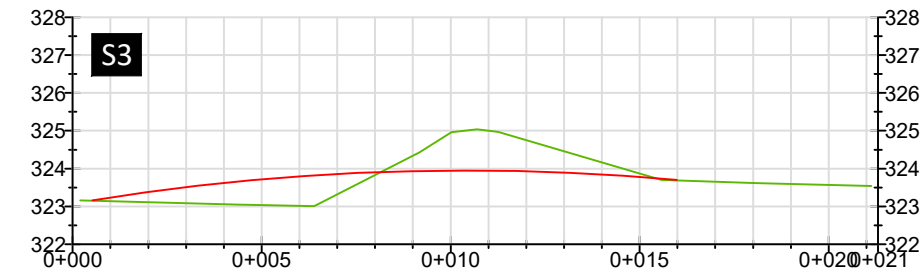
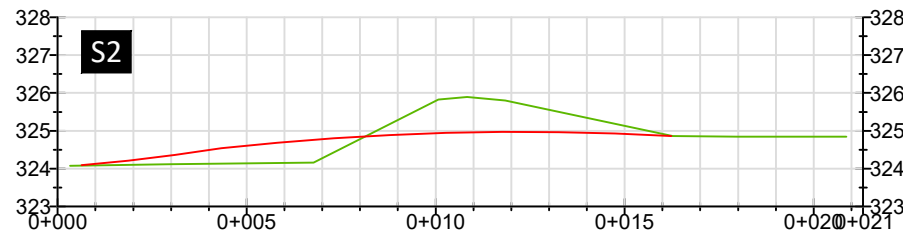
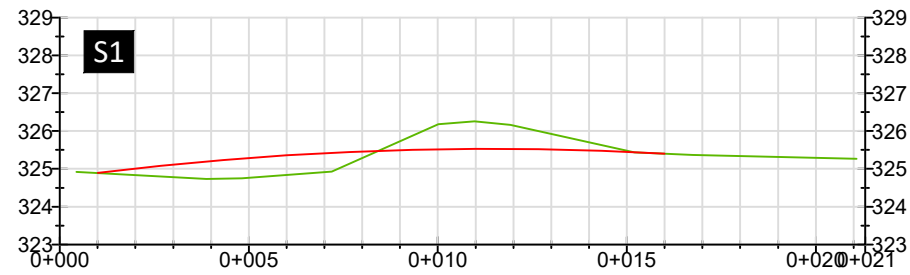
CUT VOLUMES

EMB REMOVAL = -8,710m3
SCRAPES = -14,010m3
BANK PROTECTION = -3,800m3

FILL VOLUMES

EMB REMOVAL = +8,710m3
FLOODPLAIN = +17,810m3

NET = ZERO



Scrape back embankment (stripping the turf and reusing it following construction) and infill area of low ground behind embankment. Excess spoil to be spread thinly across designated areas of floodplain.

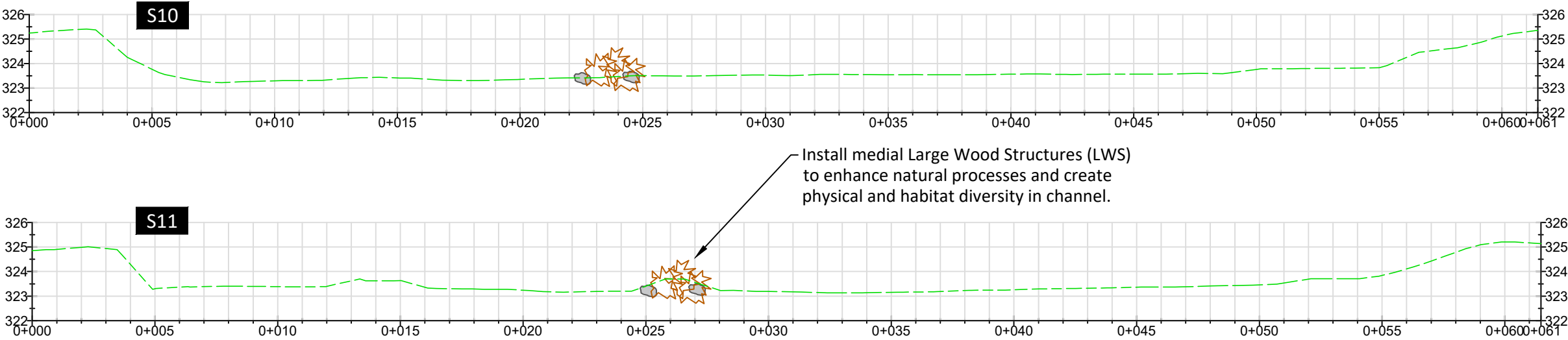
Excavation of scrapes to enhance habitat and flood storage. Include variable depths creating different habitats and maximising wildlife benefits. Excess spoil to be spread thinly across designated areas of floodplain.

