# Upper Spey Embankment Condition Assessment

Final Report

Cairngorms National Park Authority

cbec eco-engineering UK Ltd

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**TABLE OF CONTENTS**



**LIST OF FIGURES**

**LIST OF TABLES**

**SUMMARY**

Most of the River Spey is embanked, between the Spey Dam and Grantown-on-Spey, providing flood protection to adjacent agricultural land. The condition and stability of the linear embankment features is under pressure from historical channel straightening, riverbank erosion, movement of flood water, trampling of the embankment surface by livestock or deer, burrowing of mammals, and a lack of riparian (river corridor) vegetation. Increased high flow events associated with climate change are likely to exacerbate riverbank erosion and increase pressure on the embankments, resulting in a requirement for increased preventative and remedial works to maintain the embankment condition.

During 2023 to 2024 a baseline assessment of ~67 km channel length of the River Spey and select tributaries was undertaken by cbec eco-engineering UK Ltd. (a river management specialist), on behalf of the Cairngorms National Park Authority (CNPA). The study area extended from the Spey Dam to Grantown-On-Spey, encompassing a cumulative embankment length of ~71.14 km. Of this total length, ~83.6% was noted to be in good condition at the time of survey (autumn 2023 and autumn/winter 2024). Signs of erosion on the embankment, indicating a high risk of breaching, were limited to ~1.2% (~0.87 km of embankment cumulatively) of the total length surveyed and ~1.6% (~1.14 km of embankment cumulatively) was found to have already breached. A breach refers to a section of embankment which has been compromised, allowing floodwater to pass through onto adjacent land. Sections at high risk of breaching may present signs of instability such as cracks, slumping or areas of exposed bare ground on the embankment face or crest. These areas at high risk of breaching are likely to be near the riverbank (e.g. less than 5m) or adjacent to an existing breach.

This baseline assessment of the embankments will enable any changes in condition, for example stabilisation, no change or deterioration, to be documented over the duration of this project.

Recommendations were proposed to help reduce the risk of erosion on the embankments in the future, these included:- riparian planting and vegetation management to promote bank stability within the river corridor; fencing to prevent trampling by livestock and deer; a natural flood management study to identify other opportunities within the study site and wider catchment to reduce flood risk; remedial works to repair locations where the embankment has been breached and locations identified as being at high risk of erosion; installation of flap valve culverts within the embankment to facilitate drainage of the fields post-flood and continued monitoring. Subsequent annual surveys, proposed for 2025 to 2028, will target areas identified as being at risk of erosion, where breaching of the embankment is likely to or has taken place and areas of concern highlighted by landowners and/or the CNPA.

## 1. INTRODUCTION

An embankment is a linear mound of compacted material constructed to protect land river flooding. The River Spey, as it flows between the Spey Dam and Grantown-on-Spey, is embanked on either one or both of its banks, throughout much of its length. These sections of the Spey embankments serve to protect the adjacent agricultural land primarily as well as contributing to the flood resilience of some residential properties and access routes.

cbec eco-engineering UK Ltd (cbec) was commissioned by the Cairngorms National Park Authority (CNPA) to undertake a high-level assessment of the condition of flood embankments and riverbanks along the River Spey and select tributaries. A cumulative channel length of ~67 km was selected for annual assessment, extending between the Spey Dam, near Laggan and Grantown-on-Spey, over a 6-year monitoring period between 2023 and 2028. The aim of the conditions assessment is to provide baseline information on the current condition of the embankments, identifying locations where the embankment has already been breached and areas at imminent risk of erosion and/or potential breaching. The degree of erosion to the riverbanks within the study area will also be assessed, particularly where it has potential to undermine an embankment. The assessment will also be used to guide requirements for any future management/maintenance, topographic survey and flood modelling requirements.

Erosion is a natural river process enabling channel adjustment, particularly in meandering channels such as this section of the River Spey. However, it is understood that riverbank erosion may be undesirable in certain locations for example, in the proximity of a flood embankment which may be undermined by bank retreat. Historical straightening of sections of the Spey is likely to have led to over deepening and instability of the channel banks which in turn may impact embankments within close proximity (i.e. less than ~5 m) of the bank. Situated within the river corridor, embankments are also subject to erosion from out of bank flow during flood events, where water flows towards, over or is held behind the bund. More frequent high flow and flood events resulting from climate change are likely to increase erosion risk to the embankments in the future. The factors outlined above will increase wear and tear and exacerbate the risk of erosion on the embankments which will ultimately increase the requirement for regular maintenance of the embankments.

Signs of erosion on an embankment may be visible in the form of cracks, signs of slumping or exposure of bare ground/loss of surface vegetation, which will be surveyed during the condition assessment. Risk of embankment erosion may also be influenced in part by livestock or deer trampling, burrowing of mammals and change in vegetation cover. Signs of erosion and the degree of stabilisation or degradation of the embankment will be noted throughout the study area during the embankment condition assessment over the study period (2023- 2028).

This study serves to inform the CNPA and landowners of the current condition of the flood embankments and riverbanks along the watercourses of interest. This baseline data will enable any changes in condition, for example stabilisation, no change or deterioration, to be documented over the duration of this project. The type and combination of contributing factors acting on the riverbank/embankment is often site-specific. To enable comparisons within and between landownership boundaries, the walkover survey focused on consistently recording the condition observed across the full ~67 km study site, regardless of causation. It is hoped that this data will enable the most at-risk locations to be targeted for future management.

This report details the study areas (Section 1.1) as well as summarising the desk study (Section 2) and conditions assessment (Section 3) undertaken as part of this baseline study. The methodology employed throughout the conditions assessment is detailed in Section 3.2 and the results of the 2023 and 2024 baseline assessments for Areas 1 to 3 presented in Section 3.3. These results include the identification of sections of embankment at risk of erosion and recommendations for future monitoring.

## 1.1 STUDY AREAS

This embankment condition assessment focuses on ~51.2 km of the River Spey between the Spey Dam, near Laggan and Grantown-On-Spey. A cumulative total of ~15.9 km of select tributaries will also be surveyed, the longest of which is a ~12 km stretch of the River Dulnain from Carrbridge to Dulnain Bridge. The study site has been divided into 3 survey areas to aid fieldwork planning and reporting. These areas are as follows:

1. Spey Dam, upstream of Laggan, to Kingussie;
2. Kingussie to Aviemore;
3. Boat of Garten to Grantown-On-Spey.

Each of the three study areas has then been divided into survey reaches as outlined in Table 1.1 and illustrated in Figure 1.1 to Figure 1.4. Table 1.1 also indicates which riverbanks (left, right or both) were assessed.[1]

The survey reaches outlined in Table 1.1 were selected by the CNPA, in liaison with landowners and the Cairngorms Crofters and Farmers Community (CCFC), targeting sections of riverbank where flood embankments are known or thought to be present. The result is a continuous conditions assessment of both banks of the River Spey from the Spey Dam to Aviemore (Areas 1 and 2), with the exception of Insh Marshes National Nature Reserve, and Boat of Garten to Grantown-on-Spey (Area 3). Insh Marshes National Nature Reserve has been omitted from this assessment due to a separate, ongoing study that is exploring management options for the RSPB reserve. Data was not collected between Aviemore and Boat of Garten where no flood embankments are present.

[1] Where left and right bank are mentioned, this refers to the banks located to the left or right, respectively, when facing in a downstream direction. For example, along this section of the River Spey, the river left bank is the western side and the river right bank is the eastern side.

**Table 1.1 Embankment condition assessment Survey Areas 1 to 3 and sub-reach extents.**

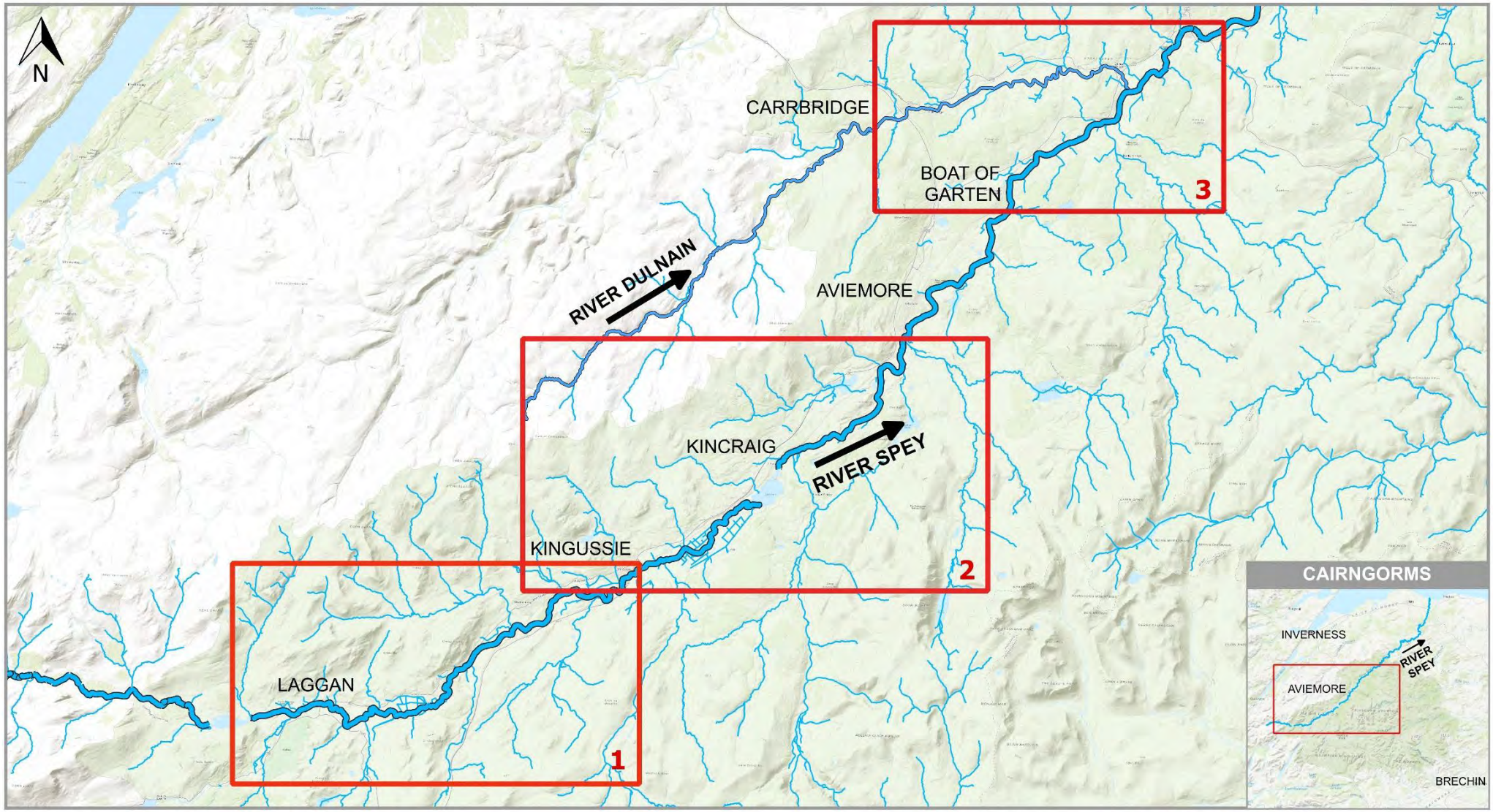
| Survey Areas | Reach Code | Watercourse | Description | Upstream Extent | Downstream Extent | Banks (Left, Right, Both) | Total Channel Length (~km)[2] |
|---|---|---|---|---|---|---|---|
| 1 Spey Dam to Kingussie | A | River Spey | Spey Dam, Laggan to B970 Road Bridge, Kingussie | NN 58224 93547 | NN 75978 99771 | Both | 25.2 |
| | B | Allt Breakachy | ~0.2 km downstream of Breakachy Bridge to the Allt Breakachy–Spey confluence | NN 63720 92999 | NN63611 93512 | Right | 0.6 |
| | C | Fèith Bhuidhe | 0.15 km downstream of road bridge to ~0.15 km upstream of the Fèith Bhuidhe–Spey confluence | NN 64053 93164 | NN 65077 93657 | Left | 1.2 |
| | D | River Calder | Calder Bridge (A86) to Calder–Spey confluence | NN 70570 98653 | NN 70802 97947 | Both | 0.9 |

[2] Both riverbank erosion and embankment condition will be assessed; therefore, channel length has been used to represent the extent of each survey reach. However, it should be noted that embankment length may be longer/shorter than the channel length depending on its planform and distance set back from the top of bank. Where both banks have been assessed, the approximate length of bank surveyed would be double the channel length indicated.

| Survey Area | Reach Code | Watercourse | Description | Upstream Extent | Downstream Extent | Banks (Left, Right, Both) | Total Channel Length (~km)$^2$ |
|---|---|---|---|---|---|---|---|
| 2 Kingussie to Aviemore | A | River Spey | B970 Road Bridge, Kingussie to River Tromie confluence | NN 75978 99771 | NH 78004 01161 | Left | 3 |
| | B | Gynack Burn | Speyside Beach Meadows to Gynack–Spey confluence | NH 75818 00188 | NH 75993 00121 | Left | 0.2 |
| | C | Raitts Burn | A9 road bridge to Raitts–Spey confluence | NH 78961 02173 | NH 79195 01714 | Both | 0.5 |
| | D | River Spey | Loch Lùb Mhàiri to the inlet to Loch Insh | NH 81147 03380 | NH 82601 03842 | Both | 2 |
| | E | Insh Marshes Main Drain | ~250 m upstream of the Main Drain–Spey confluence, downstream to the confluence | NH 82296 03636 | NH 82476 03810 | Both | 0.25 |
| | F | Dunachton Burn | Railway bridge to the Dunachton–Spey confluence | NH 82397 04548 | NH 82563 04441 | Both | 0.25 |
| | G | River Spey | Kincraig Bridge to B970 road bridge, Aviemore | NH 83514 05581 | NH 89495 11588 | Both | 11 |

| Survey Area | Reach Code | Watercourse | Description | Upstream Extent | Downstream Extent | Banks (Left, Right, Both) | Total Channel Length (~km)² |
|---|---|---|---|---|---|---|---|
| 3 Boat of Garten/ Carrbridge to Grantown-on-Spey | A | River Spey | Boat of Garten to Grantown-on-Spey | NH 94668 19097 | NJ 02032 24637 | Both | 10 |
| | B | River Dulnain | Carrbridge to confluence with Spey | NH 90989 22890 | NJ 00399 23797 | Both | 12 |
| | | | | | Sub total | Area 1 | 27.9 |
| | | | | | | Area 2 | 17.2 |
| | | | | | | Area 3 | 22 |
| | | | | | **Total** | **All Areas** | **67.1** |

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREAS OVERVIEW MAP




**Condition Assessment**

- Survey Areas
- 1 Survey Area Number

**Watercourses**

- River Spey
- River Dulnain*
- Other Tributaries*

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 2 4 6 8 10 km

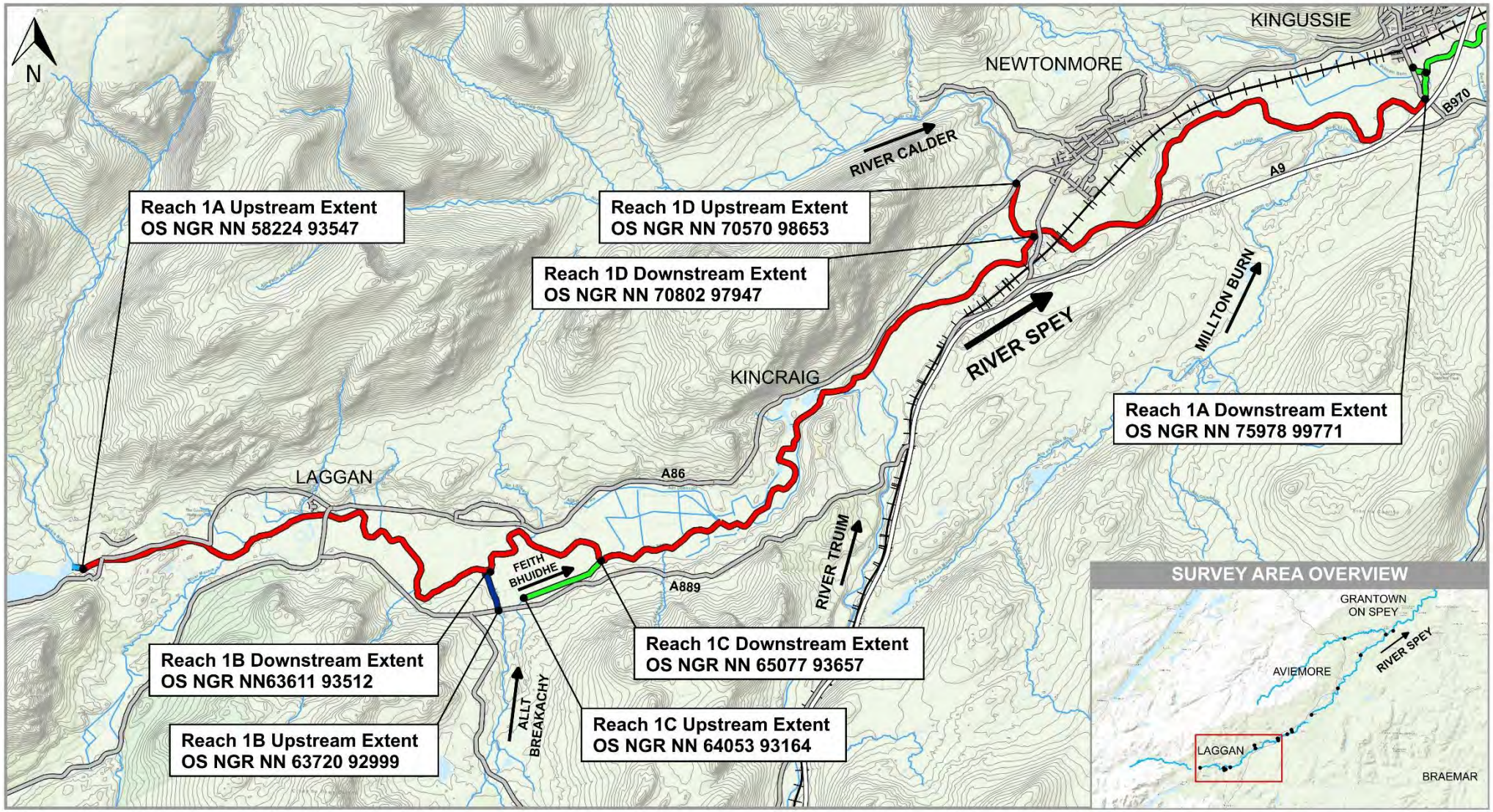
| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 AUG 2024 |
| Drawn | AE & GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |

Scale @ A4 - 1:255,000
British National Grid
GCS OSGB 1936



**Figure 1.1 Overview map showing the three areas surveyed during the embankment conditions assessment.**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1




**Condition Assessment**

Areas Surveyed:*

- Both Banks
- Right Bank Only
- Left Bank Only
- Not Surveyed (River Spey)
- Not Surveyed (Tributaries)
- Survey Extents

**Other Features***

- A9
- Other Roads
- Railway Line
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 1 2 3 km

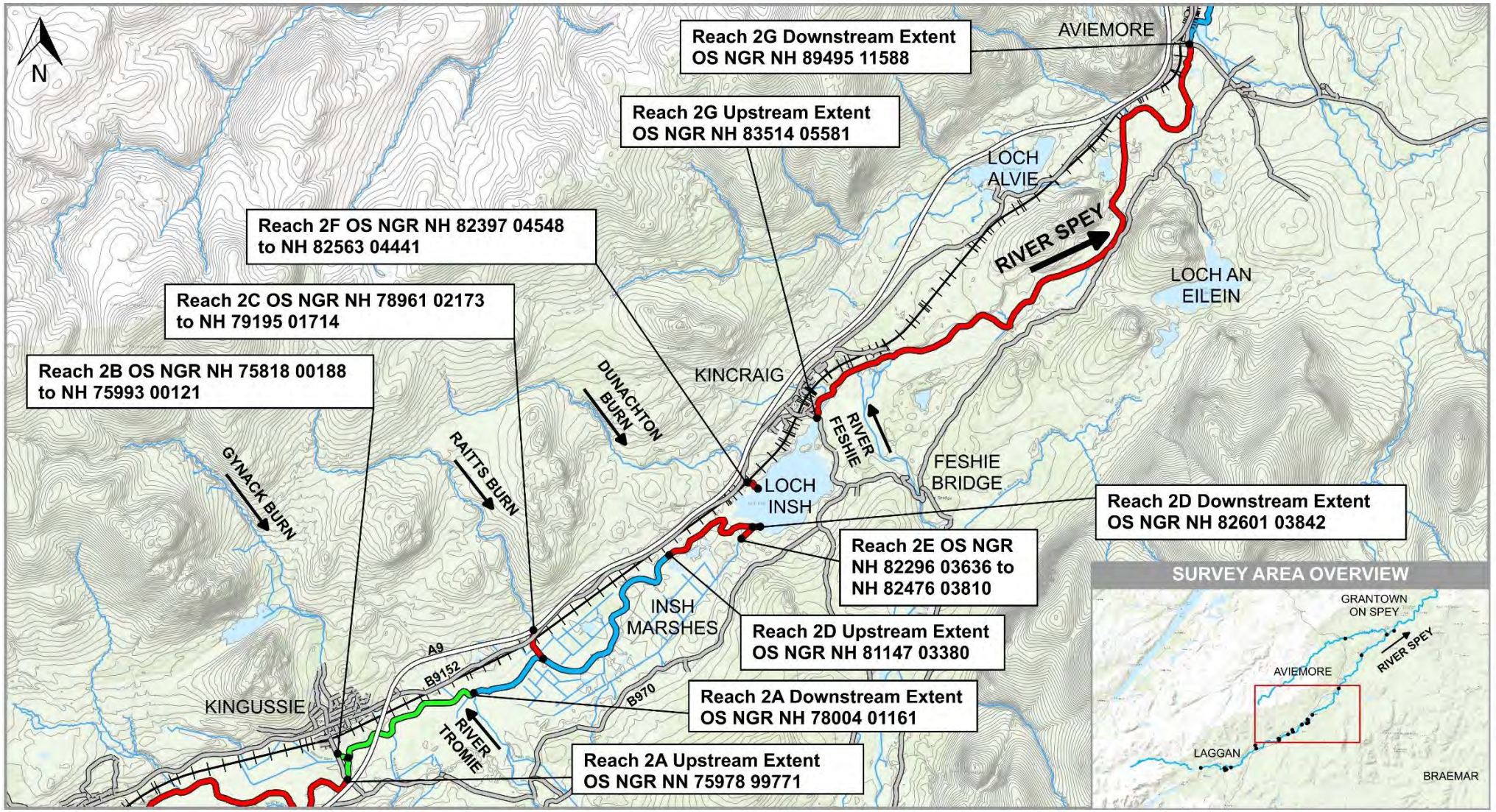
| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 AUG 2024 |
| Drawn | AE & GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |

Scale @ A4 - 1:70,000

British National Grid
GCS OSGB 1936



**Figure 1.2 Locations and extents of reaches surveyed within Area 1.**




**Condition Assessment**

Areas Surveyed:*

- Both Banks
- Right Bank Only
- Left Bank Only
- Not Surveyed (River Spey)
- Not Surveyed (Tributaries)
- Survey Extents

**Other Features***

- A9
- Other Roads
- Railway Line
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 1 2 3 km

| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 AUG 2024 |
| Drawn | AE & GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |

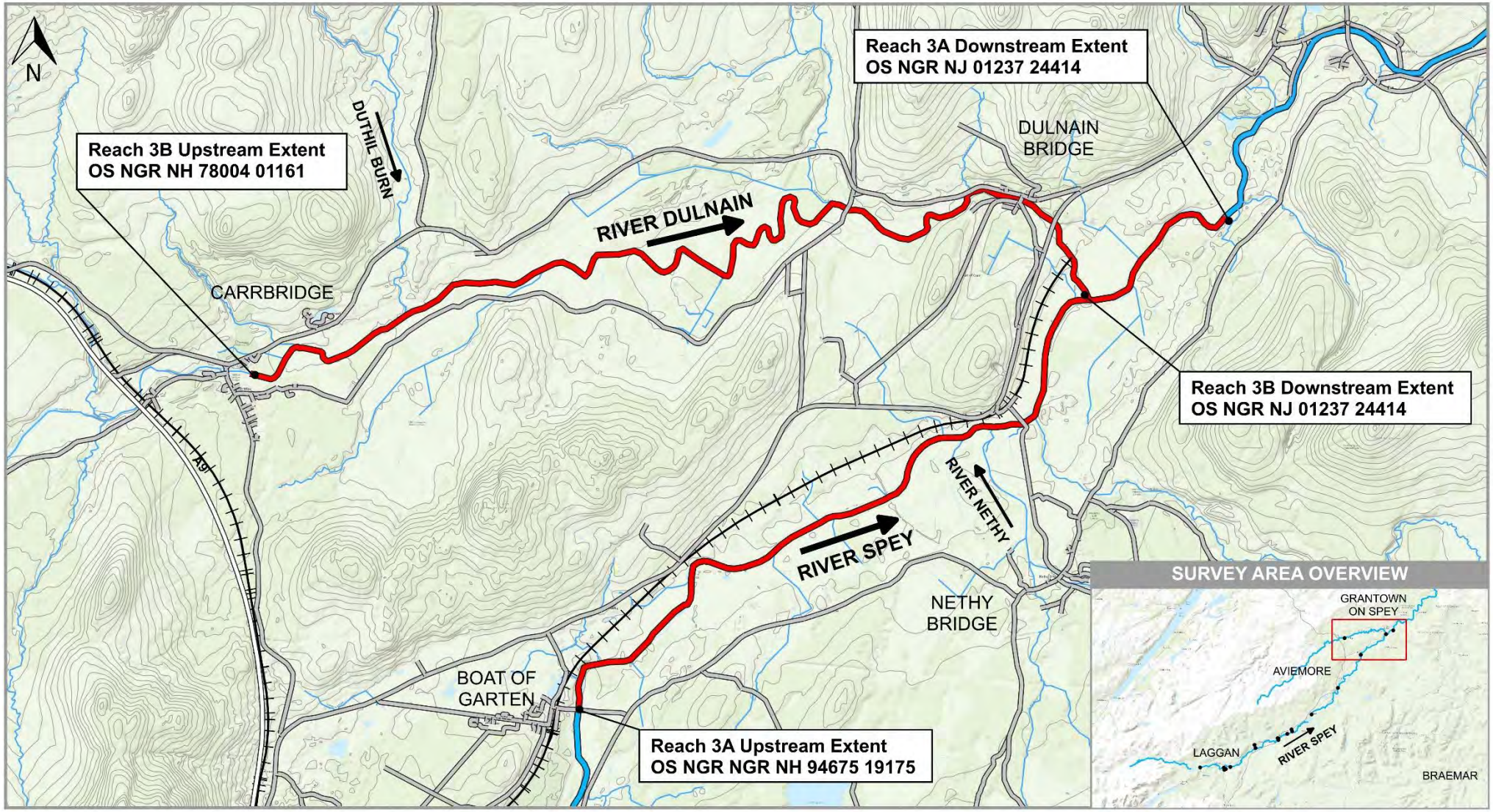
Scale @ A4 - 1:85,000

British National Grid
GCS OSGB 1936



**Figure 1.3 Locations and extents of reaches surveyed within Area 2.**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 3




**Condition Assessment**

Areas Surveyed:*

- Both Banks
- Right Bank Only
- Left Bank Only
- Not Surveyed (River Spey)
- Not Surveyed (Tributaries)
- Survey Extents

**Other Features***

- A9
- Other Roads
- Railway Line
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 1 2 3 km

| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 AUG 2024 |
| Drawn | AE & GP |
| Surveyed | GP, OS & AE |
| Reviewed | LM |

Scale @ A4 - 1:60,000

British National Grid GCS OSGB 1936



**Figure 1.4 Locations and extents of reaches surveyed within Area 3.**

## 1.2 PROJECT TIMELINE

Annual embankment condition assessments will be undertaken over a six-year monitoring period (2023 to 2028), as set out in Table 1.2. The baseline survey for Area 3 (Boat of Garten to Grantown-on-Spey) was undertaken by cbec in early-December 2023, prior to beaver introduction into the catchment. Areas 1 (Spey Dam to Kingussie) and 2 (Kingussie to Aviemore) were assessed between September to December 2024, within the first-year post-beaver introduction. Following completion of these baseline surveys, annual monitoring walkovers will be carried out between 2025 and 2028, to assess any changes in embankment and riverbank condition for each of the survey areas. Improvements in condition (i.e. stabilisation and revegetation), no change in condition and/or degradation of the condition of the riverbank and/or embankment (i.e. increased severity of erosion or increased likelihood of embankment breach) will be recorded during these annual walkovers.