Create island features to increase habitat diversity within the scrapes while reducing excess cut material.

Excavation of scrapes to enhance habitat and flood storage. Include variable depths creating different habitats and maximising wildlife benefits. Excess spoil to be spread thinly across designated areas of floodplain.

Create island features to increase habitat diversity within the scrapes while reducing excess cut material.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION	
In addition to the hazards/risk normally associated with the types of work detailed on this drawing, note the following risks and information.	
* Please note that risks listed here are not exhaustive.	
CONSTRUCTION	
* Working in close proximity to deep water environments.	
* Disturbing or striking existing utilities and services.	
MAINTENANCE/CLEANING	
* No unusual hazards/risks	
DECOMMISSIONING/DEMOLITION	
* No unusual hazards/risks	
It is assumed that all works will be carried out by a competent contractor.	
LEGEND	
Existing levels Proposed levels	

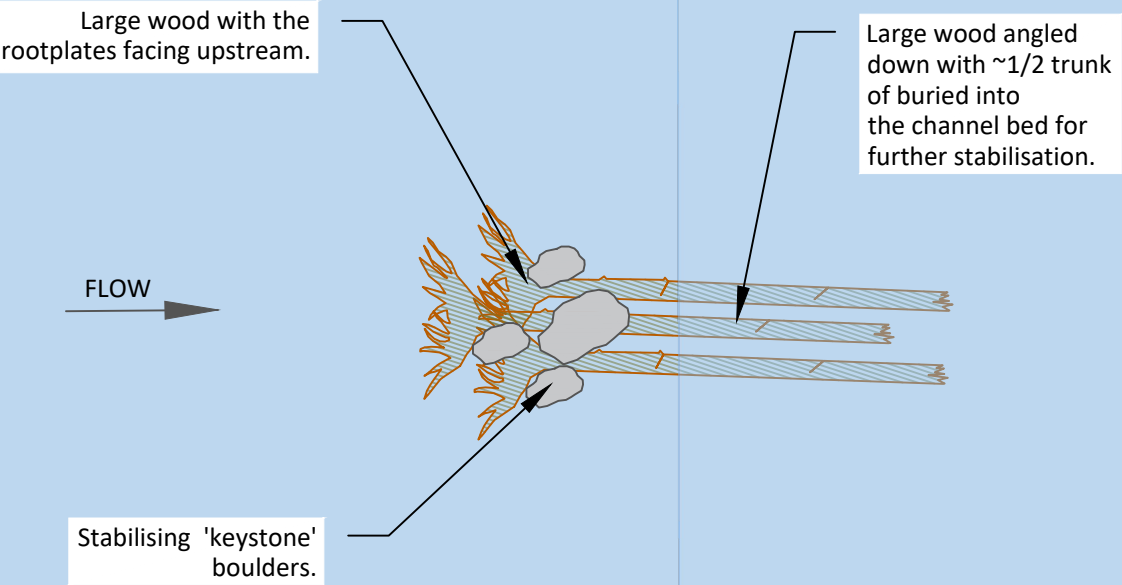


SAFETY HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards/risk normally associated with the types of work detailed on this drawing, note the following risks and information.
* Please note that risks listed here are not exhaustive.
CONSTRUCTION
* Working in close proximity to deep water environments. * Disturbing or striking existing utilities and services.
MAINTENANCE/CLEANING
* No unusual hazards/risks
DECOMMISSIONING/DEMOLITION
* No unusual hazards/risks
It is assumed that all works will be carried out by a competent contractor.