**Table 1.2 Embankment condition assessment programme from 2023 to 2028.**

| Year | Condition Assessment | |
|---|---|---|
| | Type | Survey Areas |
| 2023 | Baseline | 3 |
| 2024 | | 1 & 2 |
| 2025 | Monitoring | 1, 2 & 3 |
| 2026 | | 1, 2 & 3 |
| 2027 | | 1, 2 & 3 |
| 2028 | | 1, 2 & 3 |

## 2. DESK STUDY

A desk-based assessment was carried out to provide an overview of embankment position and extent, channel/floodplain connectivity and risk of flooding and erosion throughout each of the three study areas. This background information was used to inform the condition assessment walkover (Section 3).

### 2.1 TOPOGRAPHY & LIDAR ANALYSIS

Light Detection and Ranging (LiDAR) is a remotely sensed method for scanning the topography of an area and can be used to identify distinct features such as embankments. A search of the Scottish Government's Remote Sensing portal concluded that 1 m resolution LiDAR data was available for the reaches of the River Spey and tributaries covered within Areas 1 to 3. Surveyed between 2011 and 2012 as part of the LiDAR for Scotland Phase 1, it is highly possible that some sections of embankment indicated may have been altered since the time of data collection (e.g. embankments removed or breached, or new embankments constructed). Nevertheless, this dataset provides a useful overview of the extent and position of embankments likely to be present within the Survey Areas. Locations and extents of embankments identified from LiDAR analysis were ground-truthed and (where required) corrected during the walkover, using Geographic Information Systems (GIS) software, to provide the CNPA with a complete record of these linear flood protection assets within the areas of interest.

### 2.2 SEPA FLOOD MODELLING

SEPA's flood risk maps were consulted to gain an initial understanding of potential flood water extents under modelled flood conditions predicted across the study areas. These areas of modelled flooding indicate potential locations where the embankments may be under increased pressure from water overtopping (during flood) and/or receding (post flood peak) across the embankments, and therefore at increased risk of erosion and, more likely to breach. This information was used to improve efficiency during the embankment walkover, highlighting key areas where breaching and at-risk sections of flood bund were likely to be identified.

### 2.3 OTHER DATA SOURCES

Consultation of aerial imagery from various sources (Bing, Google and ESRI), identified multiple locations showing signs of erosion to or breaching of the embankments. Key indicators of erosion, visible from the aerial imagery, included areas of bare ground/absent of vegetation, gaps in the embankment, or ponding of water adjacent to the embankment. These areas of potential breach risk were mapped during the desk study to inform the condition assessment walkover.

During the walkover, landowner liaison was undertaken in the form of informal meetings and/or email exchanges. These discussions enabled landowners to highlight key areas of concern in relation to their section(s) of embankment and to explain how floodwater typically moves through their land. Where possible this anecdotal evidence was used to target key areas of concern along the embankment during the condition assessment. Liaison with all landowners within the three study areas was not possible within the time constraints of the walkover, however it is hoped that the thoughts of these individuals will be able to be captured during subsequent community engagement events led by the CNPA.

## 3. CONDITIONS ASSESSMENT

cbec undertook baseline condition assessments of the River Spey and select tributaries in winter 2023[3] (Area 3) and autumn to winter 2024[4] (Areas 1 and 2). Weather conditions were generally dry and river levels were within the lower half of the normal range.[5] These water levels were considered optimal for this survey, to enable the riverbanks to be clearly viewed (i.e. not obscured by the water) and their condition assessed. However, it should be noted that undertaking the survey in the autumn to early winter months meant that summer vegetation growth may have overgrown and stabilised last winter's erosional scars, thus obscuring some signs of instability (e.g. cracks or areas of erosion within the riverbanks and embankment). To maximise the detection of instability as far as possible given the survey timing, a continuous survey on foot of banks and embankments throughout the three survey areas was undertaken, to allow for a closer inspection of these linear features than could be achieved through remotely sensed data such as the use of unmanned aerial vehicles (UAV/drone). The embankments and the riverbank were walked throughout the survey extents outlined in Table 1.1 with a focus given to areas highlighted within the desk-based assessment as presenting a higher likelihood of erosion and/or areas with good channel-floodplain connectivity, both of which could result in the embankment being more vulnerable to breaching in these locations.

### 3.1 BACKGROUND TO BANK EROSION AND EMBANKMENT BREACHING

An embankment breach is defined as any location where the embankment crest has been lowered, or a section of the bund has been removed as a result of natural processes (e.g. erosion or subsidence) or manmade intervention. Sources of erosion may be from fluvial (river) processes including bank erosion, which could undermine the bund, as well as biological drivers such as animal burrowing, penetration of plant roots or trampling by livestock.

For the purpose of this assessment, bank erosion refers to any location where the bank face, between the top of the bank and the riverbed, shows signs of instability. Where an embankment is positioned within ~5 m of the channel top of bank, bank erosion may undermine the bank and result in the collapse of the embankment over time. Details of the criteria used to record the bank erosion severity are provided within Section 3.2.

Damage to an embankment may also occur in the absence of riverbank erosion. For example, the bund may be scoured by 'out-of-bank' flow during a flood event, either whilst the floodwaters enter the floodplain or when they recede back into the channel post-flood. The latter is particularly damaging where water is trapped on the 'dry' side of the embankment (furthest from the river). The flow and recedence of flood water puts pressure on the embankment and may exacerbate existing damage

[3] Area 3 was surveyed between 11th and 19th December 2023

[4] Areas 1 and 2 were surveyed over multiple weeks; 24th to 27th September, 1st to 4th, 10th to 11th October and 11th December 2024.

[5] The nearest gauge for Area 1 and the upstream half of Area 2 (i.e. upstream of Loch Insh) was Invertruim, which recorded water levels ranging between 0.36–0.44 m during this part of the survey. For the downstream half of Area 2 the Kincraig gauge was consulted, recording a range of 0.298 to 0.996; this was still well within the lower half of the normal range for this section of the River Spey. The Grantown gauge, situated ~3 km downstream of Area 3, confirmed that water levels were well within the lower half of the normal range for this lower section of the survey area (0.68–0.86 m). Gauge levels were obtained from the Shoothill Ltd. Gauge Map: https://www.gaugemap.co.uk/#!Map

such as cracks, dimpling from livestock hooves or burrows within the structure of the flood defence. Where embankments are set back from the top of the channel bank, the bund is likely to be more at risk from flood waters than being undermined by bank erosion. The conditions assessment will consider these factors individually and in combination to determine the overall breach risk to the embankments present along the River Spey and its tributaries within the Study Areas (Section 1.1).

## 3.2 METHODOLOGY

During the baseline condition assessment, the following features were noted and/or recorded:

- Risk of embankment breach,
- Locations where embankment breaches have already occurred,
- Bank erosion and severity,
- Other features that may influence riverbank/embankment stability,
- Georeferenced photographs.

Where damage to the riverbank and/or embankment was noted, the condition of these breached and at-risk of erosion areas were assessed against the criteria set out in Table 3.1, with example photographs provided in Figure 3.1 to Figure 3.6.

These criteria are intended to provide a broad representation of key factors influencing erosion/breach risk, making them applicable across large-scale study areas such as in the present study. The condition of the riverbanks and embankments across the study reaches of the River Spey and select tributaries was considered as a whole, rather than divided into separate land parcels, to ensure that the ranking of potential embankment breach risk is comparable through the full assessment area and to highlight areas where, if desired, conditions assessment could be prioritised.

It is acknowledged that other localised factors may contribute to erosion/breach risk, including set-back distance of embankments and rates of bank retreat (which in turn are controlled by a number of factors, including bank composition and location in relation to overall channel planform). Nevertheless, the approach adopted here represents a robust high-level assessment of risk that can be achieved at relatively low cost, making it appropriate for baseline and ongoing monitoring.

**Table 3.1 Criteria used for the assessment of riverbank and embankment condition.**

| Catergory | Criteria[6] |
|---|---|
| **Riverbank Erosion Severity** | |
| Low | ▪ Evidence of past bank erosion<br>▪ Bank appears to be stabilised<br>▪ Partial to full bank face vegetation cover<br>▪ Deposition at the bank toe stabilising the bank<br>▪ Bank height 1 m or less |
| Moderate | ▪ Actively eroding<br>▪ Partial coverage of vegetation on bank face<br>▪ Evidence of some deposition and stabilisation at the bank toe |
| High | ▪ Actively eroding<br>▪ Little to no bank face vegetation<br>▪ Steep bank face slope (>70$^{o}$) |
| **Embankment Erosion and Breaching Risk** | |
| No Risk Identified | ▪ No signs of instability (e.g. cracks or slumping)<br>▪ No/minimal impact from animal burrowing<br>▪ No /minimal impact from scrub/tree growth<br>▪ No bank erosion within 5 m of the top of the channel bank |
| Low | ▪ Embankment within ~5 m of the top of bank and no/low-severity bank erosion present<br>▪ Embankment more than ~5 m from the top of bank and low/moderate-severity bank erosion present<br>▪ Small/localised cracks, areas of bare ground or other signs of instability on either embankment face or crest.<br>▪ Signs of biological erosion such as mole hills or roots of scrub/tree vegetation |
| Moderate | ▪ Embankment within ~5 m of the top of bank and moderate-severity bank erosion present<br>▪ Embankment more than ~5 m from top of bank and moderate/high-severity bank erosion present<br>▪ Cracks, areas of bare ground or other signs of instability extending across up to half of one embankment face or crest. |
| High | ▪ Embankment within ~5 m of the top of bank and severe bank erosion present<br>▪ Cracks, areas of bare ground or other signs of instability extending across over half of one embankment face or the crest. Alternatively, where these signs are noted on both sides of the embankment.<br>▪ Section of bank within ~10 m of an existing embankment breach<br>▪ Opposite a confluence or in a location where unconstrained out-of-bank flow may erode the embankment regardless of distance from the top of the riverbank |
| Breached | ▪ Location where the embankment has already breached |
| Formalised Breach | ▪ Location where the embankment crest has been intentionally lowered. This may be undertaken for flood management benefits or other site-specific purposes.<br>▪ Erosion protection, for example erosion control mating or concrete/stone, may be present to stabilise the formalized breach when water passes over it. |

[6] Depending on the location, a section of riverbank or embankment may be classified based on one or more of the criteria listed.

## Riverbank Erosion Severity

**Figure 3.1. Low-severity riverbank erosion.**

**Figure 3.2 Moderate-severity riverbank erosion.**

**Figure 3.3. High-severity riverbank erosion.**

## Embankment Breach Risk

**Figure 3.4 Low risk of embankment breach. Slumping of the embankment crest appears to have been caused by livestock trampling. The embankment is set back from the riverbank and signs of slumping observed are localised.**

**Figure 3.5 Moderate risk of embankment breach. Situated within 5 m of the riverbank, with slumping and bare ground exposed on the dry side of the embankment.**

**Figure 3.6 High risk of embankment breach. Embankment positioned along the top of the riverbank. Bare ground and slumping evident across over half of the embankment crest width.**

## 3.3 SUMMARY OF FINDINGS

The cumulative length of embankment at risk of breaching or already breached in each Survey Area is presented in Table 3.2, based on the assessment criteria outlined in Table 3.1. From this data, the baseline condition assessment concluded that ~83.6% (~59.5 km of embankment cumulatively) of the total embankment length surveyed (~71.14 km cumulatively) was deemed to be in good condition at the time of survey, with breaches noted to occupy only ~1.6% (~1.14 km of embankment cumulatively) of the total length. Approximately ~16.4% of the total embankment length was found to be eroding to varying levels of severity (high, moderate or low risk of embankment breaching), with ~1.2% of these representing sections at high risk of breaching (~0.87 km of embankment cumulatively).

**Table 3.2 Summary of embankment breach risk identified during the 2023/24 condition assessment.**

| Survey Area | Total Length of Embankment present (km)[7] | Embankment Breach Risk (km) | | | | |
|---|---|---|---|---|---|---|
| | | Formalised Breach | Already Breached | High | Moderate | Low |
| 1 | 27.5 | 0.04 | 0.36 | 0.22 | 0.33 | 0.83 |
| 2 | 12.88 | 0 | 0.43 | 0.44 | 0.29 | 0.34 |
| 3 | 30.76 | 0 | 0.35 | 0.21 | 0.64 | 7.24 |
| **Total (km)** | **71.14** | **0.04** | **1.14** | **0.87** | **1.26** | **8.41** |
| **% of the total embankment length surveyed** | | **0.06** | **1.6** | **1.2** | **1.8** | **11.8** |

Based on observations made during the condition assessment, a series of factors contributing to riverbank and embankment instability and erosion risk were identified. These factors have been summarised in the subsequent section (3.3.1), followed by a detailed breakdown of the assessment results for each area: Survey Area 1 – Spey Dam to Kingussie (Section 3.3.2), Survey Area 2 – Kingussie to Aviemore (Section 3.3.3) and Survey Area 3 – Boat of Garten to Grantown-on-Spey (Section 3.3.4). Eroding areas recorded have been mapped for all surveyed reaches, to enable their locations and extents to be clearly depicted. Where breaches have occurred, the adjacent sections of embankment were classified as at high risk of breaching as this gap in the bund will act as a preferential flow route during flood events. Photographs of eroding and breach locations have been included within the map series for ease of reference.

[7] Includes sections of embankment on both banks of the channel.

### 3.3.1. Factors Impacting Riverbank and/or Embankment Stability

The main factors influencing **riverbank stability** and severity of erosion were as follows.

- **Livestock trampling** of the riverbank to drink from the watercourse, feed on bankside vegetation or shelter. Movement of livestock erodes the bank face, removing soil and surface vegetation, which exposes the bank to further erosion (Figure 3.7). The hooves also lead to pitting of the ground surface and eventually small hollows, which are further exploited by the flow, leading to slumping of the bank. Comparisons of Figure 3.14 to Figure 3.16 with Figure 3.17 to Figure 3.19 show the difference in bank erosion observed between sections of channel with and without riparian fencing, respectively. The former provides protection from trampling of the bank.
- **Gradient of the bank**. Sections of bank exhibiting a gentle gradient (e.g. 1:2 or 1:3 slope) or low height (<1 m high) were noted to be more stable and less prone to erosion. This bank geometry promotes the establishment of vegetation, compared to steeper slopes that are more difficult for vegetation to colonise, which further contributes to the bank stability.
- **Vegetation cover**, as outlined above, greatly increases the stability of the riverbank. In the survey areas where continuous tree cover was noted along the bank top, riverbank erosion was noted to be minimal or absent. Well-established riparian corridors were observed along most of the bank between the Spey Dam and Laggan Bridge (upstream part of Reach 1A), as well as upstream (Reach 2D) and downstream of Loch Insh (Reach 2G from Kincraig Bridge to the B970 bridge, Aviemore). This observation highlights the benefit of a well-established riparian corridor for bank stability.
- **Channel planform**. In rivers, erosive force is focused around the outside of the meander bend, leading to natural lateral migration of the channel over time (Figure 3.8). Multiple areas of erosion around the outsides of meander bends were noted, particularly where riparian vegetation was limited. It is understood that channel adjustment, while a natural river process, may be undesirable within an agricultural setting; therefore, this erosion could be managed by undertaking riparian planting and/or fencing along the bank to improve bank stability.

The main factors influencing the **embankment condition** and stability were as follows.

- **Damage to the embankment face or crest** can loosen the material within the embankment and/or create holes and crevices in the surface that leave the bund more at risk from erosive force. This surface damage was noted to be caused by the following factors within the study areas.
    - **Livestock trampling** across (i.e. when grazing or to reach the watercourse for water) or sheltering around the embankment has left sections of the bund pitted and with patchy or no surface vegetation cover, increasing the risk of further erosion (Figure 3.8). Sections of embankment were found to be in a more stable condition where fence lines were positioned on the dry side of the bund, preventing or reducing the frequency of trampling of the flood defence.
    - **Scrub and young tree growth** was noted along the embankment within multiple sections of Survey Areas 1 to 3 (Figure 3.9 and Figure 3.10). In contrast to grass and ruderal flora, roots of scrubby plants penetrate deeper into the embankment, which can reduce compaction and over time destabilise the structure of the embankment. While more extensive root networks are typically beneficial for bank stability in

natural riverbanks, the root networks of scrubby plants can affect the stability of manmade embankments in a similar way to animal burrowing, ultimately increasing the vulnerability of the embankment to erosion.

- **Burrowing of animals.** Mole hills and rabbit burrows were noted on the embankment face and adjacent floodplain sporadically throughout the survey extents (Figure 3.11). Tunnelling within the embankment is likely to reduce the stability of the bund and provide openings that may be exploited by flood water, increasing the risk of erosion and potential for breaching. The density of mole hills was found to be low at the time of survey and therefore is not concluded to be a major concern at present. However, continued monitoring of mole hill density across the embankment is recommended, particularly in areas identified as at risk of breaching.

- **Riverbank erosion** within ~5 m of the embankment already or showing potential to undermine the embankment, leading to its collapse over time (Figure 3.12).
- **Out-of-bank flow during flood events**. This flow is not bound by the orientation of the channel banks and therefore follows the most direct path. For example, at meander bends, out-of-bank flow can flow directly towards the embankment (e.g. as at the breaches on the river left (western) bank around the tight meander bend, located just upstream of the River Tromie confluence; Figure 3.32). Similarly, the presence of an island causes the flow to split around this mid-channel feature and flow directly towards the banks or embankment. This was observed as a contributing factor towards the breaches at Blargie Estate (Figure 3.15), which floods the access road.
- **Water building up behind an embankment during flood events** puts pressure on the embankment, during both the flood event and the period that follows whilst flood waters recede. Water enters the floodplain either through existing breaches, at the ends of the embankment or by overtopping. This factor primarily affects taller sections of embankment (>1 m). Signs of instability caused by this factor usually include cracks on the embankment surface; however, given the height and density of summer vegetation growth it was difficult to undertake this visual assessment. Nevertheless, this factor has still been listed here as anecdotal evidence indicated that the fields behind the embankments inundate during flood events, such that this pressure is likely to be having an effect on the embankment condition. Where floodwaters can drain back into the channel more quickly, for example in sections of embankment containing culverts with flap valves that facilitate drainage of the floodplain, reduced impact on embanked condition was observed in the Survey Area 3 (Tullochgorum Farm).

**Factors influencing riverbank and/or embankment stability**

**Figure 3.7. Livestock trampling across the riverbank, leading to soil erosion and loss of surface vegetation.**

**Figure 3.8 Bank erosion on the outer bank of a meander is a natural process in meandering channels. Native riparian planting and set-back fencing could promote increased stability in such areas over time.**

**Figure 3.9. Scrub growth on the crest and face of an embankment.**

**Figure 3.10 Young tree growth and regeneration across the crest and face of an embankment.**

**Figure 3.11 Burrow within the crest of an embankment. Mole hills and burrows were occasionally noted in Areas 1 and 2, but their position and density were insufficient to cause concern at the time of survey.**

**Figure 3.12 Riverbank erosion undermining an embankment positioned at the top of the bank. High risk of embankment breach.**

### 3.3.2. Survey Area 1 – Spey Dam to Kingussie

Information relating to embankment and riverbank condition in Area 1 is presented in Figure 3.13 to Figure 3.29.

The primary causes of bank erosion within Area 1 were trampling of the bank by livestock, slumping and bank face erosion caused by hydraulic action. Livestock access to riverbanks and embankments leads to compaction and loss of surface vegetation, making these linear features more susceptible to further erosion and instability. Fencing along the river corridor, preventing livestock access to the bank or embankment, was seen to provide protection from this form of erosion. For example, comparisons between sections with (Figure 3.14 to Figure 3.16) and without fencing (Figure 3.17 to Figure 3.18) to separate grazing land from the embankment and/or riverbank show a significant difference in the degree of riverbank erosion and risk to the embankments identified.

Bank erosion was also noted around the outsides of meander bends in multiple locations throughout Area 1. Erosion on the outer bank of meander bends is a natural river process, typical of meandering channels but exacerbated by the absence of riparian vegetation. It is appreciated that land loss as a result of bank erosion can be undesirable, particularly in an agricultural setting. Therefore, riparian planting and fencing would be recommended within these areas to reduce the risk of further agricultural land loss.

Short sections (i.e. less than ~25 m) of embankment categorised as having low to moderate embankment breach risk were noted locally throughout Study Area 1. Livestock trampling of the embankment (which lowers the crest level, exposing bare ground and leading to slumping or pitting of the embankment face) and/or deterioration of the embankment condition indicated by cracks and slumping of the embankment face were noted as the primary causes of erosion in these sections. Occasional evidence of burrowing (e.g. mole hills and rabbit warrens) was observed, but the density of these erosional features was found to be low at the time of survey. Accordingly, burrowing is not considered to be a major concern at present. Ongoing monitoring should focus on these low- to moderate-breach risk areas in order to identify any further deterioration or stabilisation.

Between Laggan and Kingussie only a handful of embankment breaches were noted, typically resulting from embankments being positioned within ~5 m of the top of bank or influenced by channel planform (i.e. breaches on the outer banks of meander bends) or in-channel features such as islands. Blargie Estate access road, leading to the Spey Dam, is situated behind a section of embankment that runs along the top of the bank on the river left (western) side of the River Spey. Breaches have occurred where the road turns a 90$^{o}$ bend to run parallel with the river. Risk of breaching in this location is exacerbated by the presence of the island in the centre of the channel causing the flow to split at this point and exerting erosion pressure on this section of embankment. The embankment breach here has been temporarily infilled with boulders; however, it is likely that this location will be breached during future flood events.

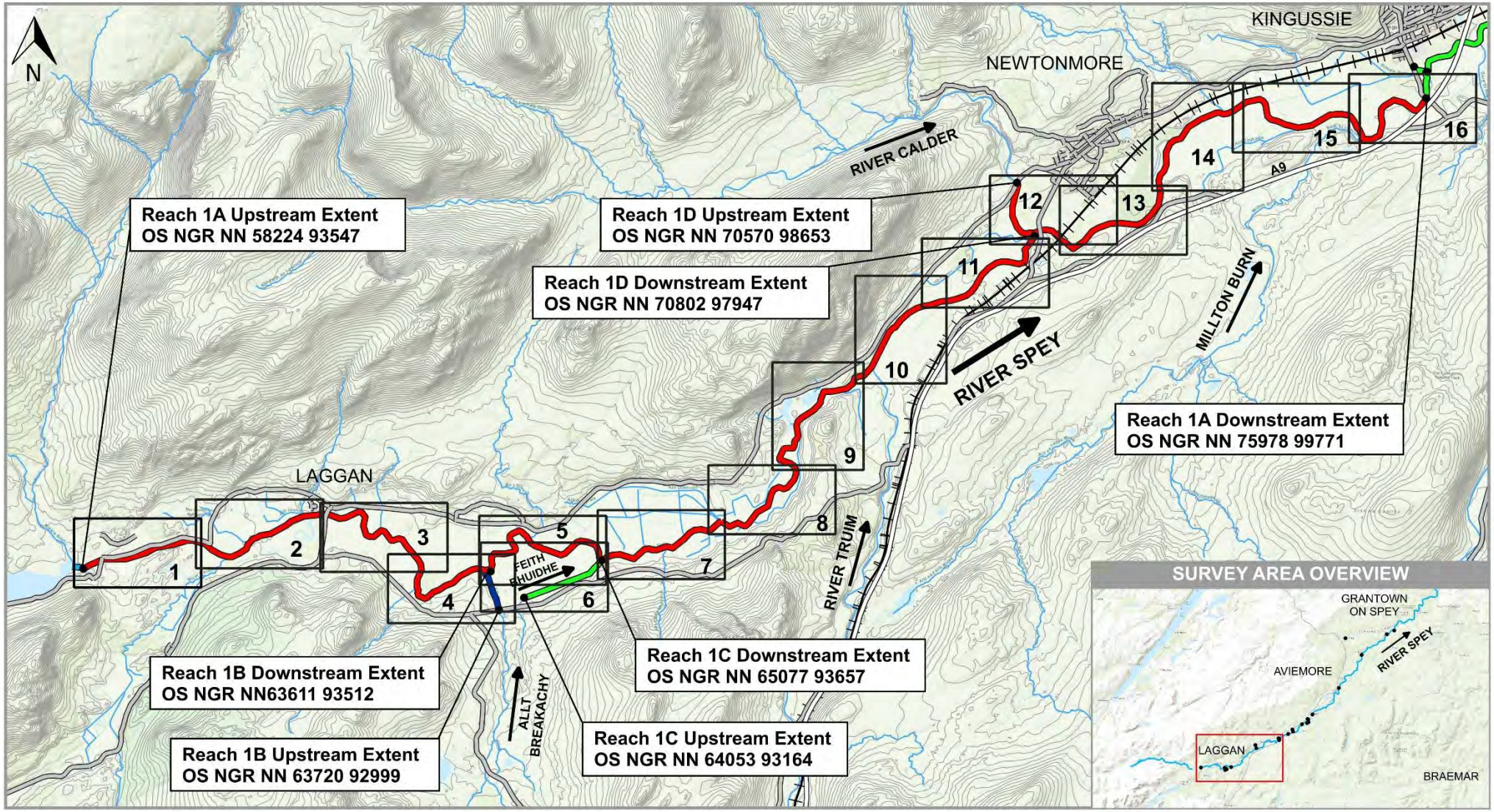
Two formalised embankment spillways are present at Breakachy Farm, on the river right (eastern) side of the River Spey between Laggan and Newtonmore (Figure 3.18). These have been mapped as formalised breach points, due to the embankment crest being purposefully lowered and lined with concrete and/or boulders to stabilise these overspill zones. Owing to this hard embankment protection, the adjacent sections of embankment were not deemed to be at risk of erosion by water passing over the spillway, as would be expected within an unprotected breach.

A ~45m wide breach, the largest breach recorded during the 2024 survey of Study Area 1, was observed at Cluny Farm. Anecdotal evidence obtained from landowner liaison during the walkover suggested that the breach at Cluny Farm had provided flood alleviation benefits to neighbouring landowners, by enabling temporary floodplain storage within the field behind the breach.

At Drumgask Farm, culverts facilitating drainage through the embankment and into the River Spey were noted in three locations, two of which were experiencing erosion with potential risks to embankment stability (Figure 3.16). Culverts through an embankment have the potential to aid surface water flow as it recedes back to the River Spey following flood events, which can help to maintain the stability of the embankment by reducing pressure caused by the water stored behind it. The drainage channel banks and the face of the embankment around these pipes were noted to be eroding at Drumgask. This erosion may be due to the volume of water and narrow size of the pipe present.

Additionally, embankments are rarely present on the river right (eastern) bank of the River Spey between the Feith Bhuidhe confluence and Milton Lodge, Newtonmore, nor on the river left (western) side between the Allt Dobhrain confluence and Newtonmore Golf Course. Where they were observed, these were present as short, discontinuous lengths. Therefore, this section was noted to be a lower priority for monitoring during the next walkover survey, planned for Autumn 2025.

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - OVERVIEW OF RESULTS MAPS




**Condition Assessment**

Areas Surveyed:*

- Both Banks
- Right Bank Only
- Left Bank Only
- Not Surveyed (River Spey)
- Not Surveyed (Tributaries)
- Survey Extents
- Map Overview Box
- 1 Map Number

**Other Features***

- A9
- Other Roads
- Railway Line
- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 1 2 3 km

| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 AUG 2024 |
| Drawn | AE & GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |

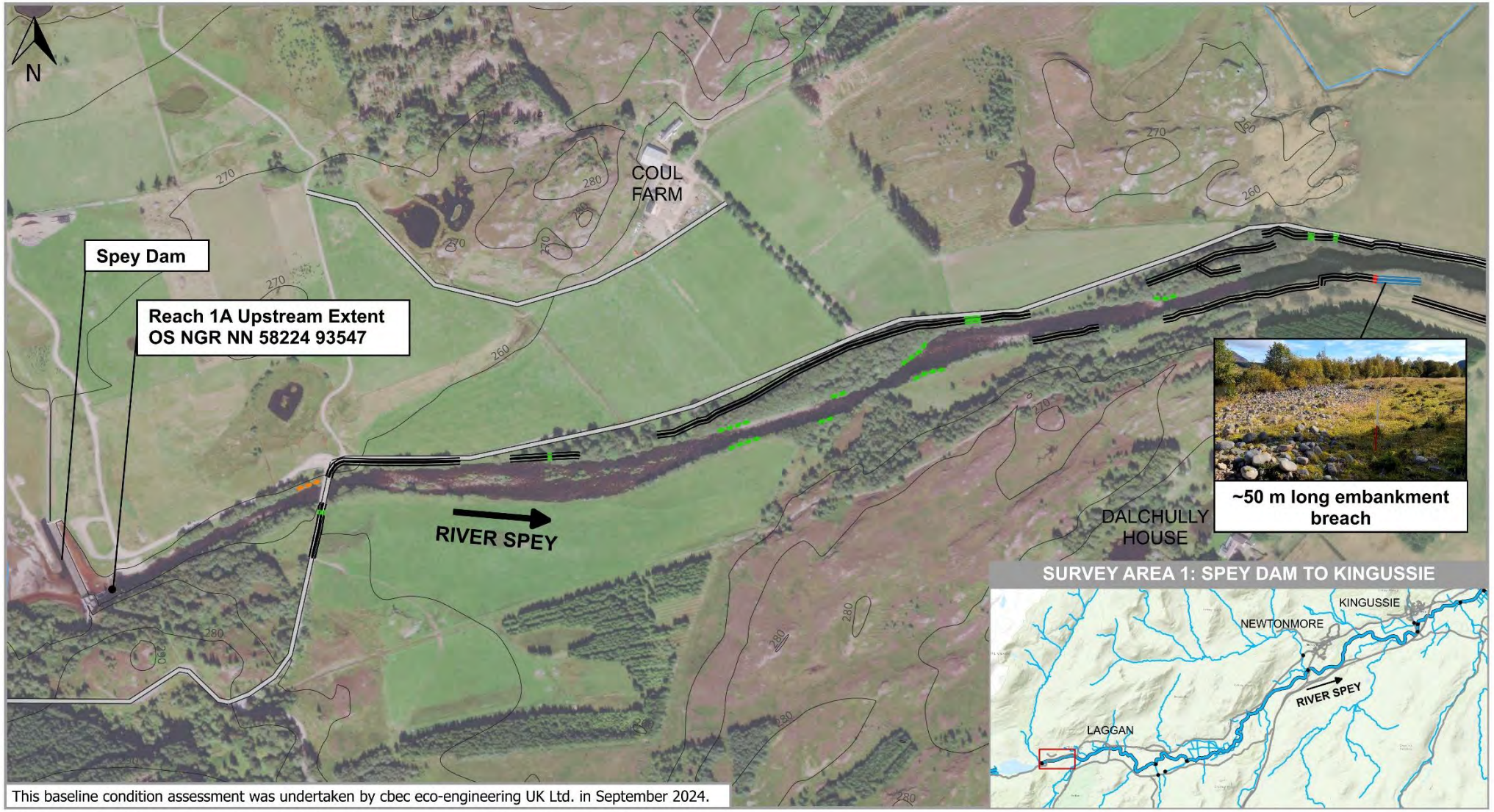
Scale @ A4 - 1:70,000

British National Grid GCS OSGB 1936



**Figure 3.13 Area 1 survey results overview map.**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 1 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

Project no. 2150649
Date 29 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
Scale @ A4 - 1:6,000
British National Grid
GCS OSGB 1936

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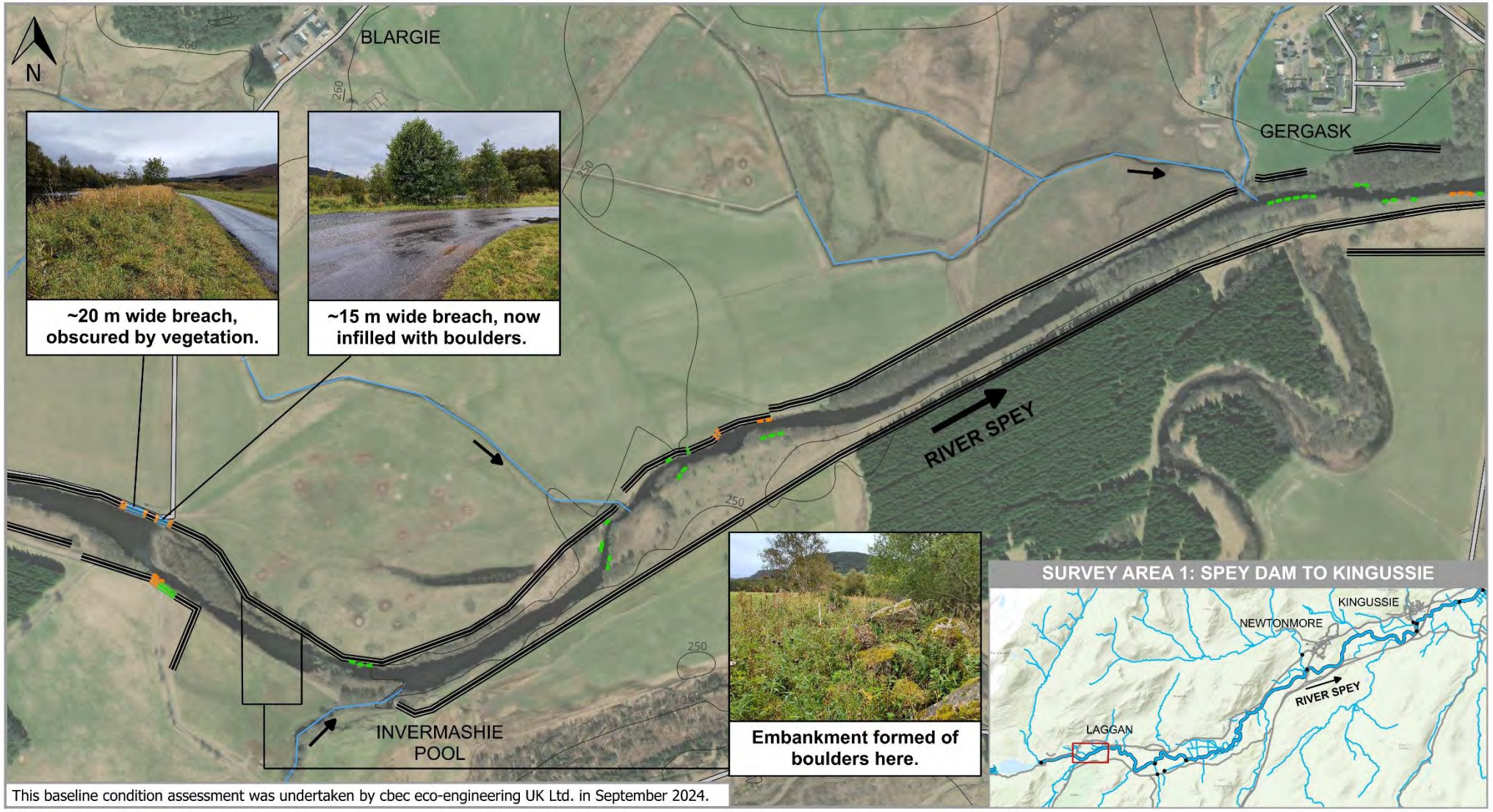
**Figure 3.14 Area 1 - Map 1 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 2 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 29 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |

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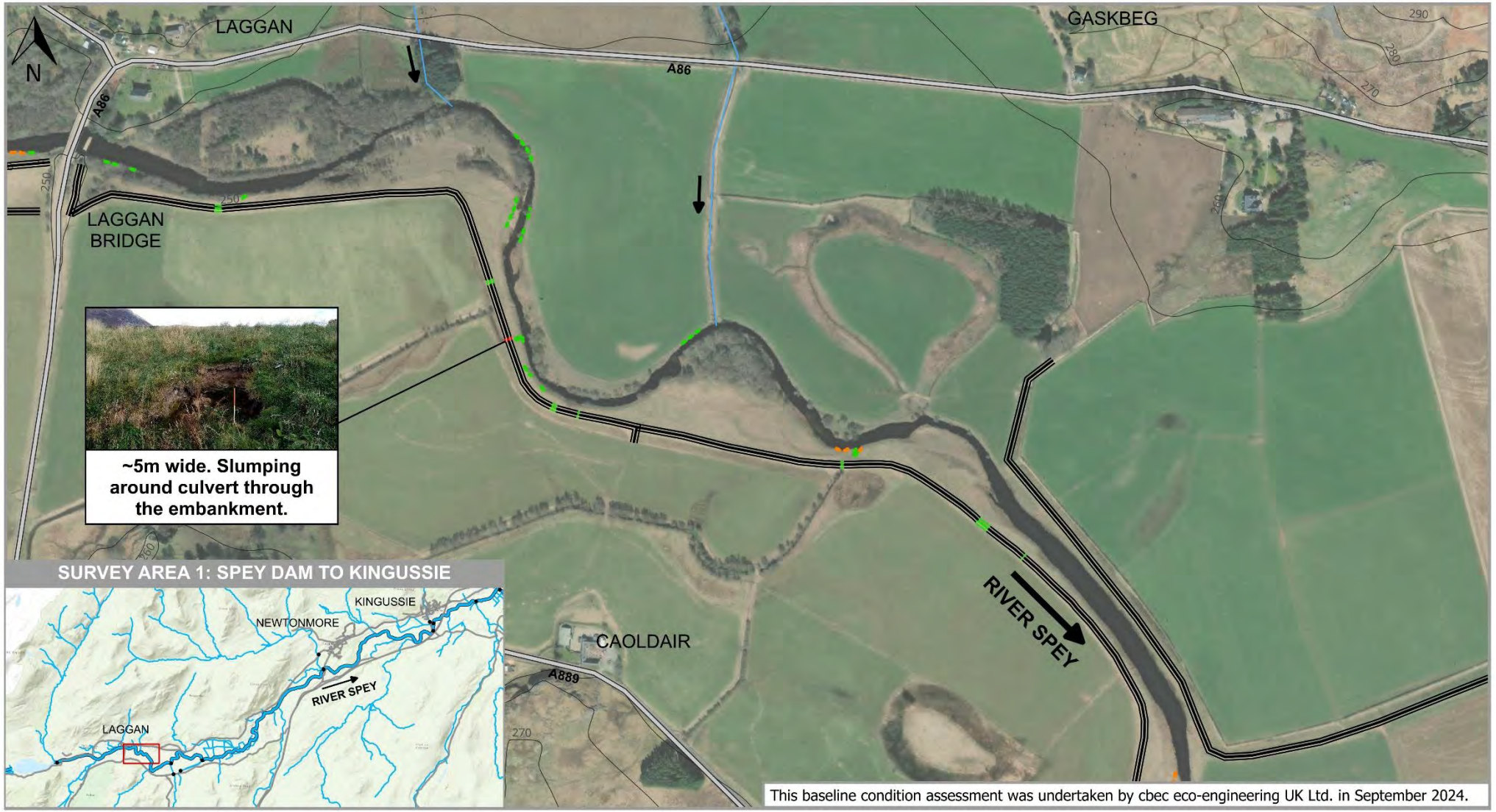
**Figure 3.15 Area 1 - Map 2 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 3 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

Project no. 2150649
Date 29 OCT 2024
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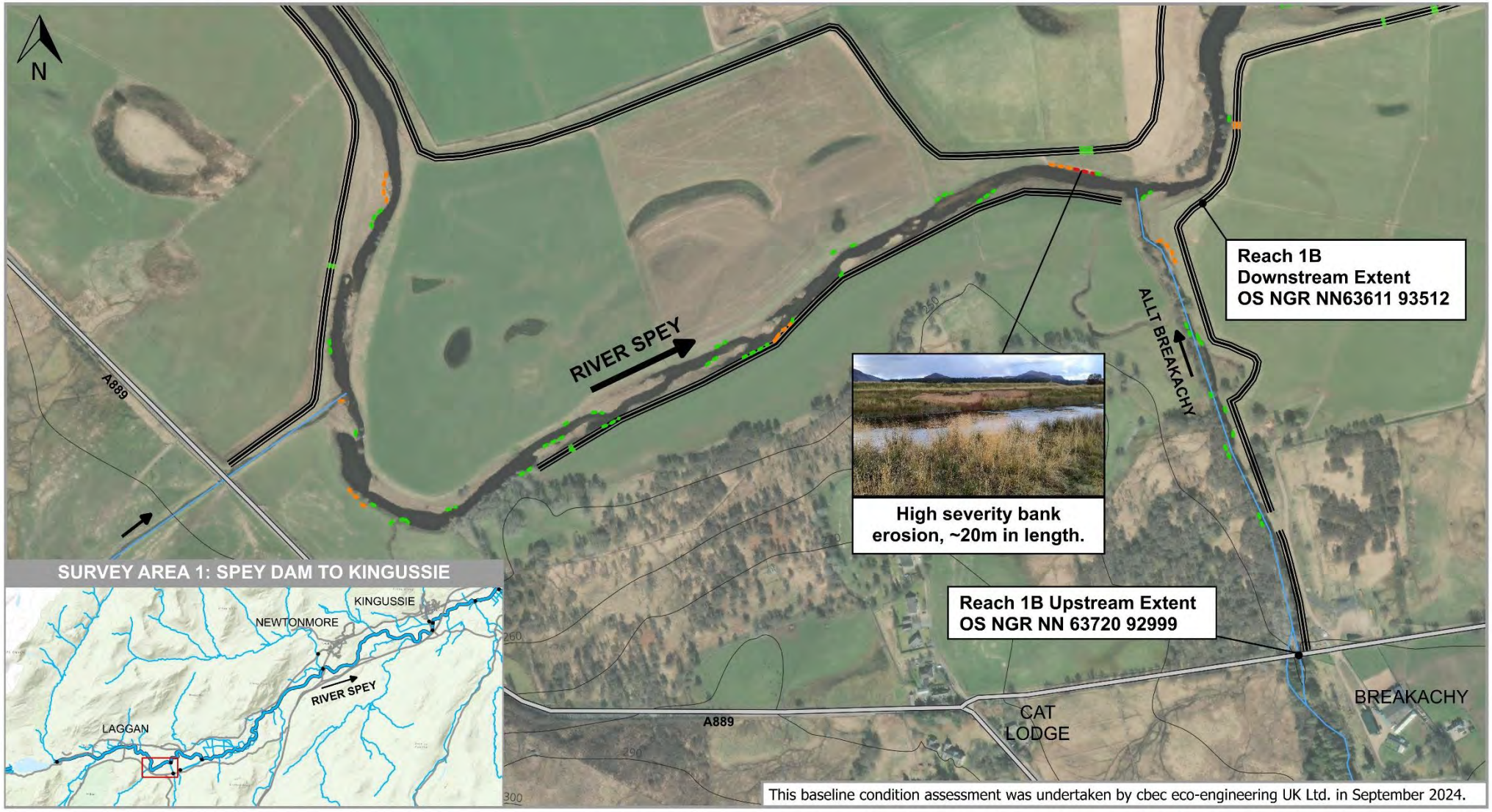
Reviewed LM
Scale @ A4 - 1:6,000
British National Grid GCS OSGB 1936



**Figure 3.16 Area 1 - Map 3 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 4 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 100 200 300 m

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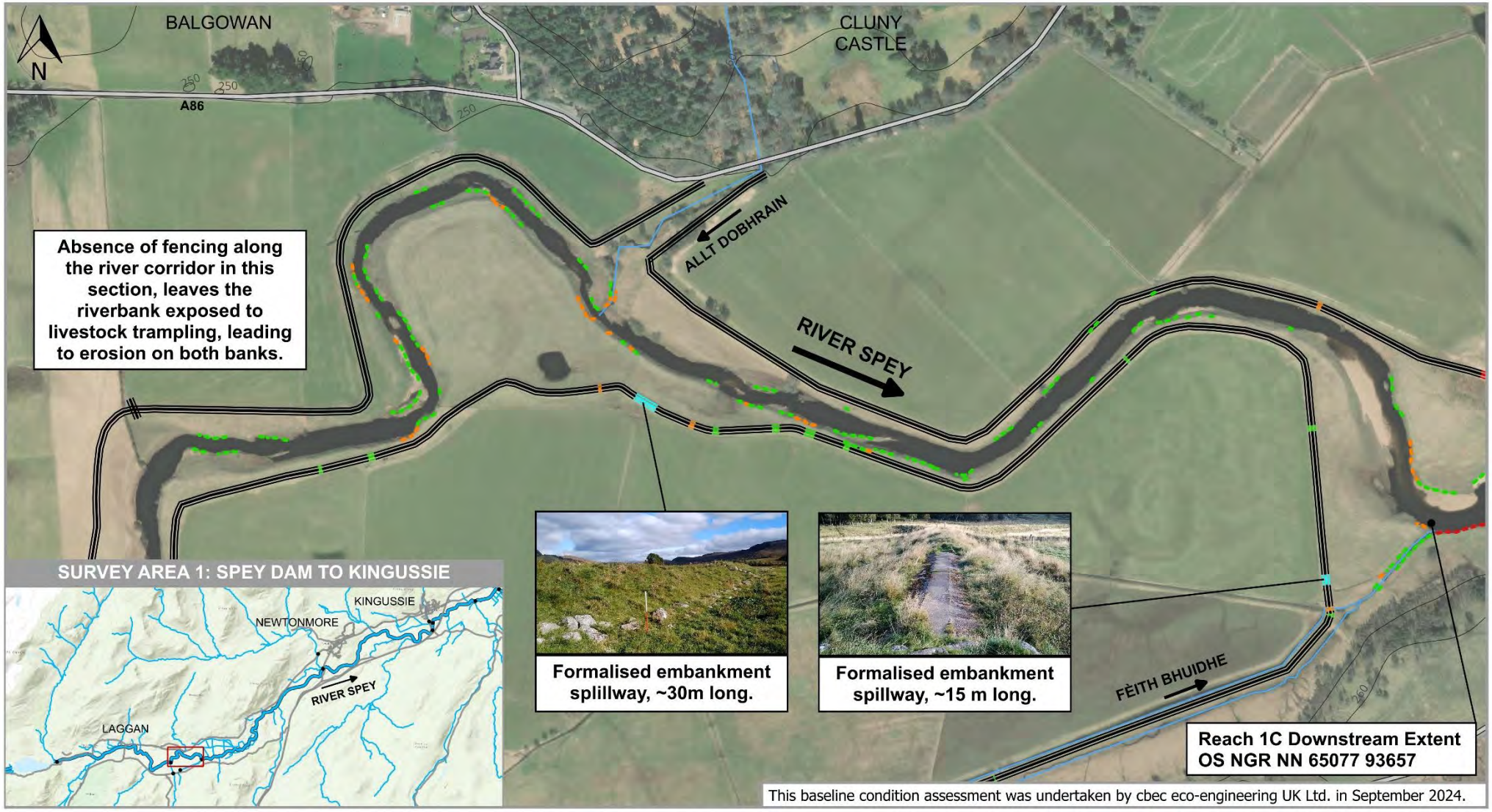
|---|---|
| Project no. | 2150649 |
| Date | 29 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.17 Area 1 - Map 4 showing the baseline survey results for the River Spey (Reach 1A) and Allt Breakachy (Reach 1B).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 5 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

Project no. 2150649
Date 29 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
Scale @ A4 - 1:6,000
British National Grid
GCS OSGB 1936

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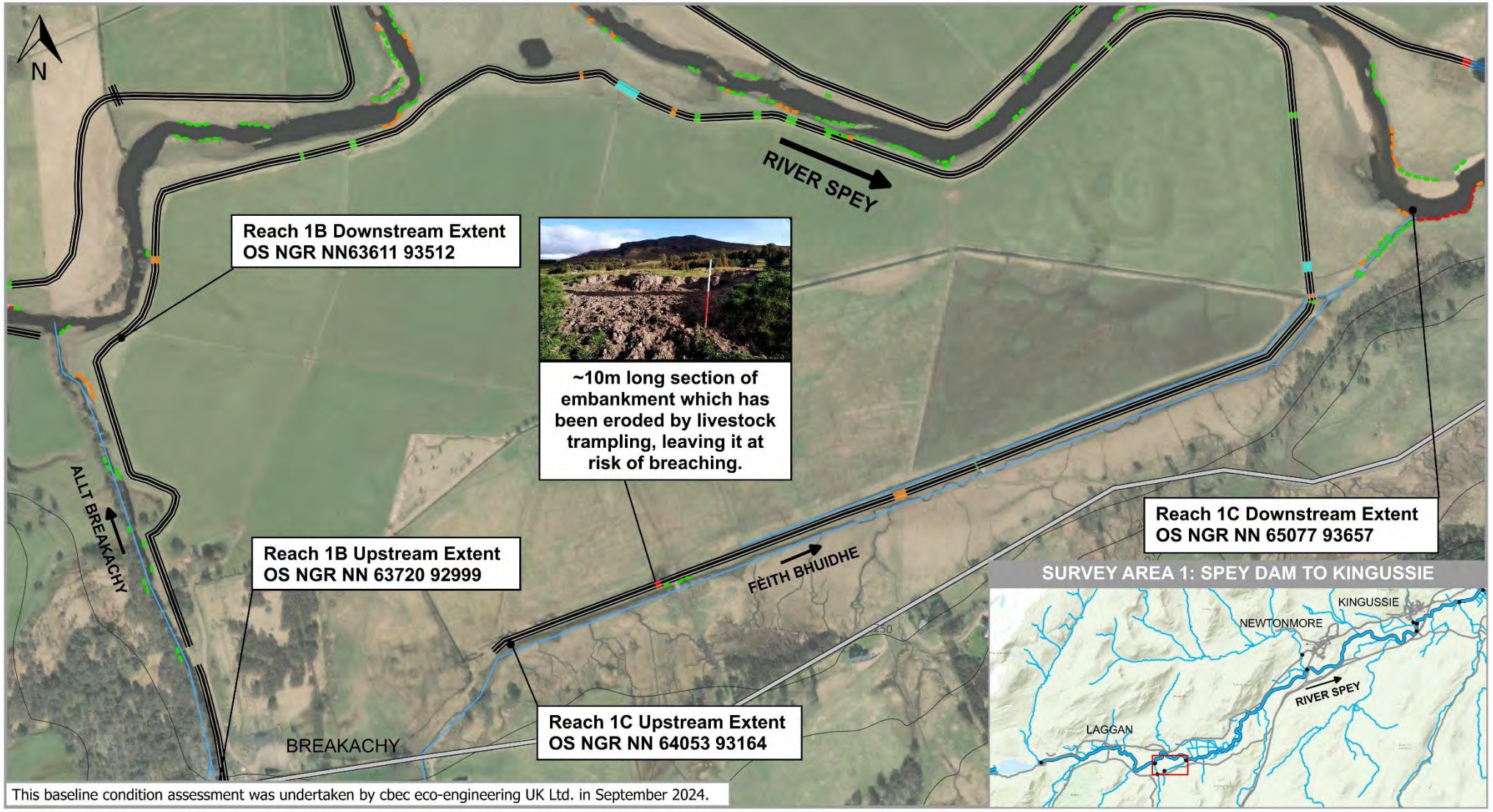
**Figure 3.18 Area 1 - Map 5 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 6 - ALLT BREAKACHY & FÈITH BHUIDHE