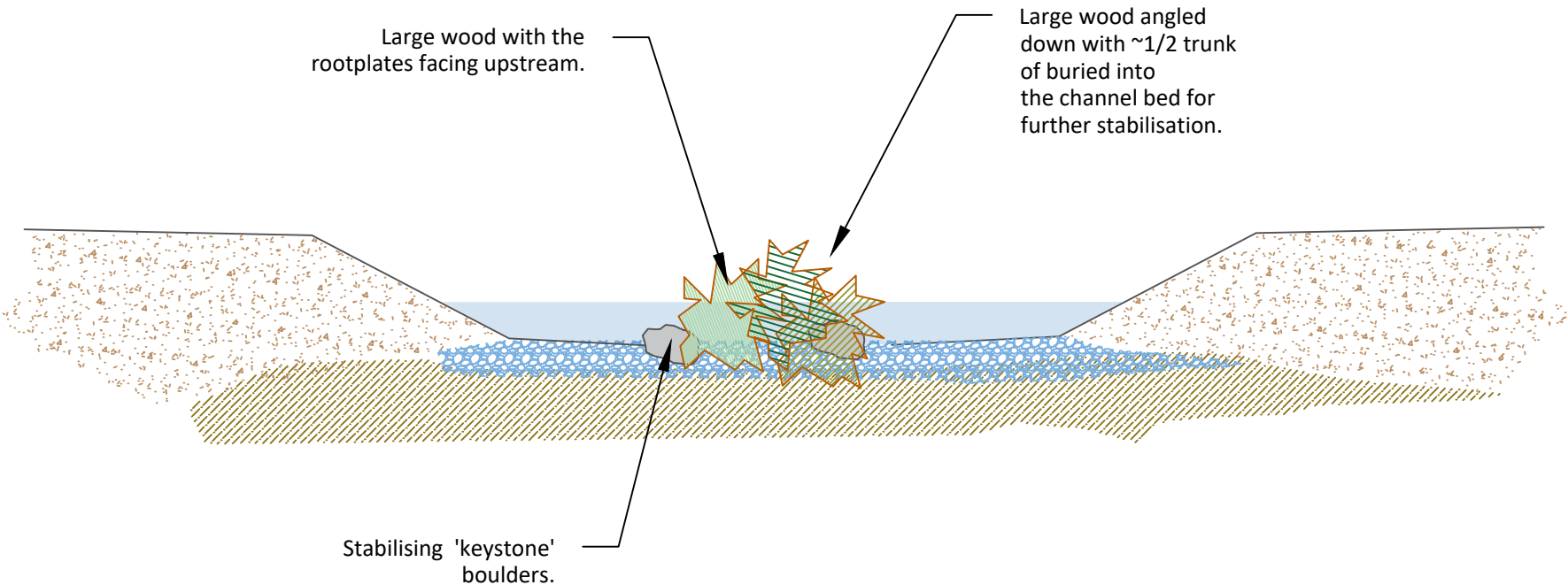
LEGEND
Existing levels Proposed levels Medial large wood structure*
*Wood structures locations are indicative only.

Project Number	2150259
Project Title	River Dee Detailed Design
Drawing Title	SECTIONS 2
Designed by LM	Scale @ A3 1:200
Drawn JI	Date 24/04/2025
Checked LM	Date 24/04/2025
Approved KC	Date 24/04/2025
Version Rev9 v1	Date 24/04/2025
Drawing Number	4

Medial Large Wood Structure



Medial Large Wood Structure



SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risk normally associated with the types of work detailed on this drawing, note the following risks and information.

* Please note that risks listed here are not exhaustive.

CONSTRUCTION

- * Working in close proximity to deep water environments.
- * Disturbing or striking existing utilities and services.

MAINTENANCE/CLEANING

- * No unusual hazards/risks

DECOMMISSIONING/DEMOLITION

- * No unusual hazards/risks

It is assumed that all works will be carried out by a competent contractor.

LEGEND

Project Number 2150259

Project Title
**River Dee
Detailed Design**

Drawing Title
**LARGE WOOD
STRUCTURES**

Designed by LM		Scale @ A3	
Drawn JI	Date 24/04/2025	British National Grid ORD SURV GB	
Checked LM	Date 24/04/2025		
Approved KC	Date 24/04/2025	Version Rev9 v1	Date 24/04/2025



Drawing Number
5