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

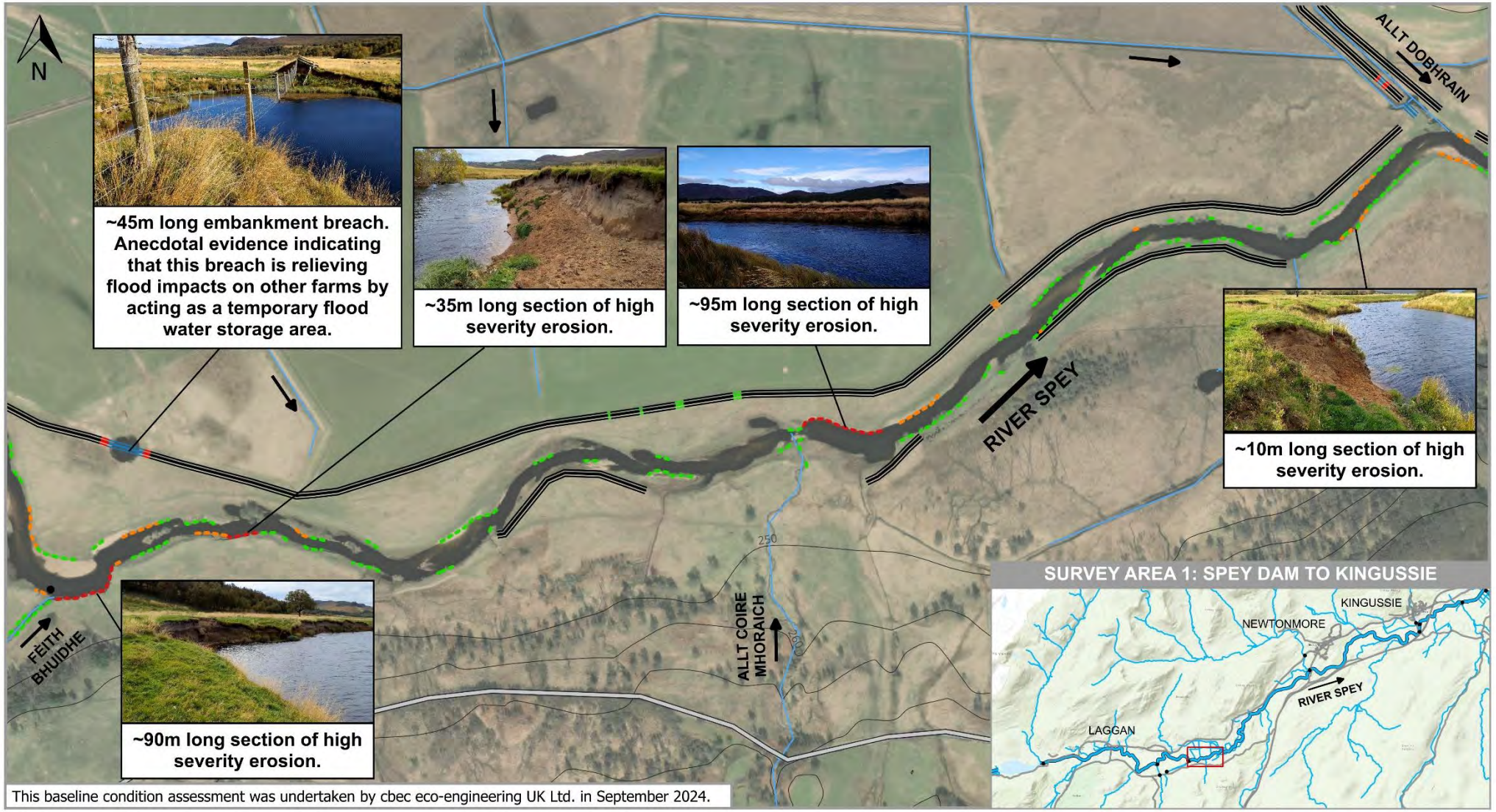
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 29 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.19 Area 1 - Map 6 showing the baseline survey results for the Allt Breakachy (Reach 1B) and Fèith Bhuidhe (Reach 1C).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 7 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

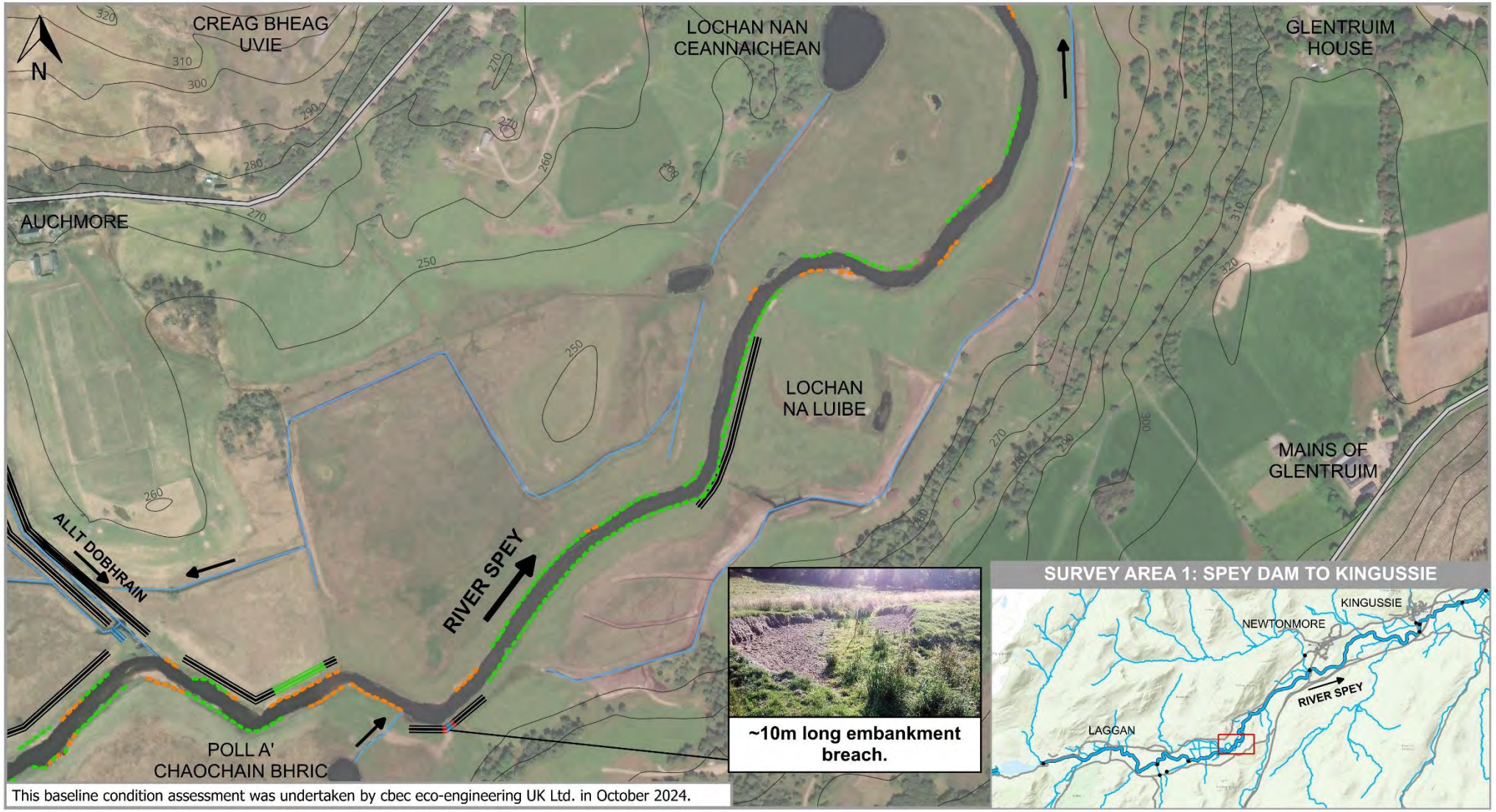
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 29 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.20 Area 1 - Map 7 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 8 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

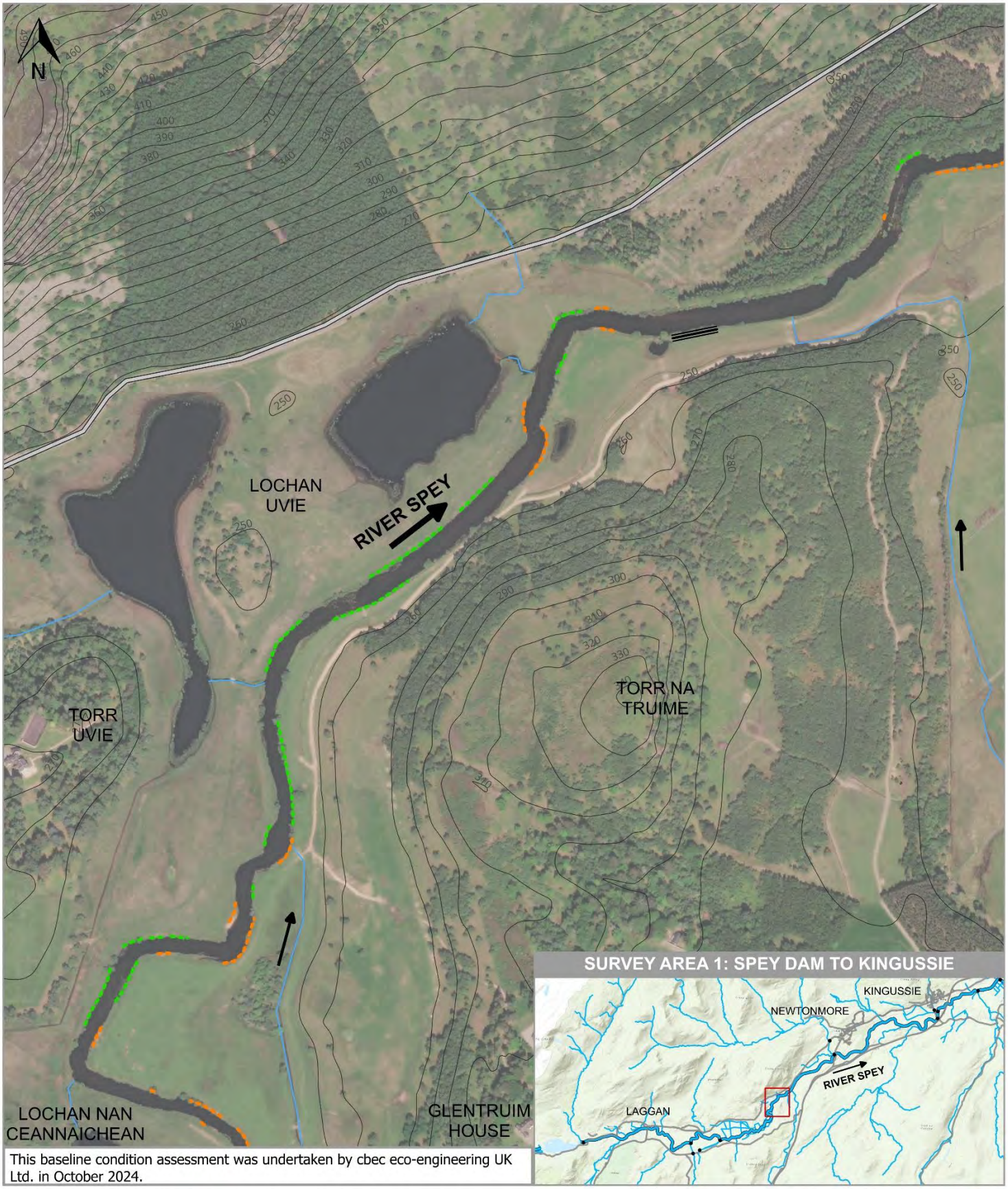
0 100 200 300 m

Project no. 2150649
Date 29 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
Scale @ A4 - 1:6,000
British National Grid GCS OSGB 1936



**Figure 3.21 Area 1 - Map 8 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 9 - RIVER SPEY




This baseline condition assessment was undertaken by cbec eco-engineering UK Ltd. in October 2024.

**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Railway Line
- Other Roads
- 10m Contour Lines
- Tributaries & Field Drains

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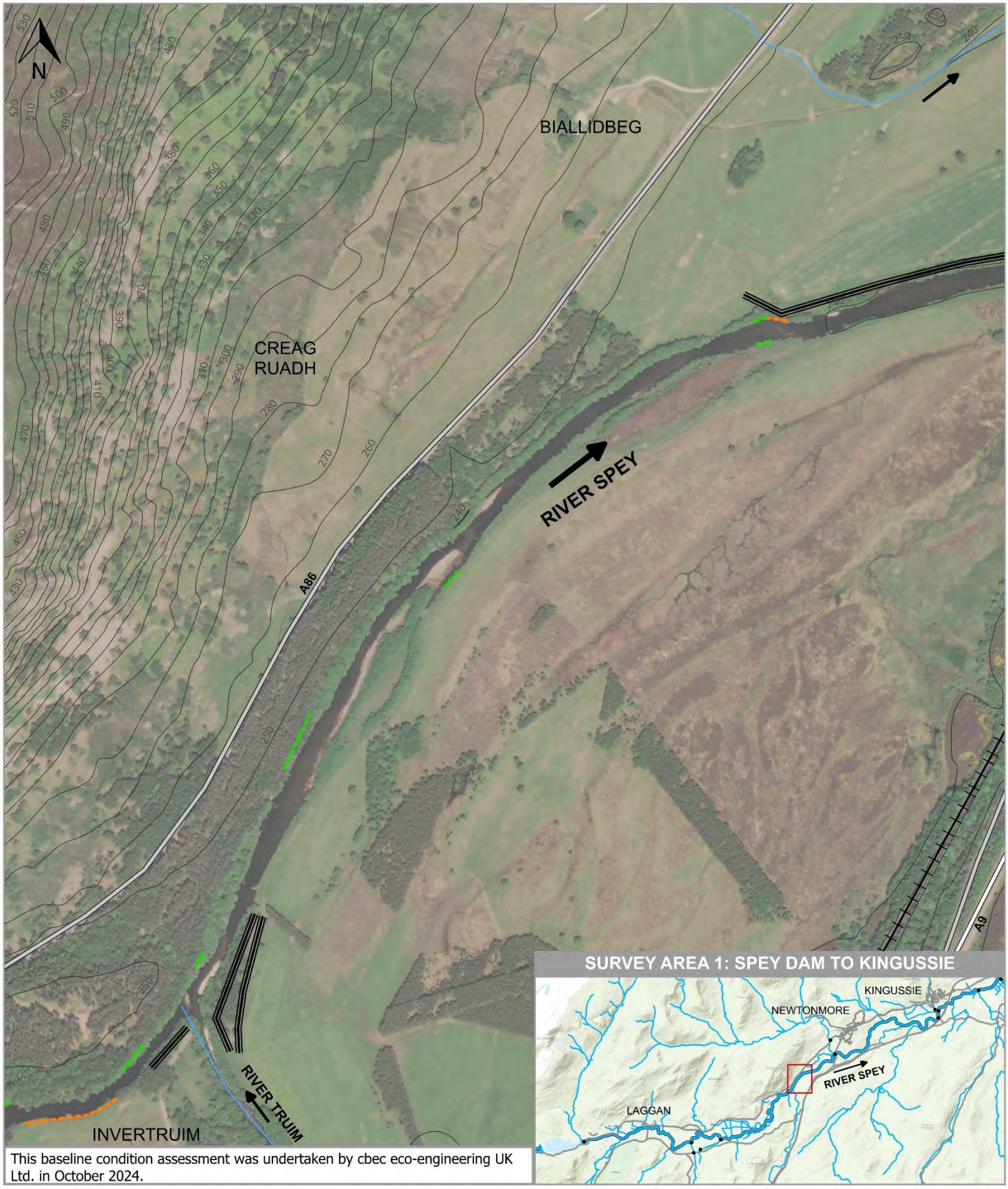
CLIENT CNPA
PROJECT UPPER SPEY EMBANKMENT
0 100 200 m
Scale @ A4 - 1:6,000

Project no. 2150649
Date 29 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
British National Grid GCS OSGB 1936

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.22 Area 1 - Map 9 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 10 - RIVER SPEY




This baseline condition assessment was undertaken by cbec eco-engineering UK Ltd. in October 2024.

**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Railway Line
- Other Roads
- 10m Contour Lines
- Tributaries & Field Drains

*Layers contain OS Data @ Crown Copyright and Database Right 2024

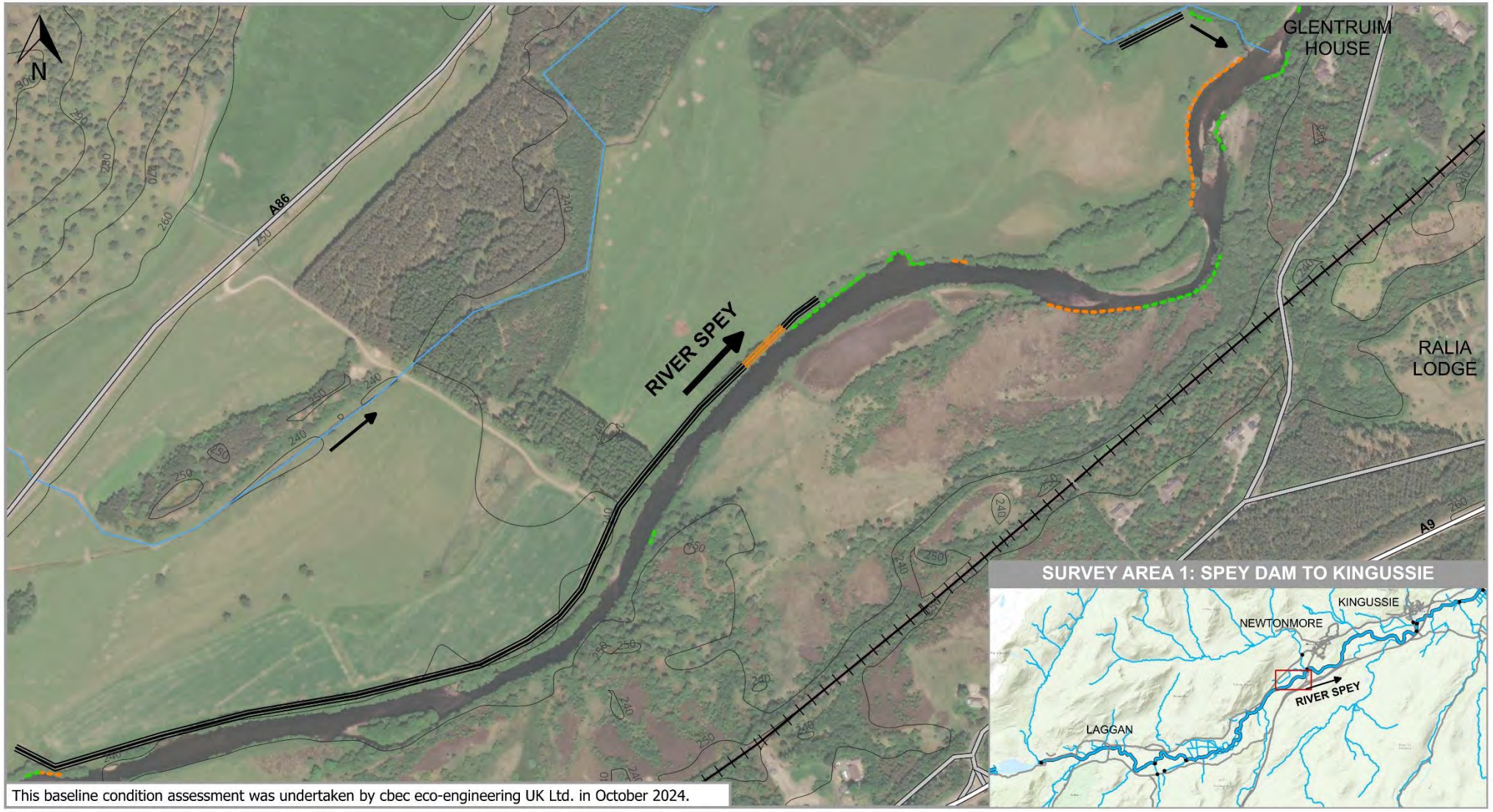
CLIENT CNPA
PROJECT UPPER SPEY EMBANKMENT
0 100 200 m
Scale @ A4 - 1:6,000

Project no. 2150649
Date 29 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
British National Grid GCS OSGB 1936

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.23 Area 1 - Map 10 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 11 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

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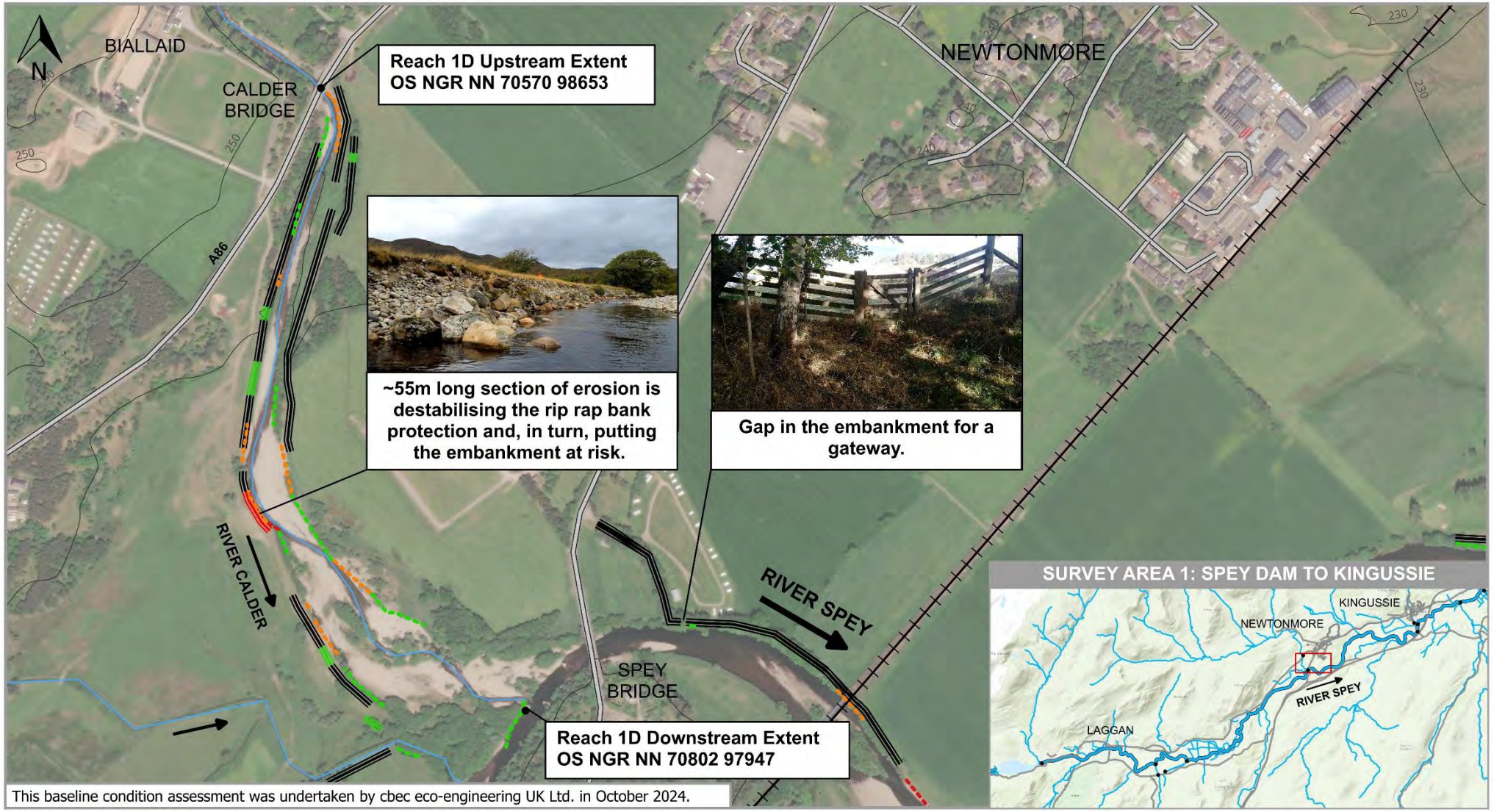
| Project no. | 2150649 |
| Date | 29 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.24 Area 1 - Map 11 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 12 - RIVER SPEY & RIVER CALDER




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 100 200 300 m

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| Project no. | 2150649 |
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| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
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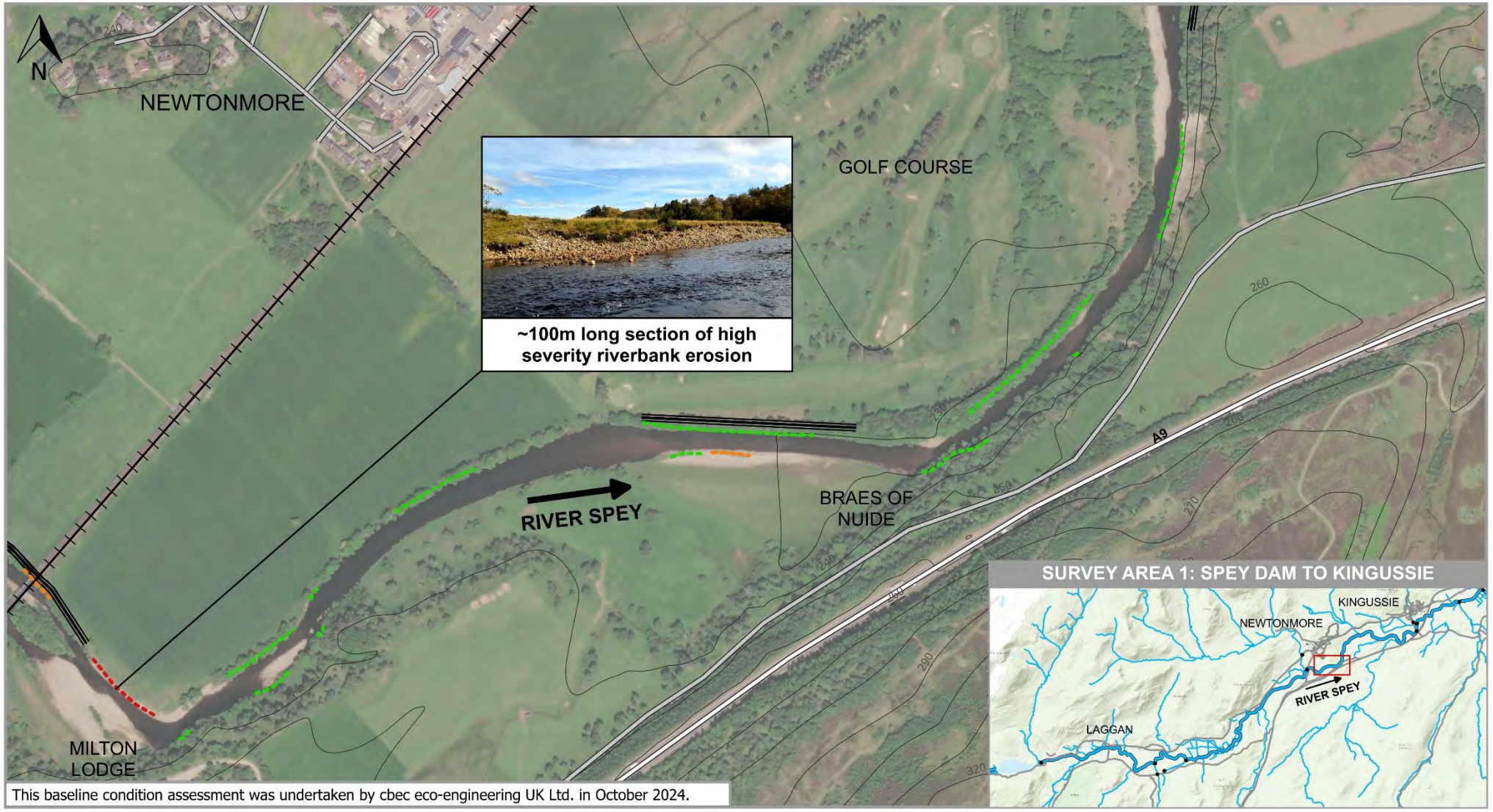
| British National Grid GCS OSGB 1936 | |



**Figure 3.25 Area 1 - Map 12 showing the baseline survey results for the River Spey (Reach 1A) and River Calder (Reach 1D).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 13 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.26 Area 1 - Map 13 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 14 - RIVER SPEY

~15m long embankment breach which has been partially infilled.

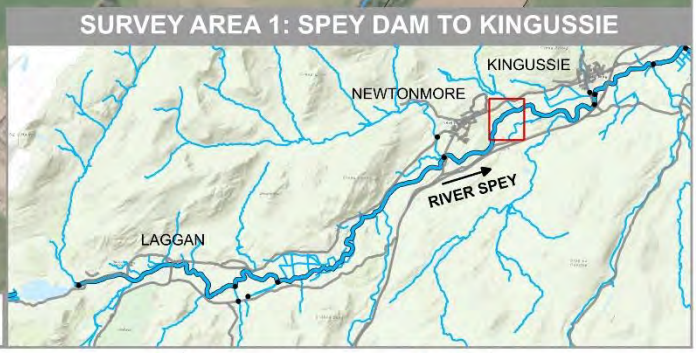
~35m long section high severity bank erosion

~20m long embankment breach.

~15m long section of riverbank erosion puts the embankment at risk of breach.

~5m long embankment breach, likely to have been caused by livestock trampling across the embankment at this point.

~95m long embankment breach




This baseline condition assessment was undertaken by cbec eco-engineering UK Ltd. in October 2024.

**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Railway Line
- Other Roads
- 10m Contour Lines
- Tributaries & Field Drains

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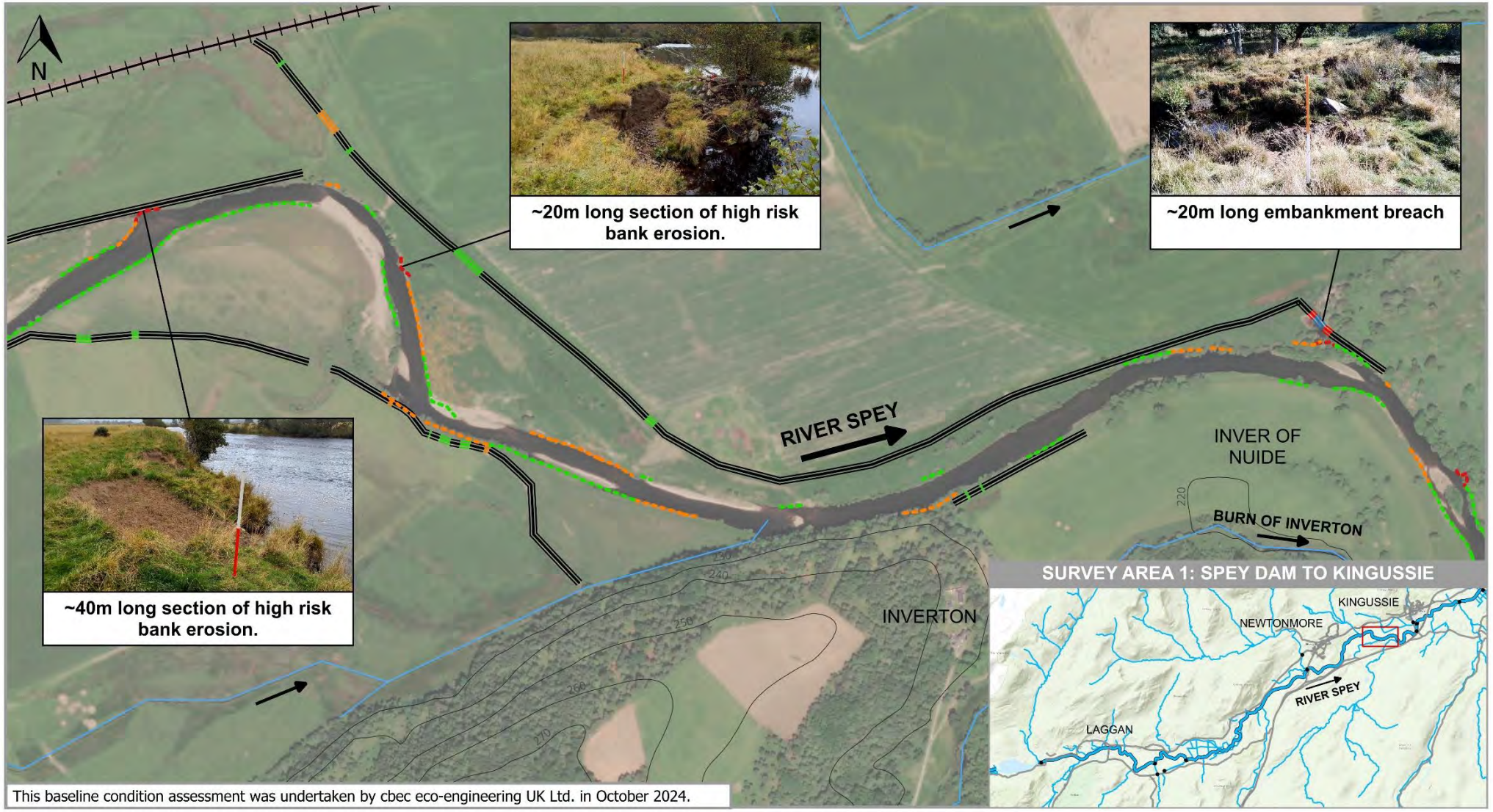
CLIENT CNPA
PROJECT UPPER SPEY EMBANKMENT
0 100 200 m
Scale @ A4 - 1:6,000

Project no. 2150649
Date 30 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
British National Grid GCS OSGB 1936



**Figure 3.27 Area 1 - Map 14 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 15 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

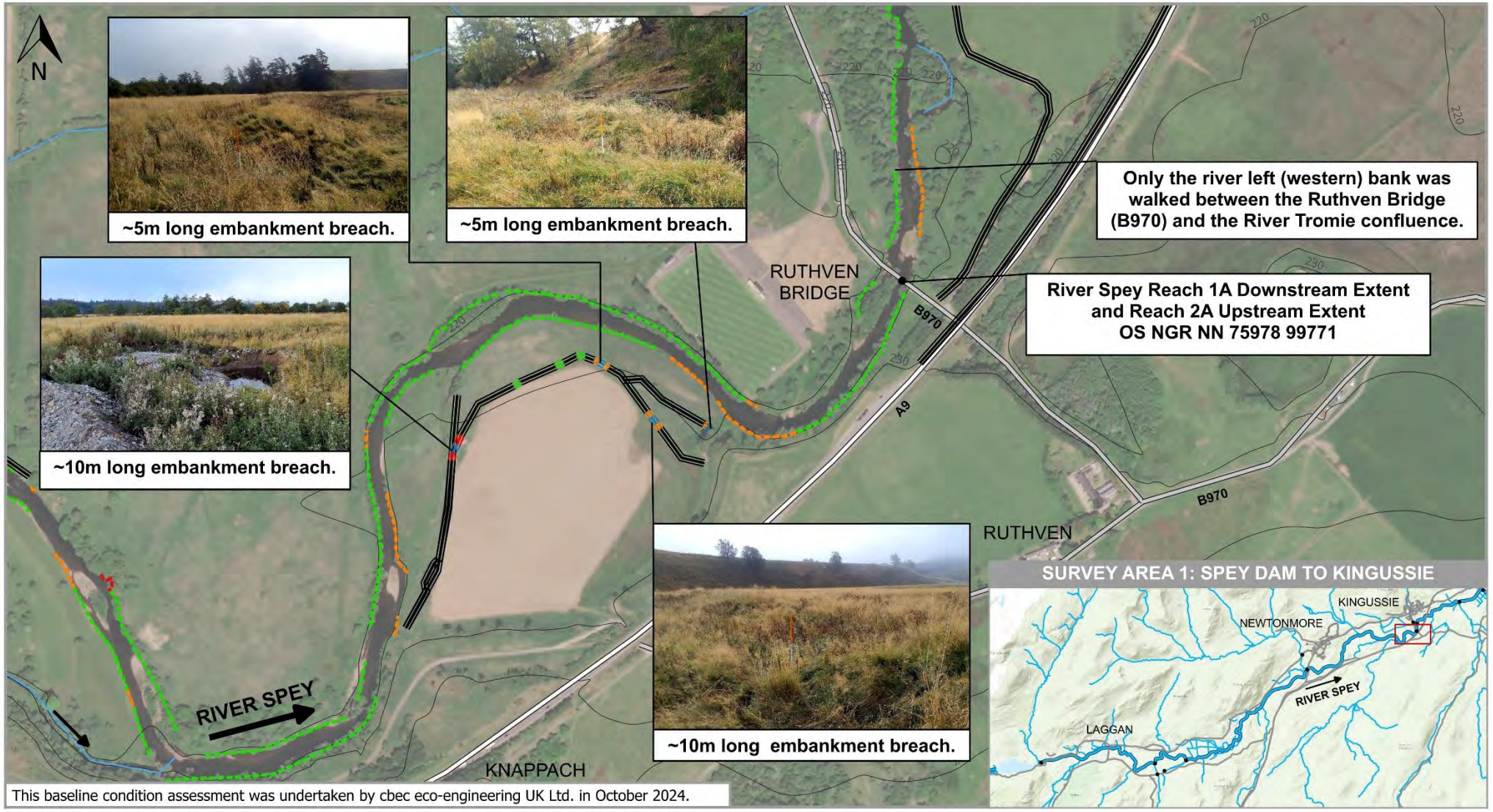
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 30 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.28 Area 1 - Map 15 showing the baseline survey results for the River Spey (Reach 1A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 1 - MAP 16 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- 10m Contour Lines
- Tributaries & Field Drains

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 100 200 300 m

Project no. 2150649
Date 30 OCT 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
Scale @ A4 - 1:6,000
British National Grid GCS OSGB 1936



**Figure 3.29 Area 1 - Map 16 showing the baseline survey results for the River Spey (Reach 1A).**

### 3.3.3. Survey Area 2 – Kingussie to Aviemore

Information relating to embankment and riverbank condition in Area 2 is presented in Figure 3.30 to Figure 3.42.

Downstream of Kingussie, moderate- to high-severity erosion was noted along the river right (eastern) bank (Figure 3.31 and Figure 3.32). Erosion severity within this area is likely related to the lack of riparian corridor vegetation, input from tributaries (i.e. Gynack Burn) and the meandering planform. As outlined in relation to Area 1, erosion around the outer bend of meanders is a natural process facilitating lateral channel adjustment. Therefore, the erosion noted between Kingussie and the River Tromie is not uncharacteristic of a meandering channel such as this section of the River Spey, although may be exacerbated by land use and management. A cluster of embankment breaches was noted around the River Tromie confluence (Figure 3.32). These breaches may be a result of the river planform (i.e. the flow of water exiting from the tight meander bend ~200 m upstream of the Tromie confluence) and the direction of flow from the tributary joining the main channel.

Insh Marshes National Nature Reserve is situated downstream of the River Tromie confluence with the River Spey. Some of the reserve was excluded from this condition assessment, to avoid duplication of works being undertaken as part of other studies regarding this ecological site. However, the Raitts Burn, which discharges into the River Spey at OS NGR NH 79195 01714 (i.e. within the reserve), was surveyed (Figure 3.33). The lower course of this tributary was noted to have multiple sections of low- to moderate-severity bank erosion and occasional, short sections (less than ~25 m) of embankment breach risk relating to cracks or slumping of the embankment face and/or crest.

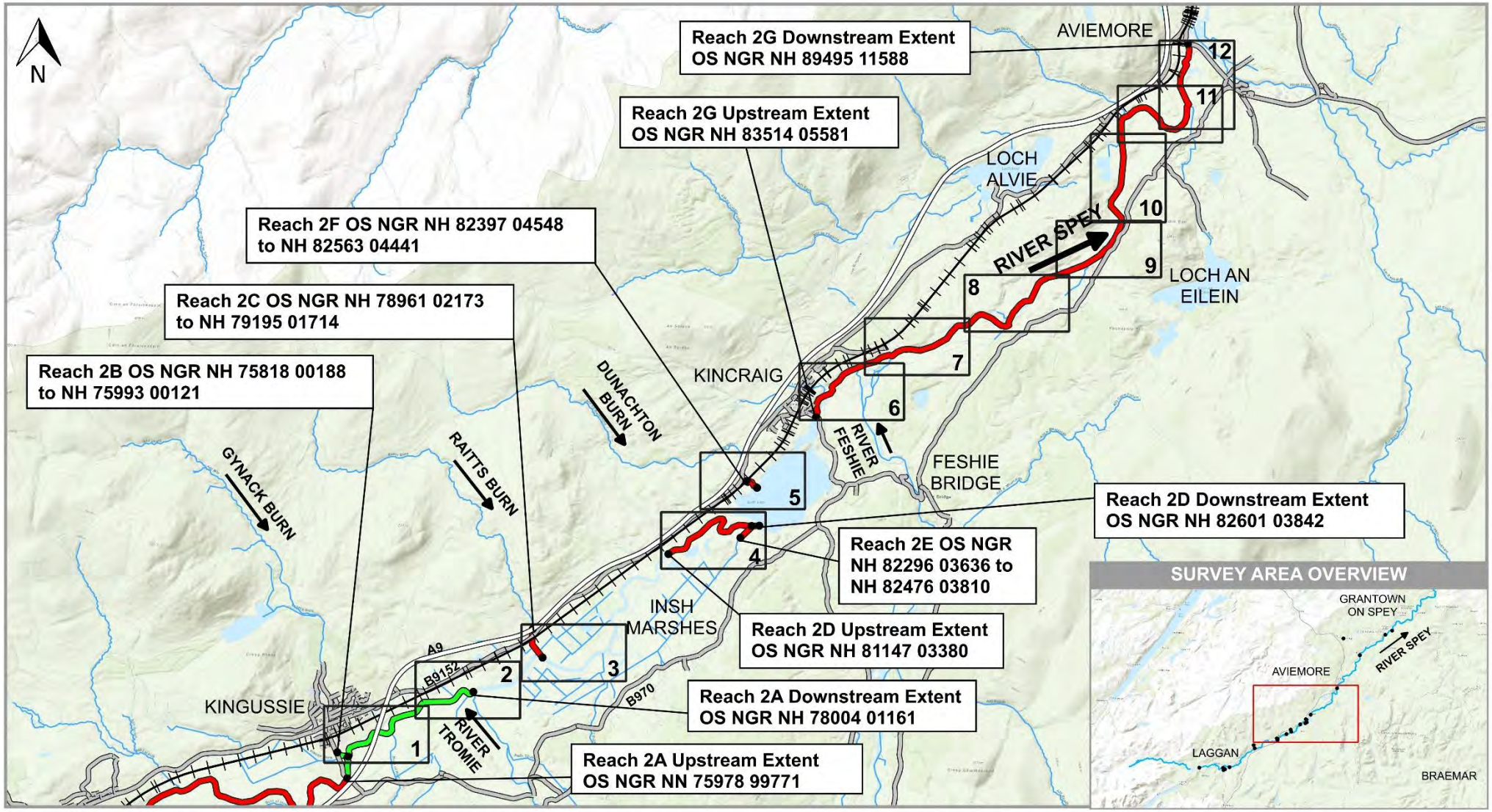
Reaches 2D to F are situated on the upstream side of Loch Insh. Where watercourses flow into a stationary waterbody, such as Loch Insh, the flow of water is slowed creating a backwater effect. This was observed at the downstream end of these three reaches, further evidenced by the abundance of marginal vegetation at the base of these riverbanks. Owing to this slower velocity, relative to the other surveyed areas of the Spey, gentler bank gradient and continuous vegetation cover, riverbanks within reach 2D were found to be stable with minimal signs of erosion. The same was noted to be true of the Insh Marshes Main Drain (Reach 2E). Dunchaton Burn exhibited a meandering planform with pool-riffle morphology. Multiple sections of minor (low severity) riverbank erosion were recorded along this watercourse, typical of this channel type, however given the presence of trees within the riparian corridor, providing bank stability, and low bank height (typically <1m), this was not deemed to be a concern at present. Embankments are absent along the surveyed sections of the Insh Marshes Main Drain (Reach 2E) and Dunachton Burn (Reach 2F). The embankment along the River Spey was found to be in good condition throughout Reach 2D, with two breach locations at the downstream end of this section, thought to have been created to enable the marsh to drain.

Downstream of Loch Insh, the River Spey was surveyed from Kincraig downstream to the B970 bridge on the southern side of Aviemore (Reach 2G; Figure 3.36 to Figure 3.42). Steep banks are present on the river left (western) side of the Spey throughout the first ~2.3 km of this section, with moderate- to high-severity erosion recorded between Wester Speybank and Speybank, owing to the height and sheer face of this part of the bank. Throughout the remainder of this reach, the riverbanks were found to be well vegetated, with a combination of ruderal vegetation and tree cover within the riparian corridor. Resultant of the vegetation cover and gentle gradient, most of the riverbanks within Reach 2G were classified as exhibiting low-severity or no erosion, not deemed to be significant enough to pose a threat to the embankments. Occasional moderate- to high-severity erosion was noted in

localised areas, particularly around the outside bends of meanders, with embankments rarely impacted (Figure 3.38, Figure 3.40 and Figure 3.41).

Embankments on the left bank were rare throughout Reach 2G, with occasional sections noted around Kinrara (Figure 3.38 and Figure 3.39) and from the Allt-na-Criche confluence to Aviemore (Figure 3.41 and Figure 3.42). Slumping due to degradation of the embankment condition and trampling by livestock were noted to be the main factors influencing the risk of embankment breach within this reach. Trampling of the embankment by livestock in the lower section of Reach 2G, between Doune Farm and the Milton Burn confluence, was concentrated around mature trees. Livestock lying around, sheltering beneath or rubbing against these trees has led to increased footfall over these sections of the embankment, lowering the crest height and increasing the vulnerability of these areas to breaching. Erection of fencing along the riparian corridor would prevent livestock access to this area, allowing the embankment time to revegetate and increasing the sustainability of any remedial works undertaken.

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - OVERVIEW OF RESULTS MAPS




**Condition Assessment**
Areas Surveyed:*
- Both Banks
- Right Bank Only
- Left Bank Only

- Not Surveyed (River Spey)
- Not Surveyed (Tributaries)
- Survey Extents
- Map Overview Box
- 1 Map Number

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

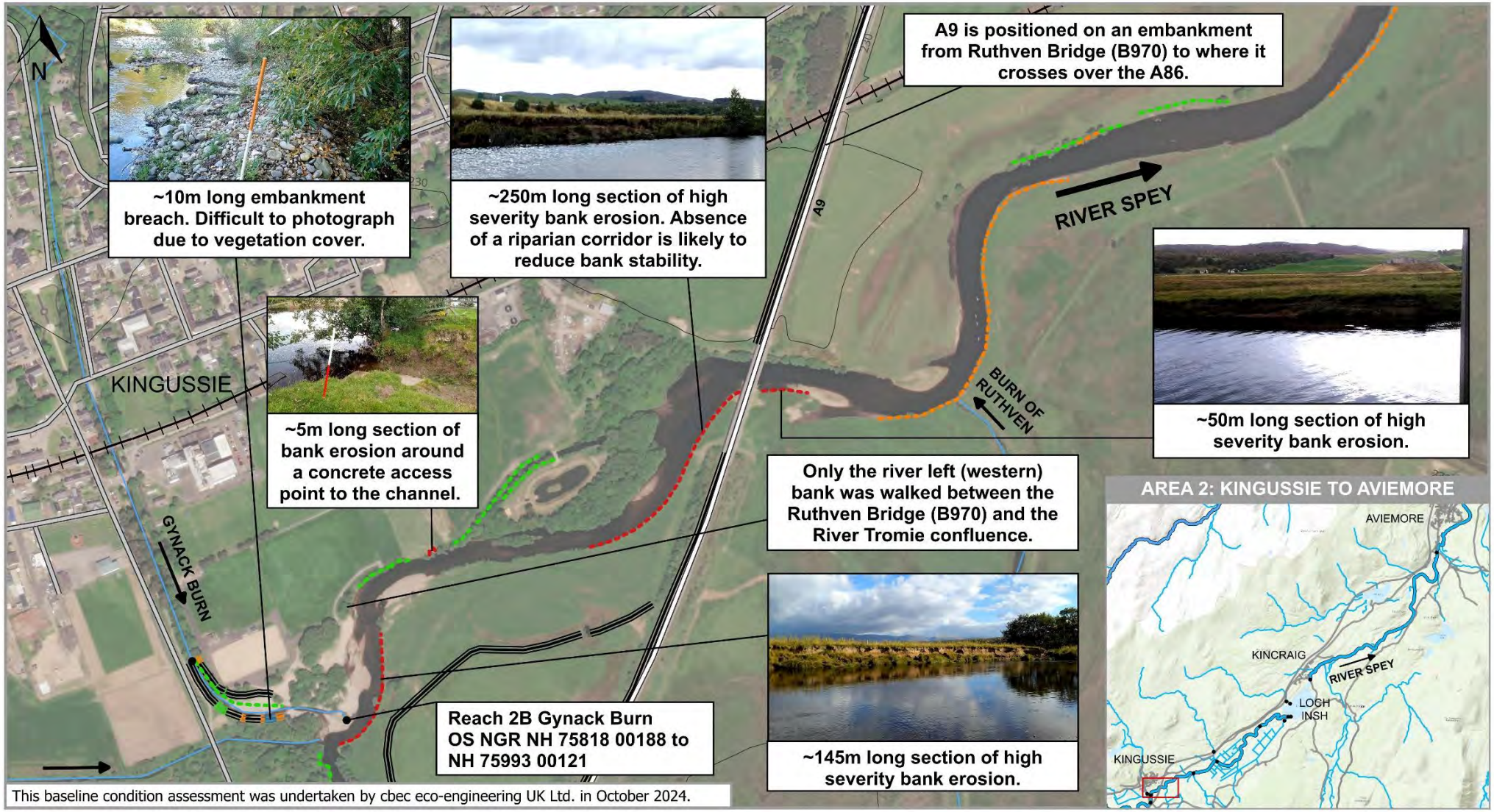
0 1 2 3 km

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:65,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.30 Area 2 survey results overview map**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 1 - RIVER SPEY & GYNACK BURN




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

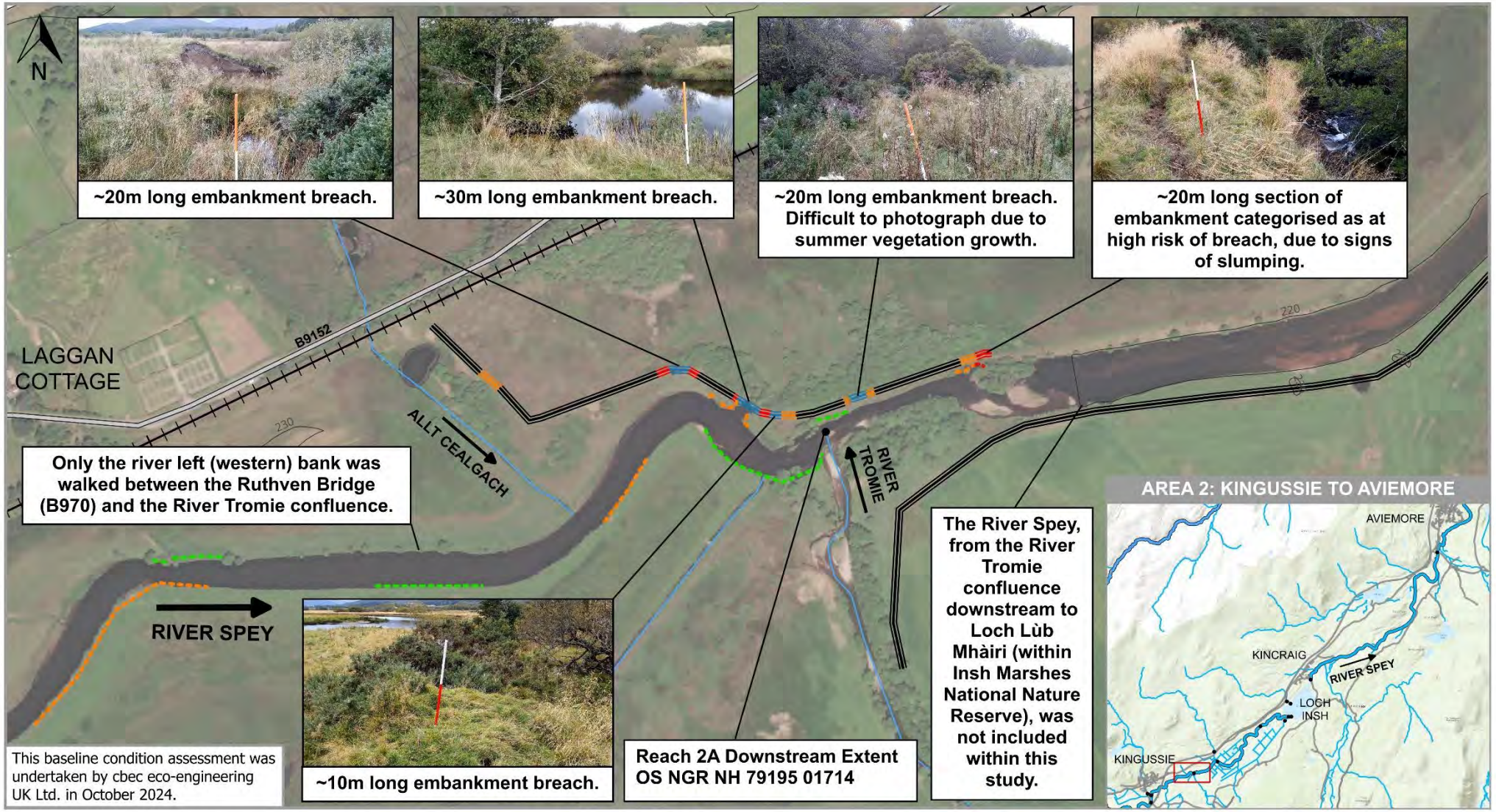
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 31 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.31 Area 2 - Map 1 showing the baseline survey results for the River Spey (Reach 2A) and the Gynack Burn (Reach 2B).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 2 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

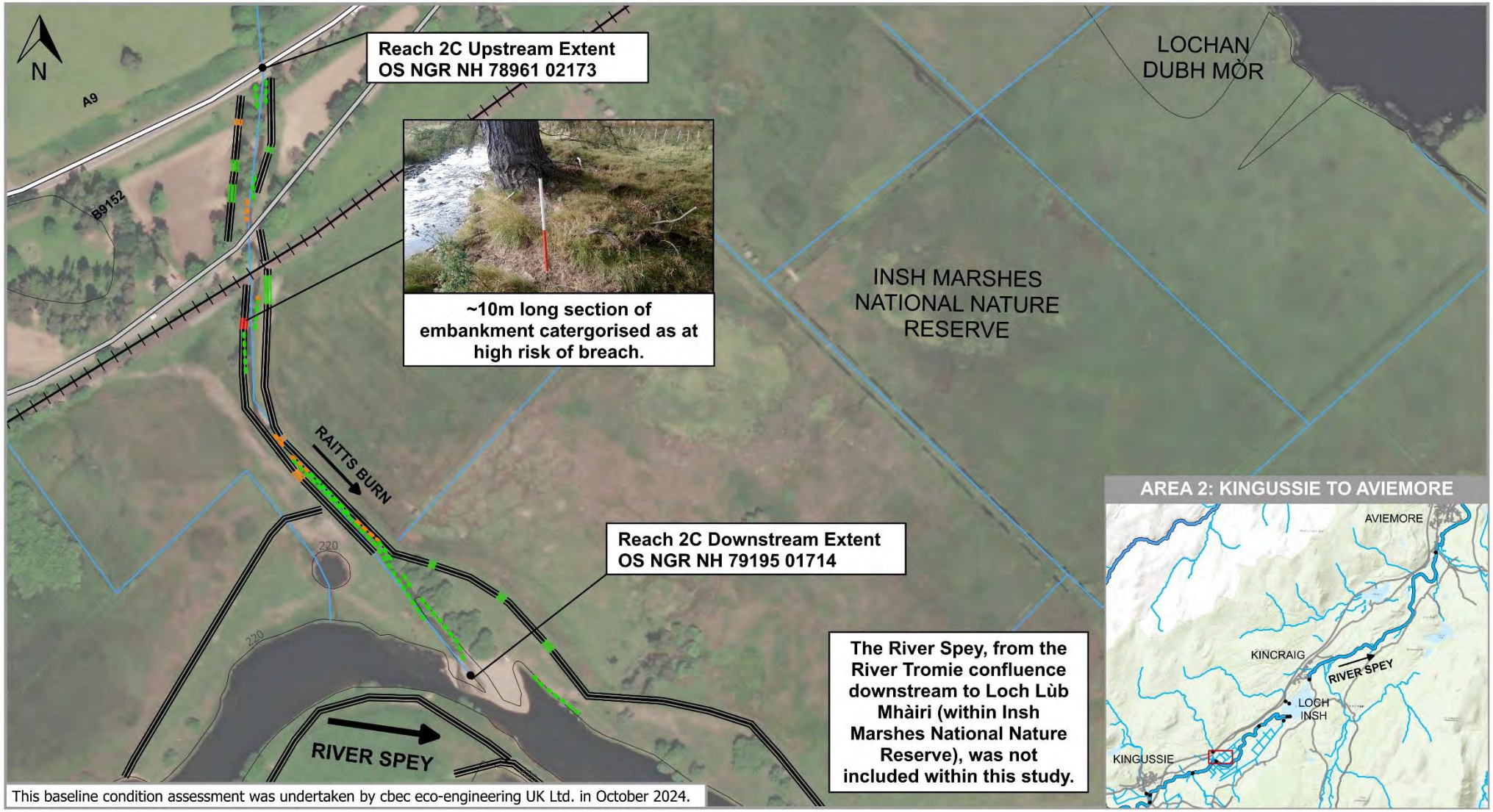
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 31 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.32 Area 2 - Map 2 showing the baseline survey results for the River Spey (Reach 2A).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 3 - RAITTS BURN




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

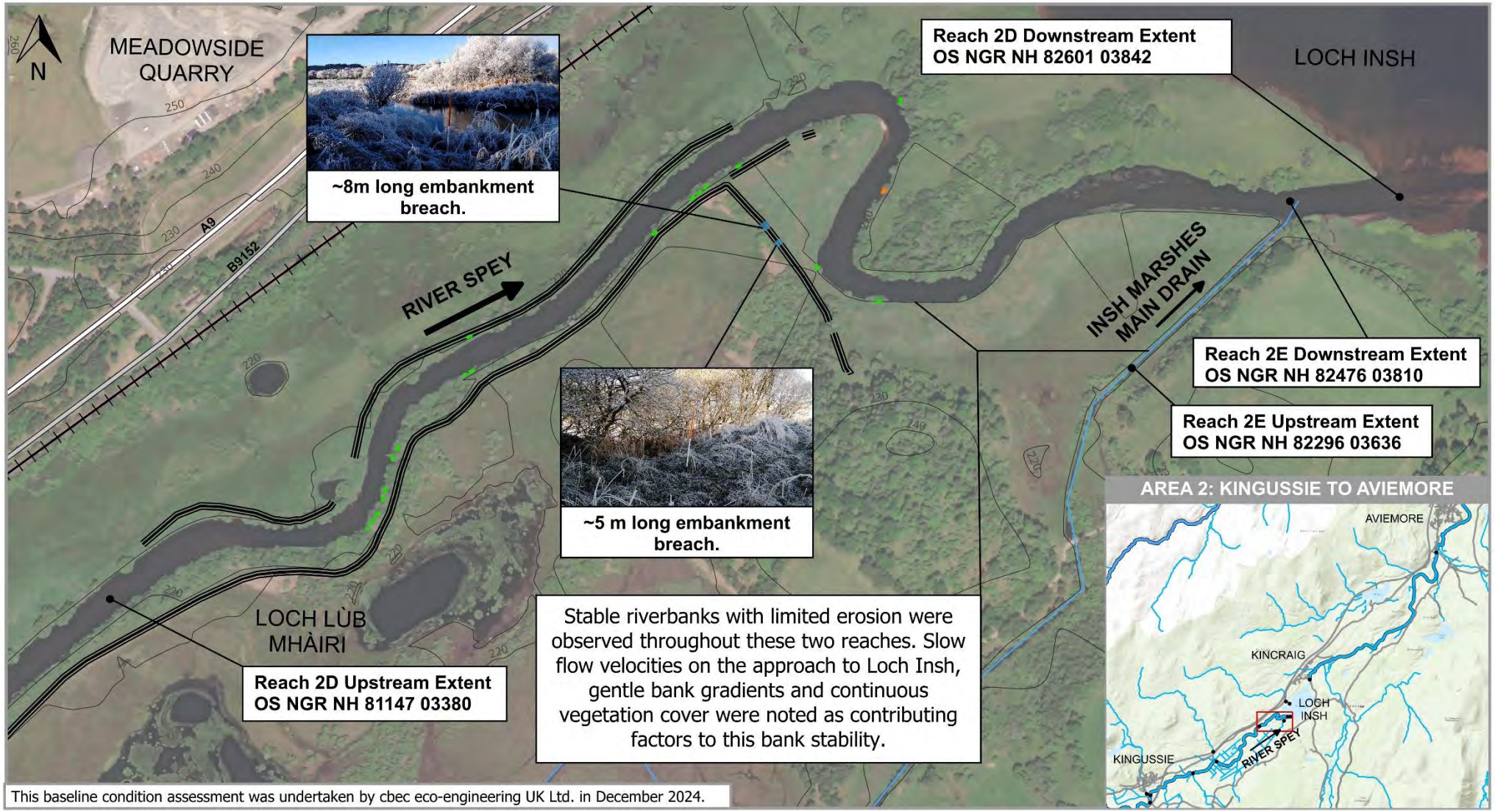
0 100 200 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 31 OCT 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 | 1:4,000 |
| British National Grid GCS OSGB 1936 | |



**Figure 3.33 Area 2 - Map 3 showing the baseline survey results for the Raitts Burn (Reach 2C).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 4 - RIVER SPEY & FIELD DRAIN




This baseline condition assessment was undertaken by cbec eco-engineering UK Ltd. in December 2024.

**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.34 Area 2 - Map 4 showing the baseline survey results for the River Spey (Reach 2D) and the Insh Marshes Main Drain (Reach 2E).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 5 - RIVER SPEY


**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

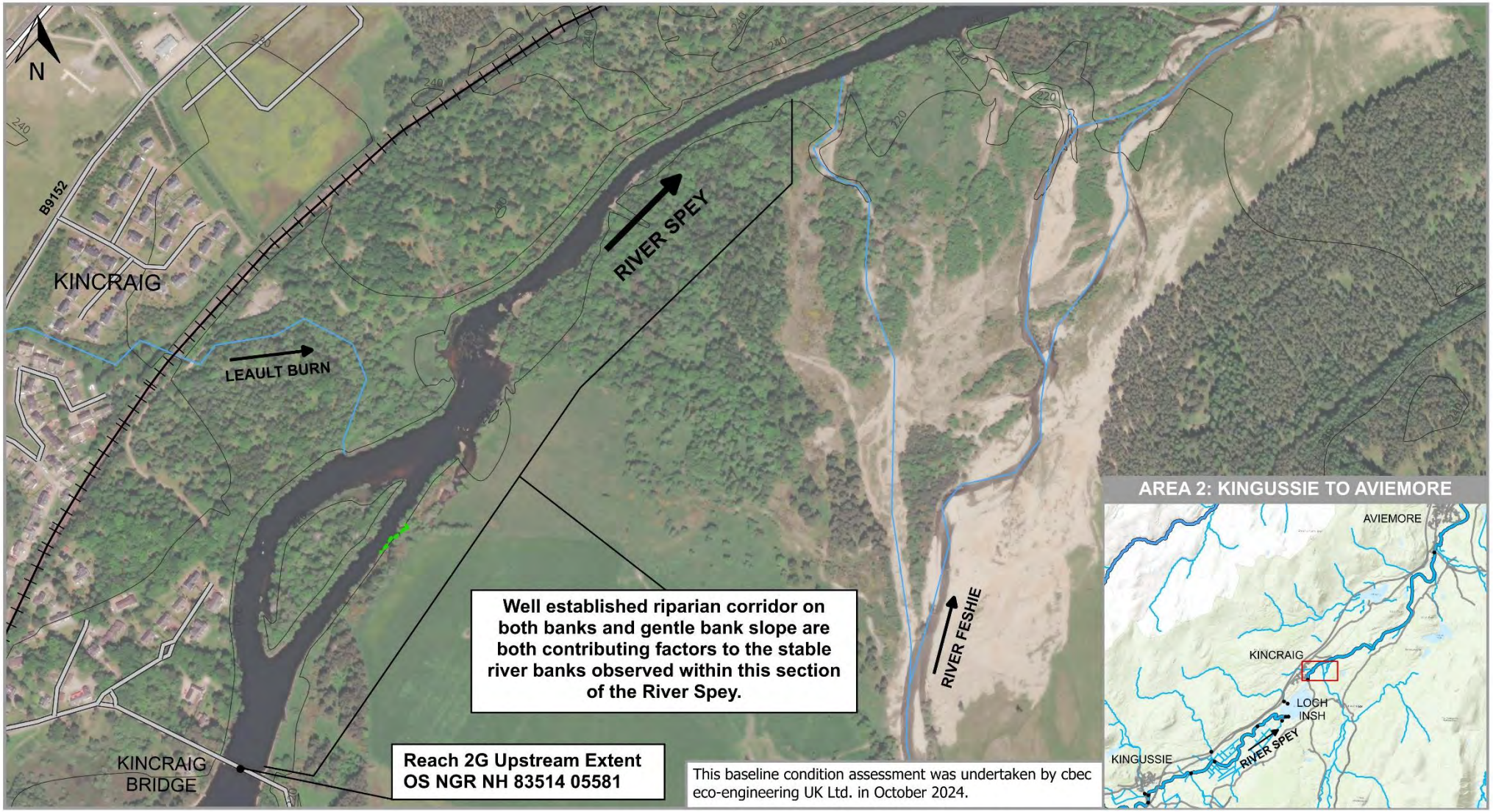
0 100 200 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:4,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.35 Area 2 - Map 5 showing the baseline survey results for the Dunachton Burn (Reach 2F).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 6 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT UPPER SPEY EMBANKMENT

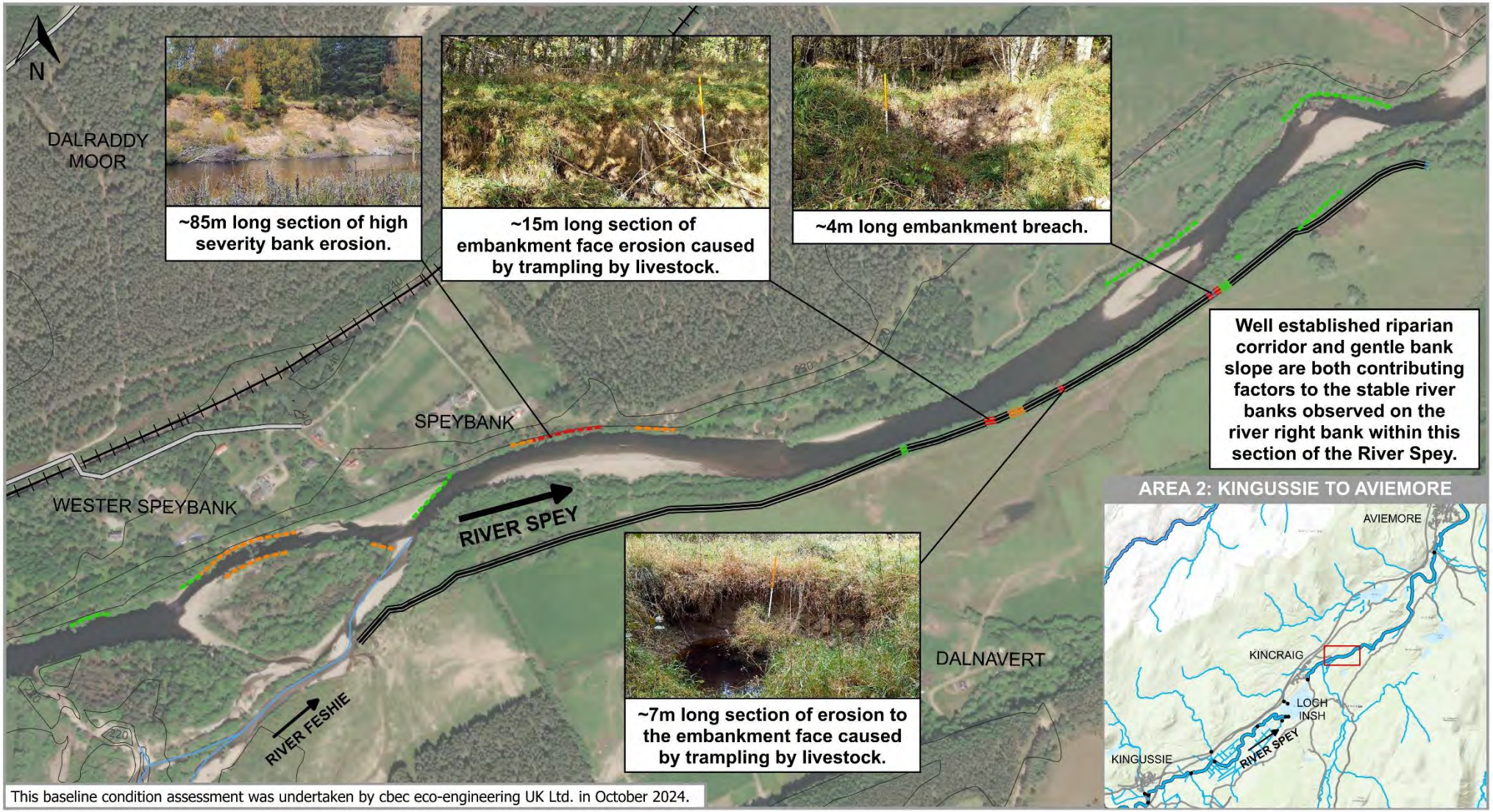
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.36 Area 2 - Map 6 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 7 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
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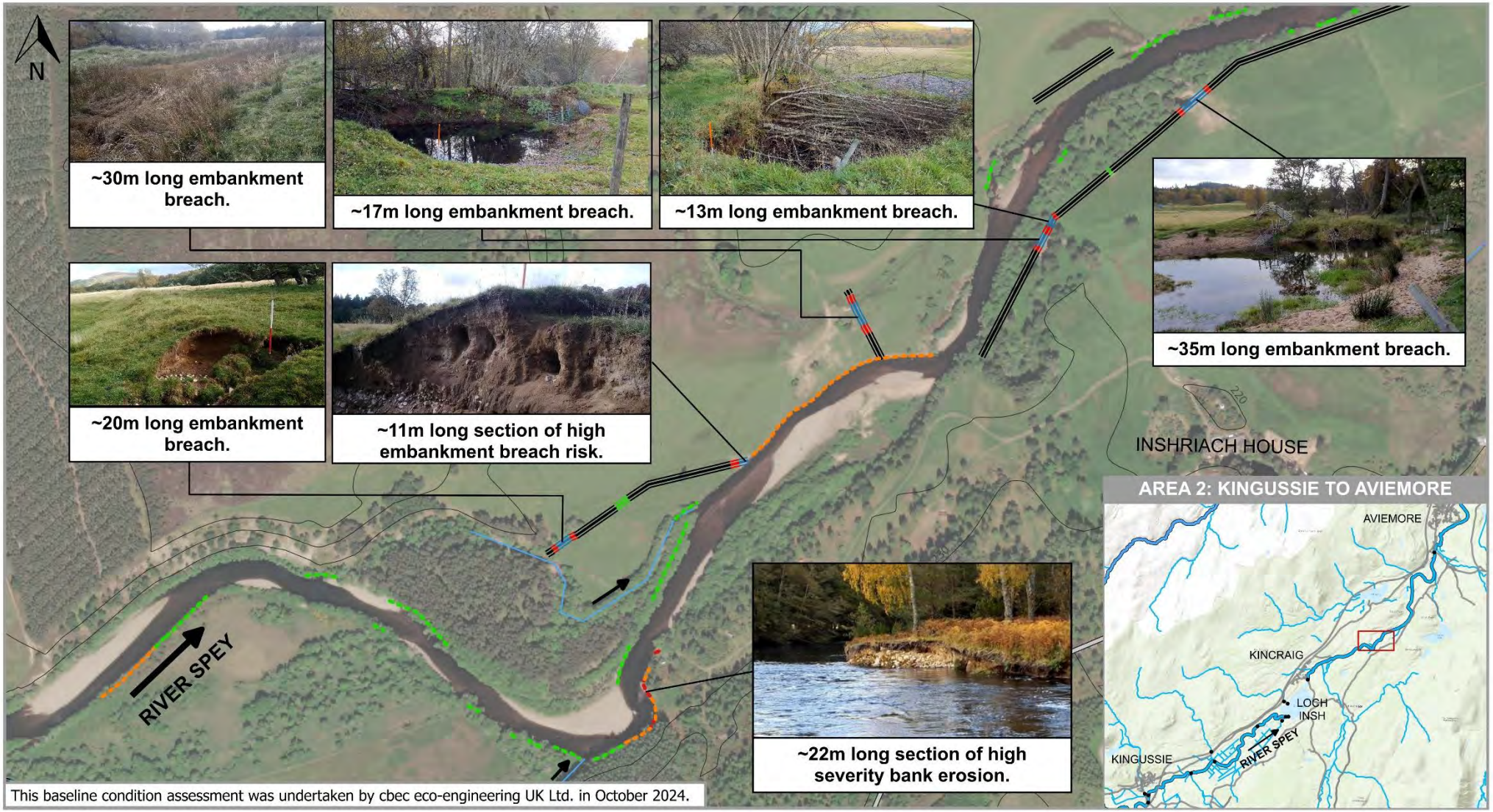
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.37 Area 2 - Map 7 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 8 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains
- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

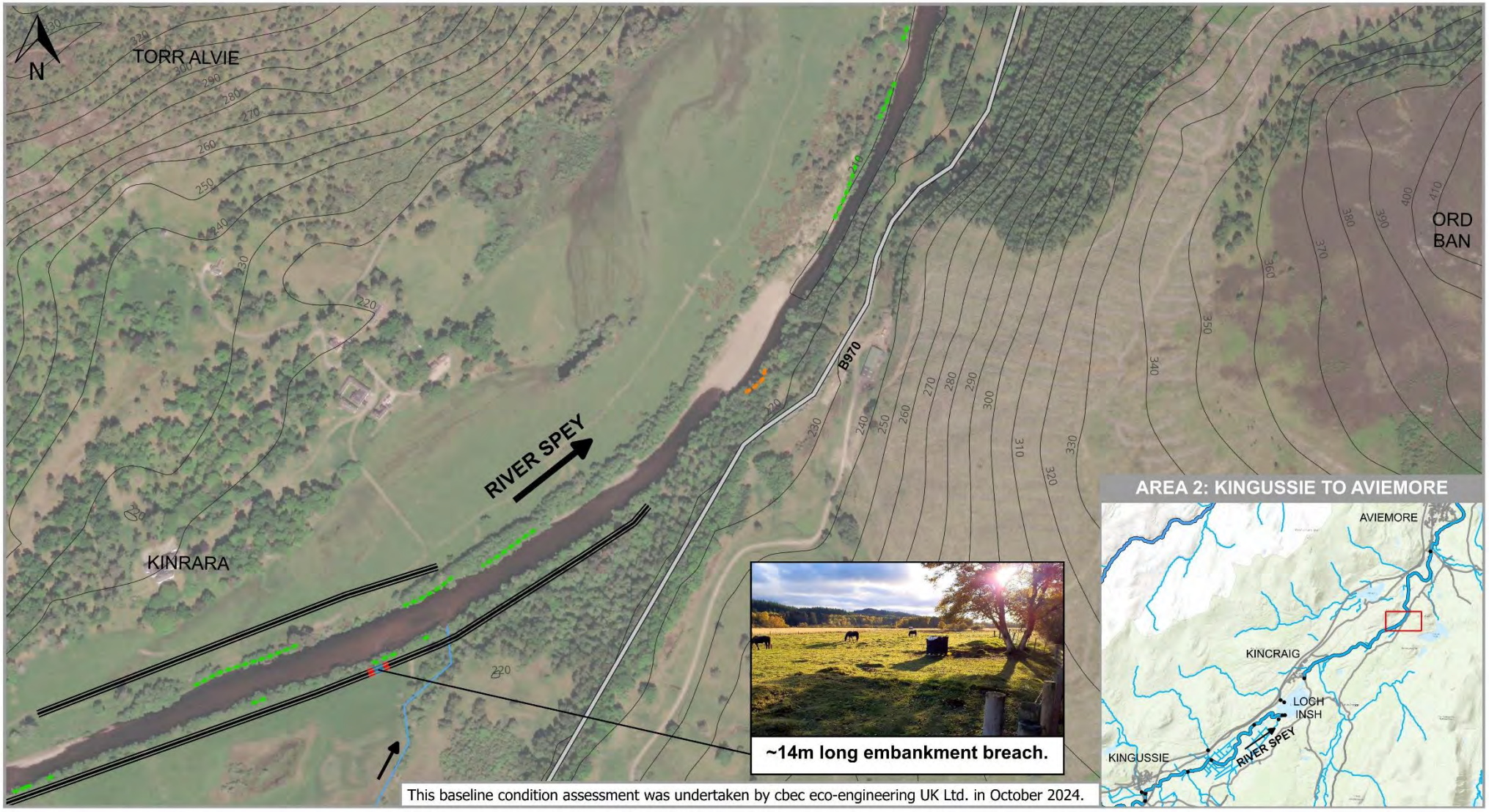
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.38 Area 2 - Map 8 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 9 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

- 10m Contour Lines

*Layers contain OS Data @ Crown Copyright and Database Right 2024

CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

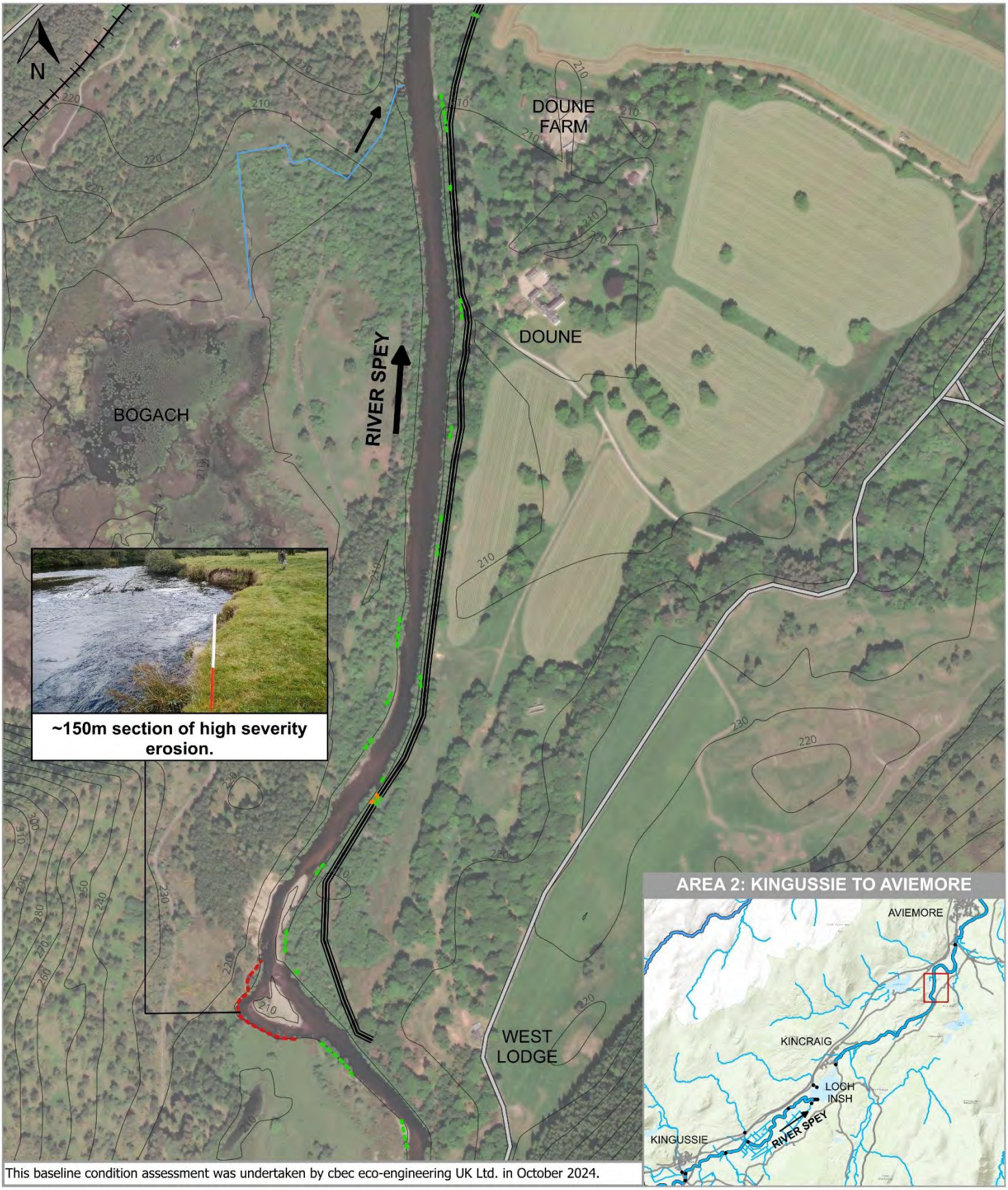
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 - 1:6,000 | |
| British National Grid GCS OSGB 1936 | |



**Figure 3.39 Area 2 - Map 9 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 10 - RIVER SPEY




This baseline condition assessment was undertaken by cbec eco-engineering UK Ltd. in October 2024.

**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Railway Line
- Other Roads
- 10m Contour Lines
- Tributaries & Field Drains

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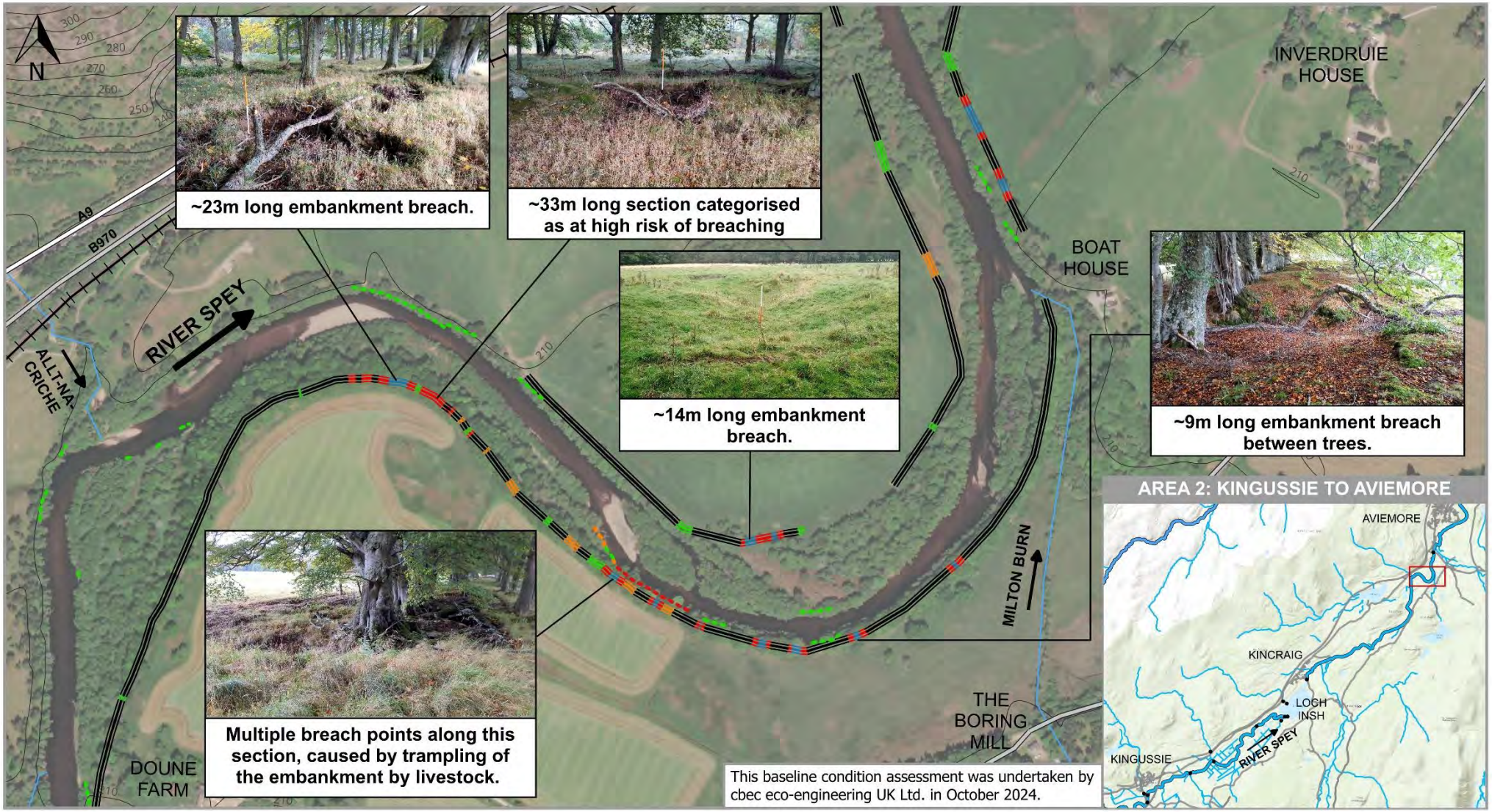
CLIENT CNPA
PROJECT UPPER SPEY EMBANKMENT
0 100 200 m
Scale @ A4 - 1:6,000

Project no. 2150649
Date 12 NOV 2024
Drawn GP
Surveyed GP, OS, AE & JE
Reviewed LM
British National Grid GCS OSGB 1936



**Figure 3.40 Area 2 - Map 10 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 11 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low

- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- Tributaries & Field Drains

- 10m Contour Lines

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CLIENT: CAIRNGORMS NATIONAL PARK AUTHORITY

PROJECT: UPPER SPEY EMBANKMENT

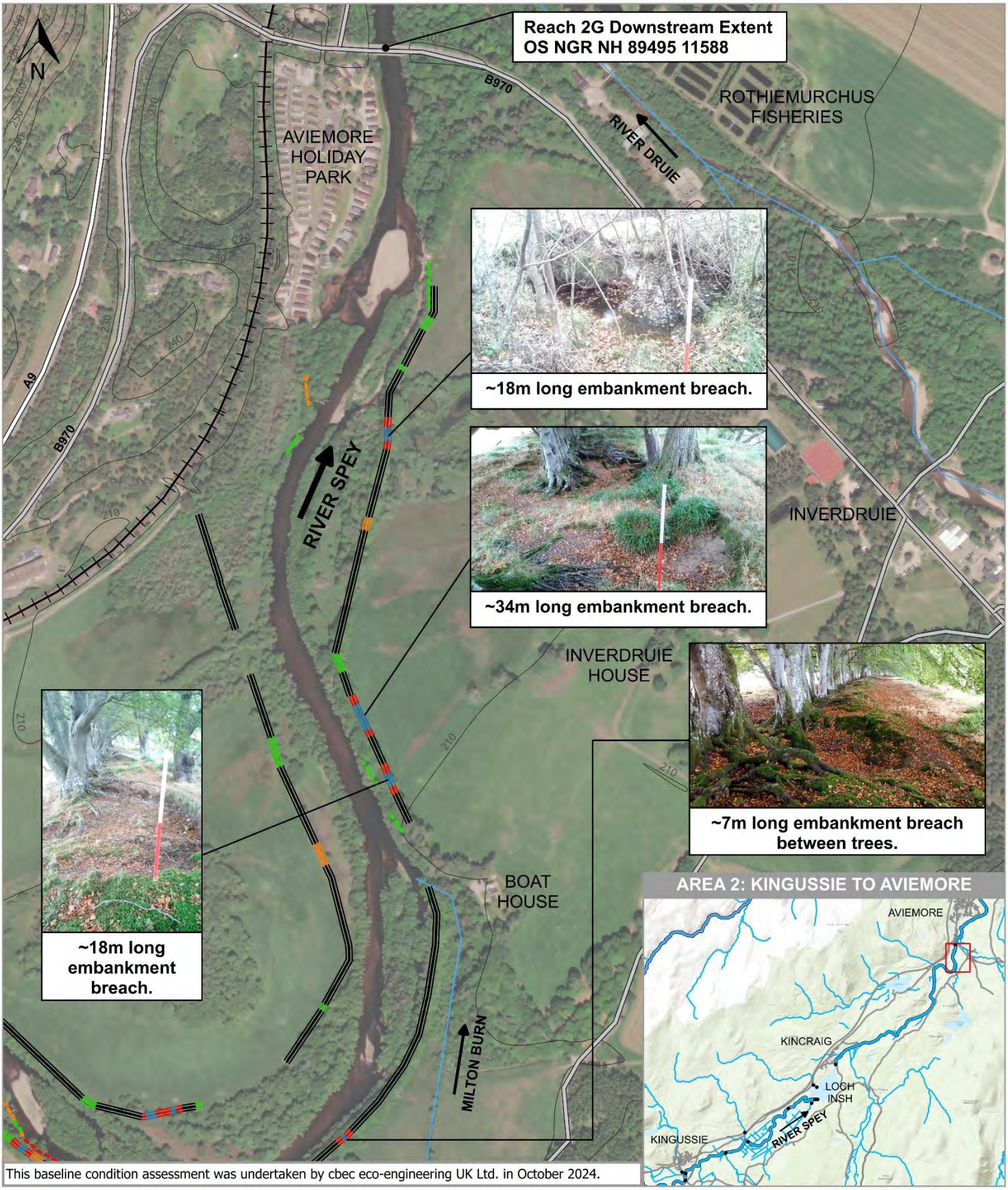
0 100 200 300 m

| | |
|---|---|
| Project no. | 2150649 |
| Date | 12 NOV 2024 |
| Drawn | GP |
| Surveyed | GP, OS, AE & JE |
| Reviewed | LM |
| Scale @ A4 | 1:6,000 |
| British National Grid GCS OSGB 1936 | |



**Figure 3.41 Area 2 - Map 11 showing the baseline survey results for the River Spey (Reach 2G).**

# EMBANKMENT CONDITIONS ASSESSMENT - SURVEY AREA 2 - MAP 12 - RIVER SPEY




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Formalised Breach
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Railway Line
- Other Roads
- 10m Contour Lines
- Tributaries & Field Drains

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CLIENT CNPA
PROJECT UPPER SPEY EMBANKMENT
0 100 200 m
Scale @ A4 - 1:6,000

Project no. 2150649
Date 12 NOV 2024
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Surveyed GP, OS, AE & JE
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GCS OSGB 1936



**Figure 3.42 Area 2 - Map 12 showing the baseline survey results for the River Spey (Reach 2G).**

### 3.3.4. Survey Area 3 – Boat of Garten to Grantown-on-Spey

*River Spey (Reach 3A)*

Information relating to embankment and riverbank condition in Reach 3A is presented in Figure 3.43 to Figure 3.52.

In Reach 3A, the embankment begins at Drumuillie Farm on the river left bank and Mains of Garten on the river right bank, with only a couple of short (<10 m) sections of embankment classified as at low risk of breaching due to the proximity (<5 m) to the top of the bank. Therefore, overall, this upper section of the Spey survey extent was classified as having no risk of breaching. At Mains of Garten Farm, on the inner bend of the meander, a ~10 m breach in the embankment was recorded. This section of embankment is set-back more than 20 m from the bank top; therefore, it is thought that this section of breaching is caused by a build-up of pressure from out of bank flows during flood events.

Between Tullochgorum and the dismantled railway line, the river left embankment was categorised as low risk of breaching due to the presence of low-severity bank face erosion. This section of embankment has been constructed with a series of drainage channels and associated flap valves/culverts within the embankment, enabling surface water to recede back to the River Spey following flood events and helping to maintain the stability of the embankment. On the river right bank between Mains of Garten and Tomachrochar, occasional sections of low embankment risk were noted, but overall, this section presented no perceptible risk of embankment breach at the time of survey.

The embankment on the river left of the River Spey downstream of the dismantled railway ends near Crofthaven and begins again around Broomhill House. On the right bank the embankment continues from Tomachrochar Farm, passing around a drainage channel and into Rothiemoon. No areas at risk of embankment breach were noted within Rothiemoon. Downstream of Broomhill Bridge to the Spey-Dulnain confluence was classified as low risk of embankment breach overall, with occasional short (<20 m) sections of moderate or high risk of erosion. Overall erosion risk was found to be similar on the river right bank within this area, aside from a site ~350 m downstream of Broomhill Bridge, where erosion of the bank has undermined the embankment causing a ~40 m breach, leaving the adjacent sections of embankment vulnerable to further erosion. The other breach location noted in Reach 3A was opposite the River Dulnain confluence, at Balliefurth Farm. In contrast to the upstream breach, the embankment is set back ~25 m from the bank and therefore has not been undercut by bank erosion; instead, the embankment has been weakened by out of bank flows from the Dulnain during flood events. These two breaches were concluded to be the priority areas for remedial works within the Spey. Since the baseline assessment of Survey Area 3 in 2023, works have been undertaken to repair the breach at Balliefurth Farm.

Downstream of the Spey-Dulnain confluence, the embankment presents low risk of breaching due to its proximity to low-severity sections of bank erosion on the river right. It is recommended that all low risk locations throughout the Spey are subject to ongoing monitoring to ensure mitigation measures are implemented should further signs of deterioration be noted.

At Ballintomb Farm on the river left bank downstream of the Spey-Dulnain confluence a section of high breach risk was noted at a low point in the embankment. No riverbank erosion was observed at this location; however, signs of erosion were noted on the ‘dry’ (northern) side of the embankment.

The surrounding floodplain topography appears to slope towards this point, indicating that flood water is likely to drain back into the channel over this part of the embankment, causing erosion to the bund. It is recommended that this section is strengthened and/or a culvert installed through the bund at this point to improve drainage and reduce the pressure to reduce the risk of breaching at this location.

*River Dulnain (Reach 3B)*

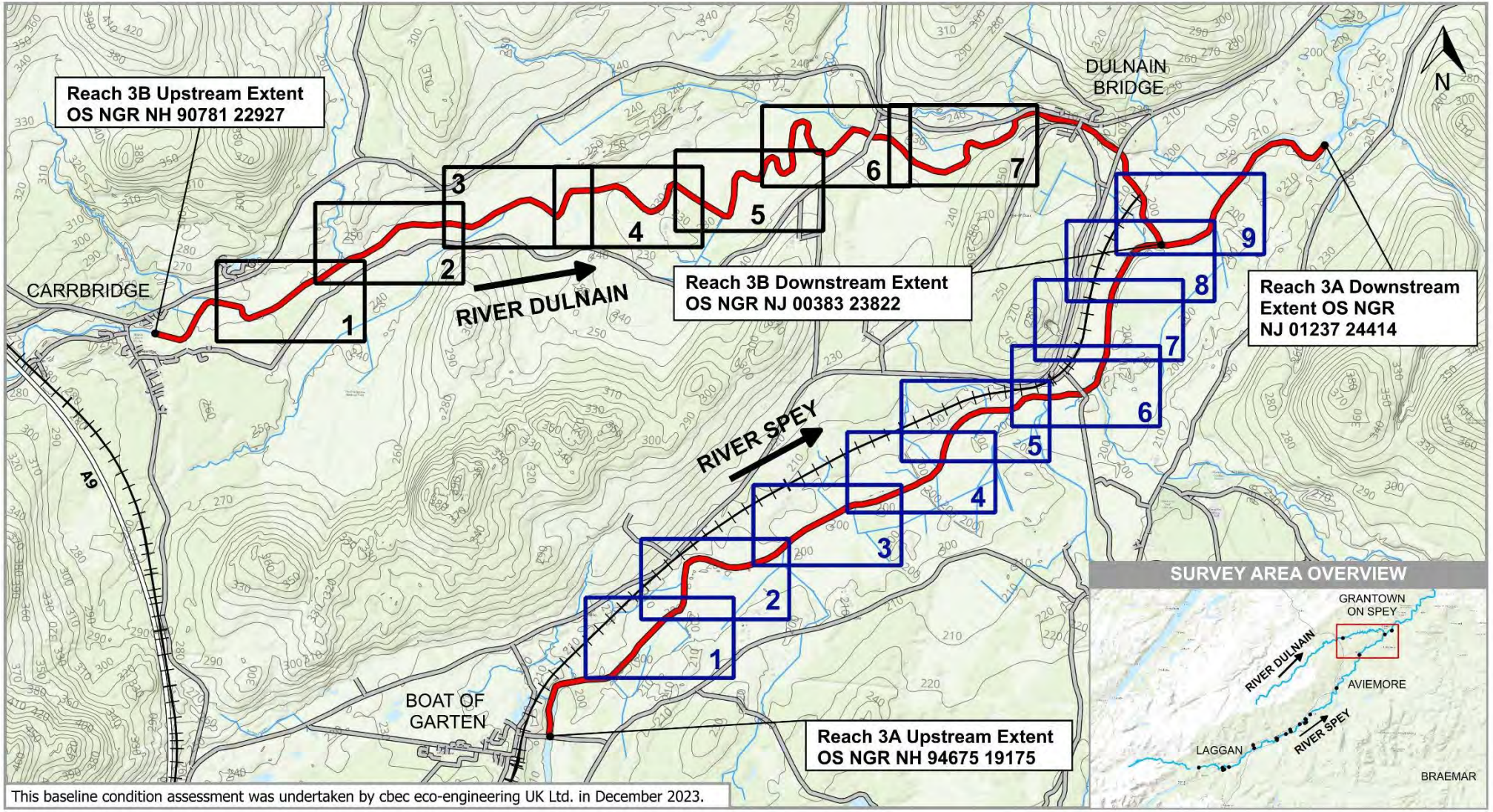
Information relating to embankment and riverbank condition in Reach 3B is presented in Figure 3.53 to Figure 3.59.

Low-severity bank erosion was noted infrequently on both banks between Carrbridge and Balnastraid Farm. Sporadic sections of low embankment breach risk were recorded throughout this upper section of the Dulnain survey extent as well as two short sections (<50 m) of moderate and high erosion risk observed on the river left bank within Balnastraid Farm. At Mullochard Farm, a~10 m wide embankment breach was recorded on the river right bank, just downstream of the Fèith Mhòr confluence with the Spey. The adjacent sections of embankment at this location were classified as high risk of breaching as this gap in the bund will act as a preferential flow route during flood events. Approximately ~200 m downstream of this breach on the opposite bank at Ballinlaggan Farm, a ~5 m long section of embankment breach is also present. These breach areas are recommended for remedial works to prevent further deterioration of the embankment but, overall, this upper section was deemed at low risk of embankment breaching due to the stable riverbanks and distance of the embankment from the riverbanks (more than 5 m on average).

At-risk areas are clustered around the meandering section of the River Dulnain between Easter Gallovie and Milton Farm. Clury and Mains of Tullochgribban farms, on either side of the watercourse at this point, present sections of moderate to high risk of embankment breach, particularly where the embankment is within ~5 m of the top of bank. Despite these moderate to high sections, the overall risk rating for this area is low, indicating that ongoing monitoring of the Dulnain embankment should be focused in this area to ensure that these low-risk areas to not deteriorate. It is also recommended that these farms are prioritised for remediation options to manage the moderate- to high-risk erosion areas.

Between Balnaan and Dulnain Bridge the embankment on the river right bank ends after the first field, whilst the left-side embankment continues to almost where the channel runs parallel with the A938 on the approach to Dulnain Bridge. The embankments within this lower section of the Dulnain are less than 0.5 m high on average and therefore are deemed to be at low risk of embankment breach. Three short sections (less than 50 m) of moderate breach risk, on the river left with Balnaan Farm, were recorded where the embankment was within 5 m of the top of bank and the bank face presented moderate risk of erosion, which may undermine the bund over time. Overall, this lower section of the Dulnain survey extent was categorised as low risk for bank face erosion and embankment breaching.

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - OVERVIEW OF RESULTS MAPS




**Condition Assessment**
Areas Surveyed:*
- Both Banks
- Not Surveyed (Tributaries)
- Not Surveyed (River Spey)

- Survey Extents

**Map Overview Boxes**
- 1 River Dulnain Map Location & Number
- 1 River Spey Map Location & Number

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines

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CLIENT CAIRNGORMS NATIONAL PARK AUTHORITY
PROJECT SPEY EMBANKMENT SURVEY

0 1 2 km

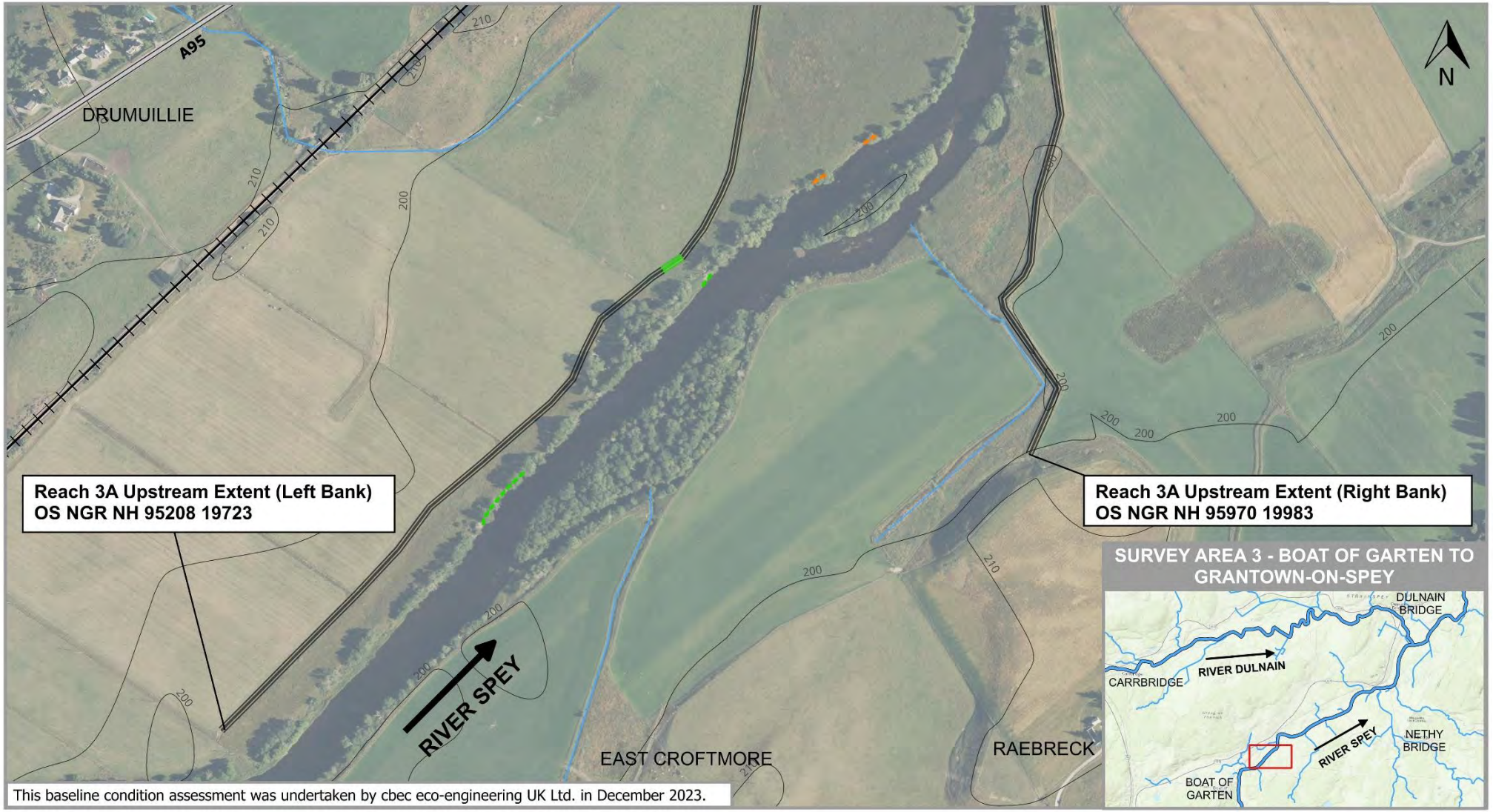
Project no. 2150556
Date 12 JAN 2024
Drawn OS
Surveyed GP & OS
Reviewed GP

Scale @ A4 - 50,000
British National Grid
GCS OSGB 1936



**Figure 3.43 Area 3 survey results overview map.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 1




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

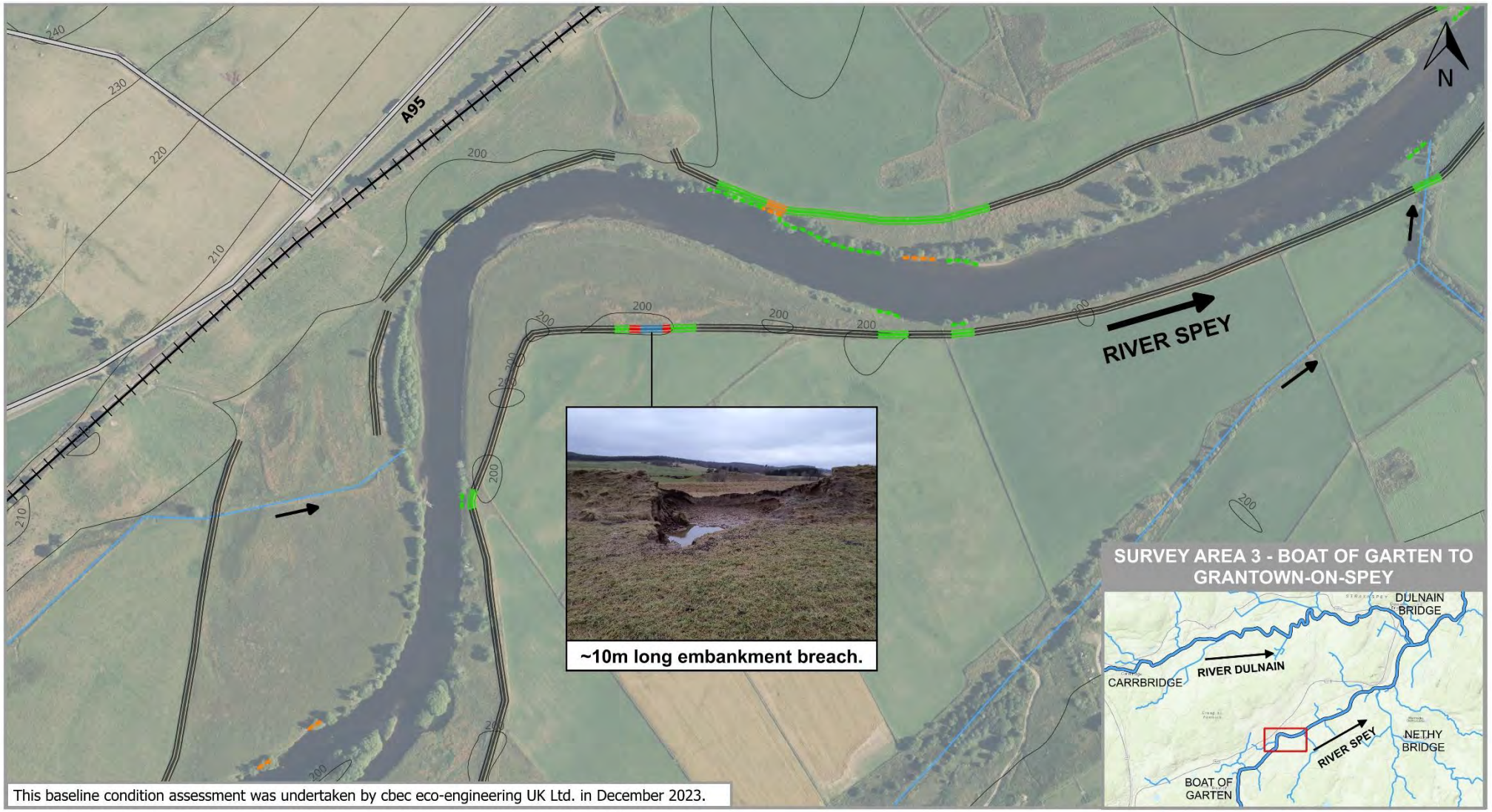
Project no. 2150556
Date 12 JAN 2024
Drawn OS
Surveyed GP & OS
Reviewed GP

Scale @ A4 - 5,000
British National Grid
GCS OSGB 1936

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.44 Area 3 – River Spey Map 1 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 2




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
Date 12 JAN 2024
Drawn OS
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Scale @ A4 - 5,000
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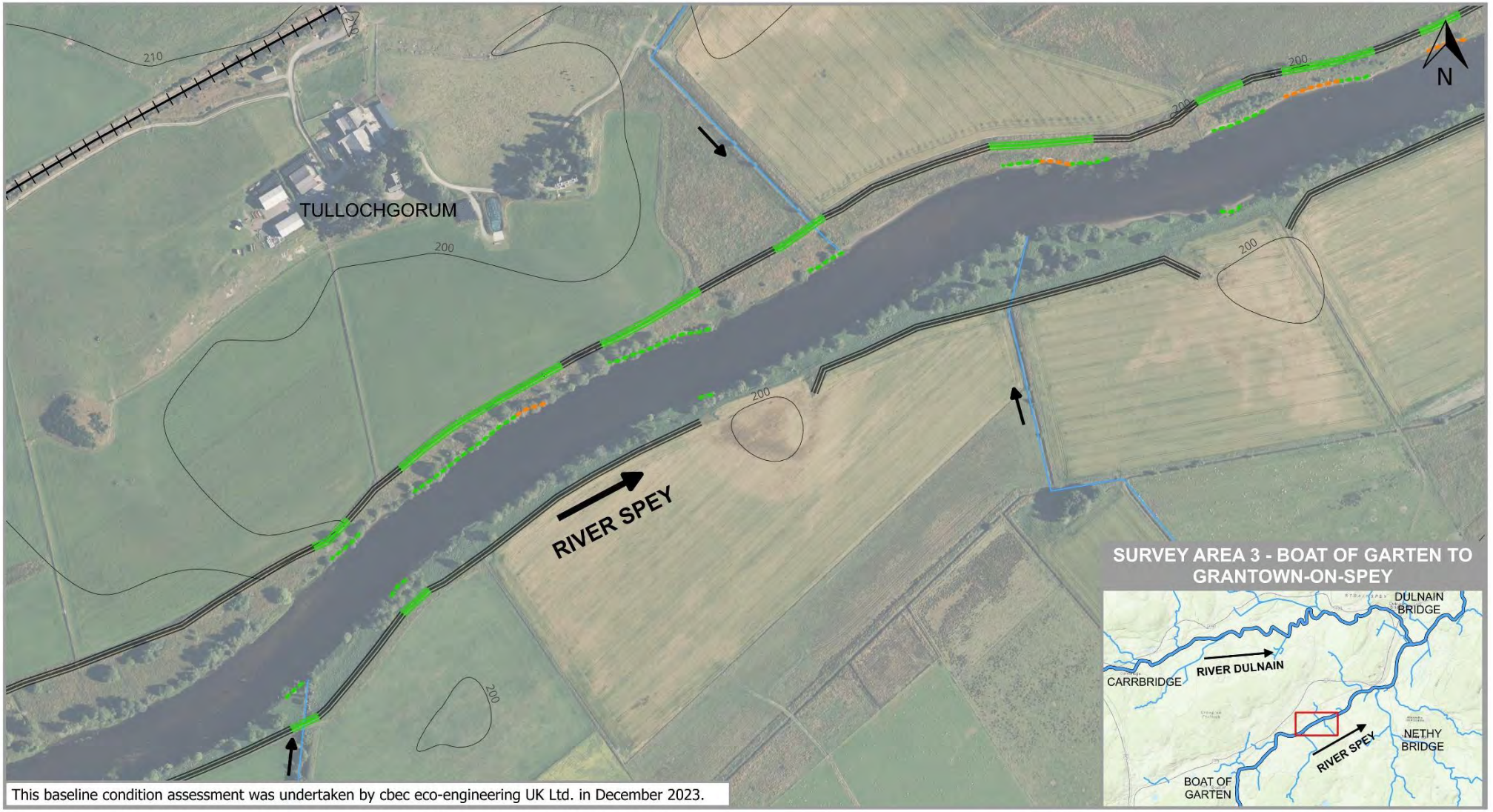
Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.45 Area 3 – River Spey Map 2 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 3




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
Date 12 JAN 2024
Drawn OS
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Scale @ A4 - 5,000
British National Grid
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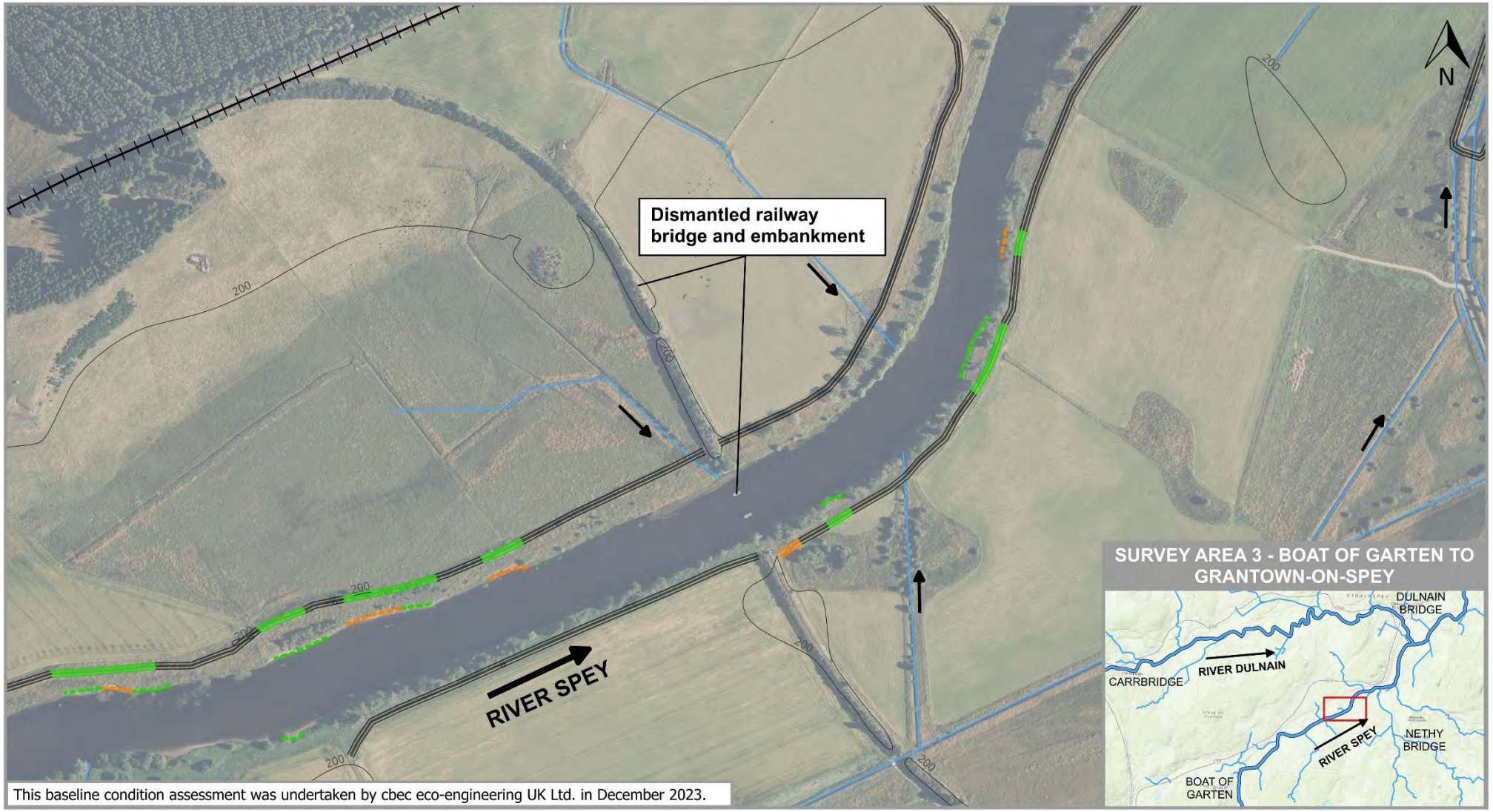
Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.46 Area 3 – River Spey Map 3 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 4




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

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British National Grid
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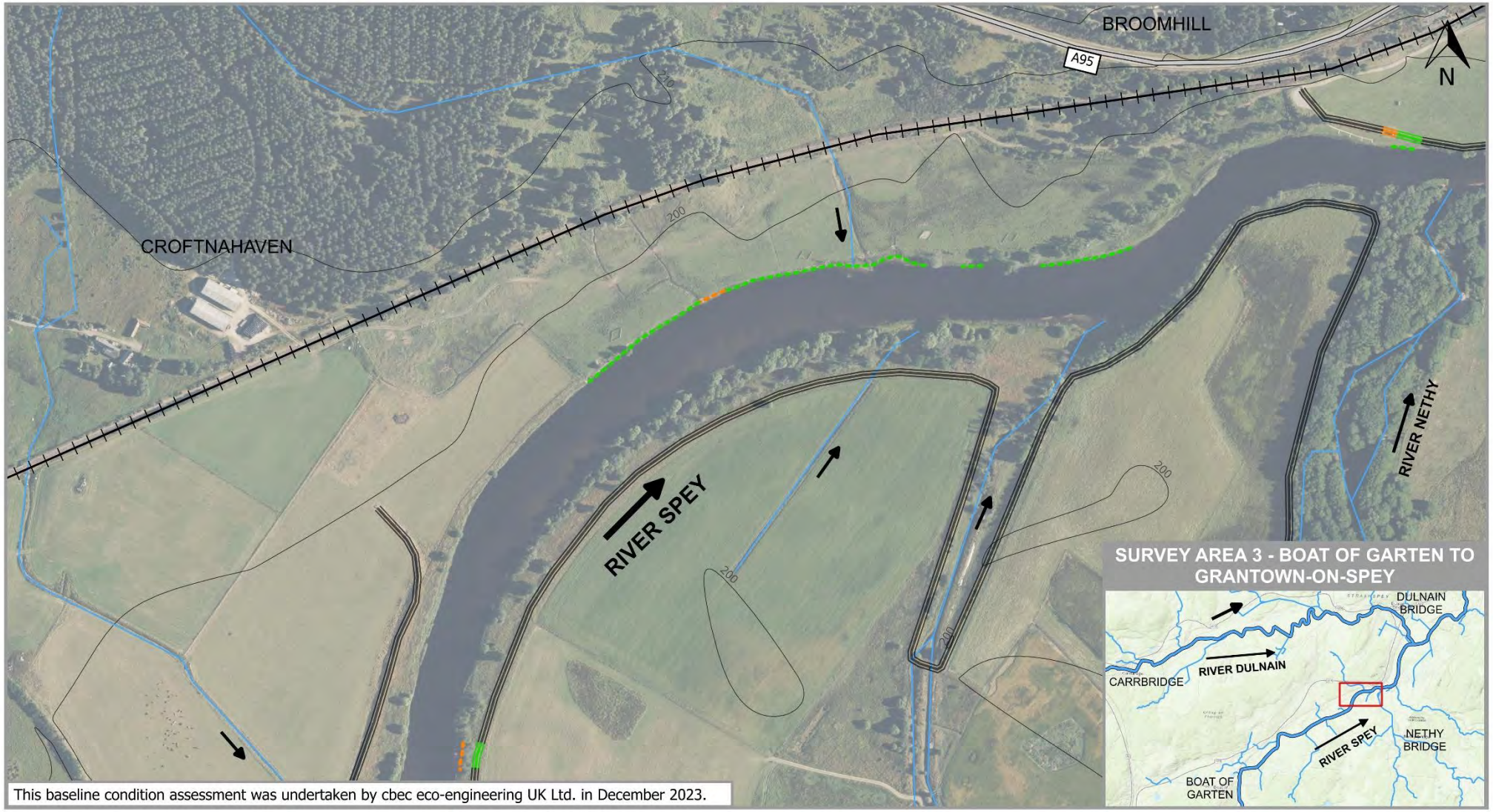
**Figure 3.47 Area 3 – River Spey Map 4 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 5




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
Date 12 JAN 2024
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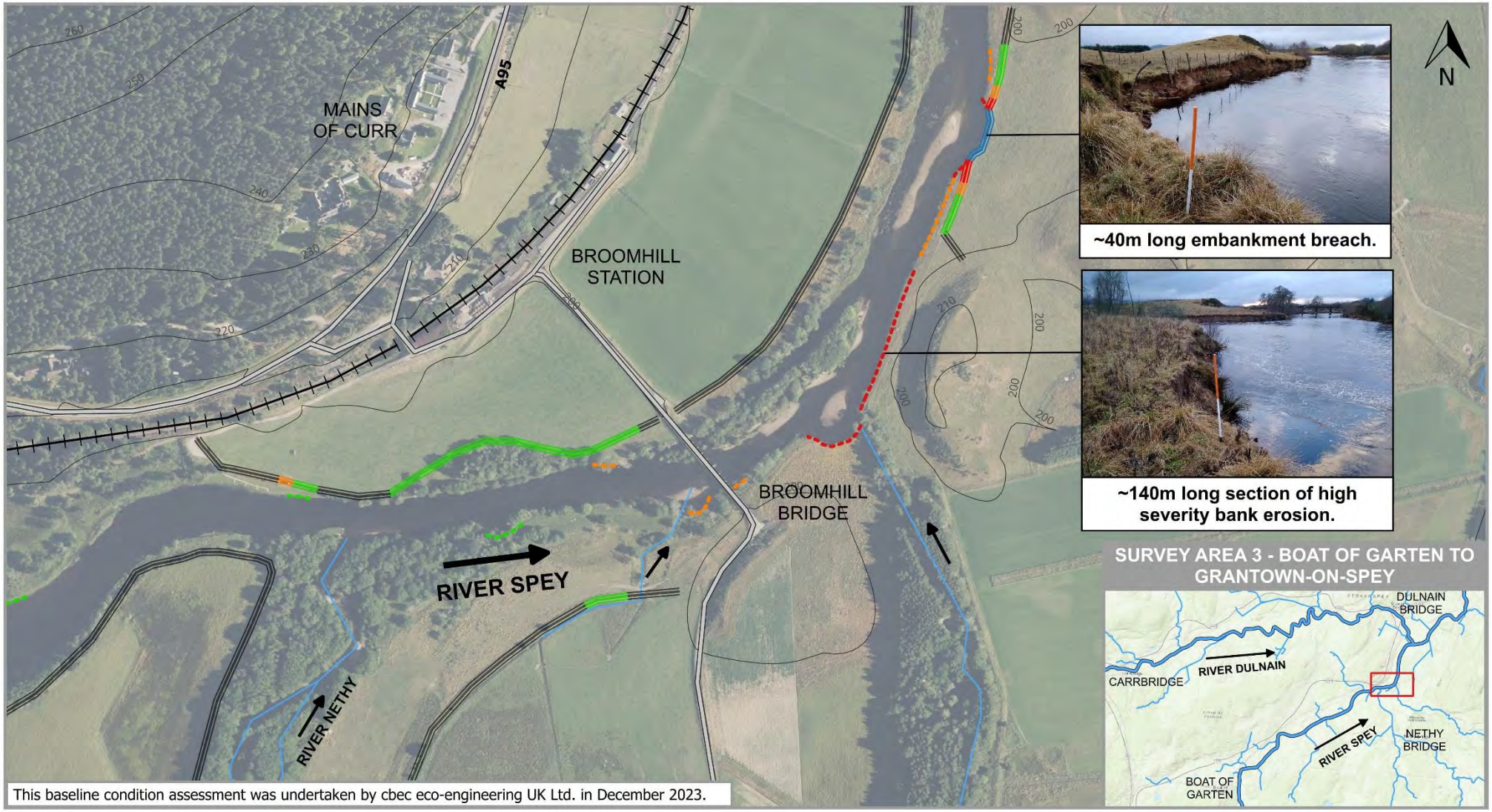
Reviewed GP

Scale @ A4 - 5,000
British National Grid
GCS OSGB 1936

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.48 Area 3 – River Spey Map 5 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 6




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
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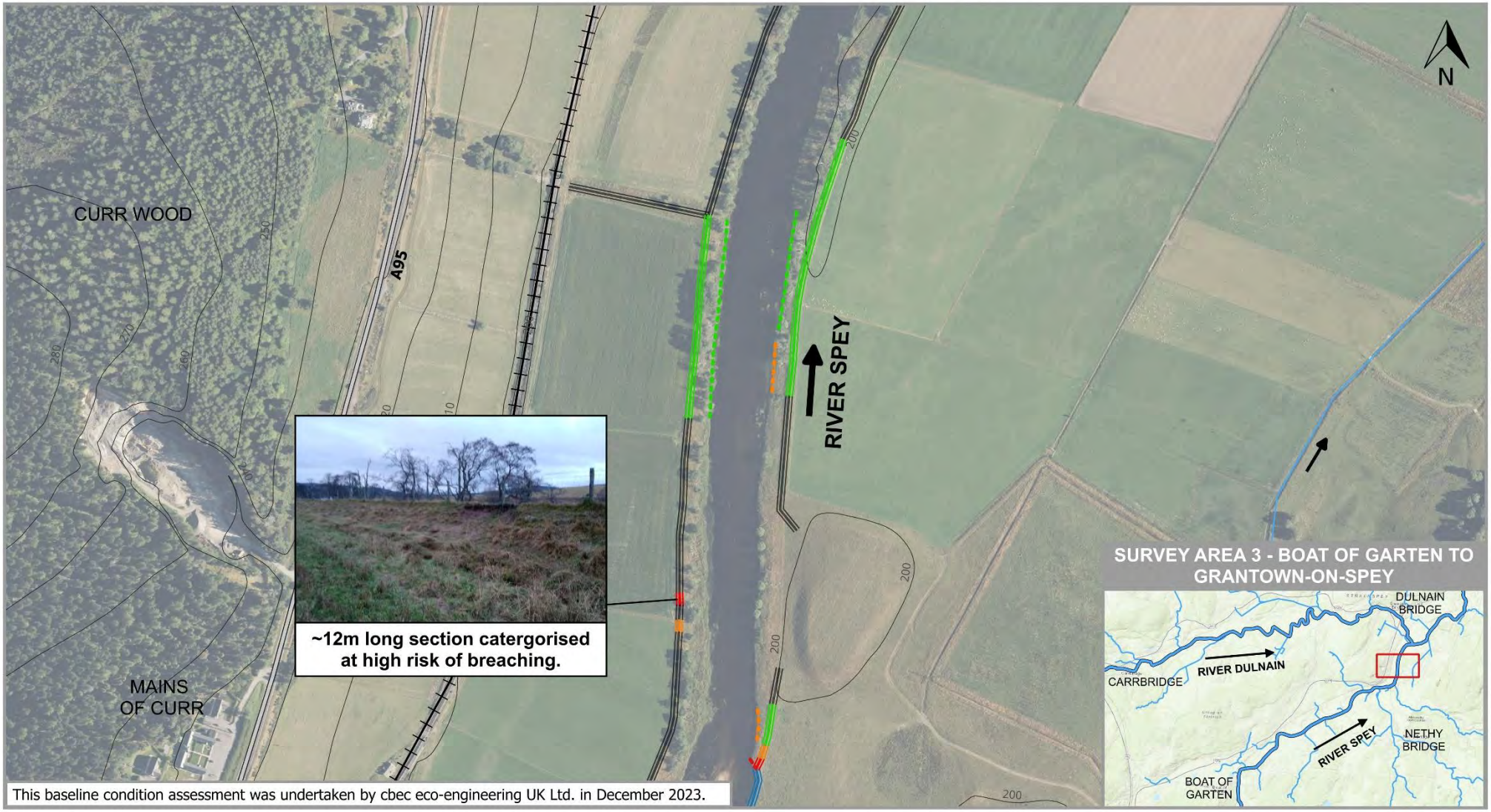
Reviewed GP

Scale @ A4 - 5,000
British National Grid
GCS OSGB 1936

Service Layer Credits: Main map and overview map sources - Service Layer Credits: Sources: Esri, HERE Garmin, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), © OpenStreetMap contributors, and the GIS User Community.

**Figure 3.49 Area 3 – River Spey Map 6 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 7




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

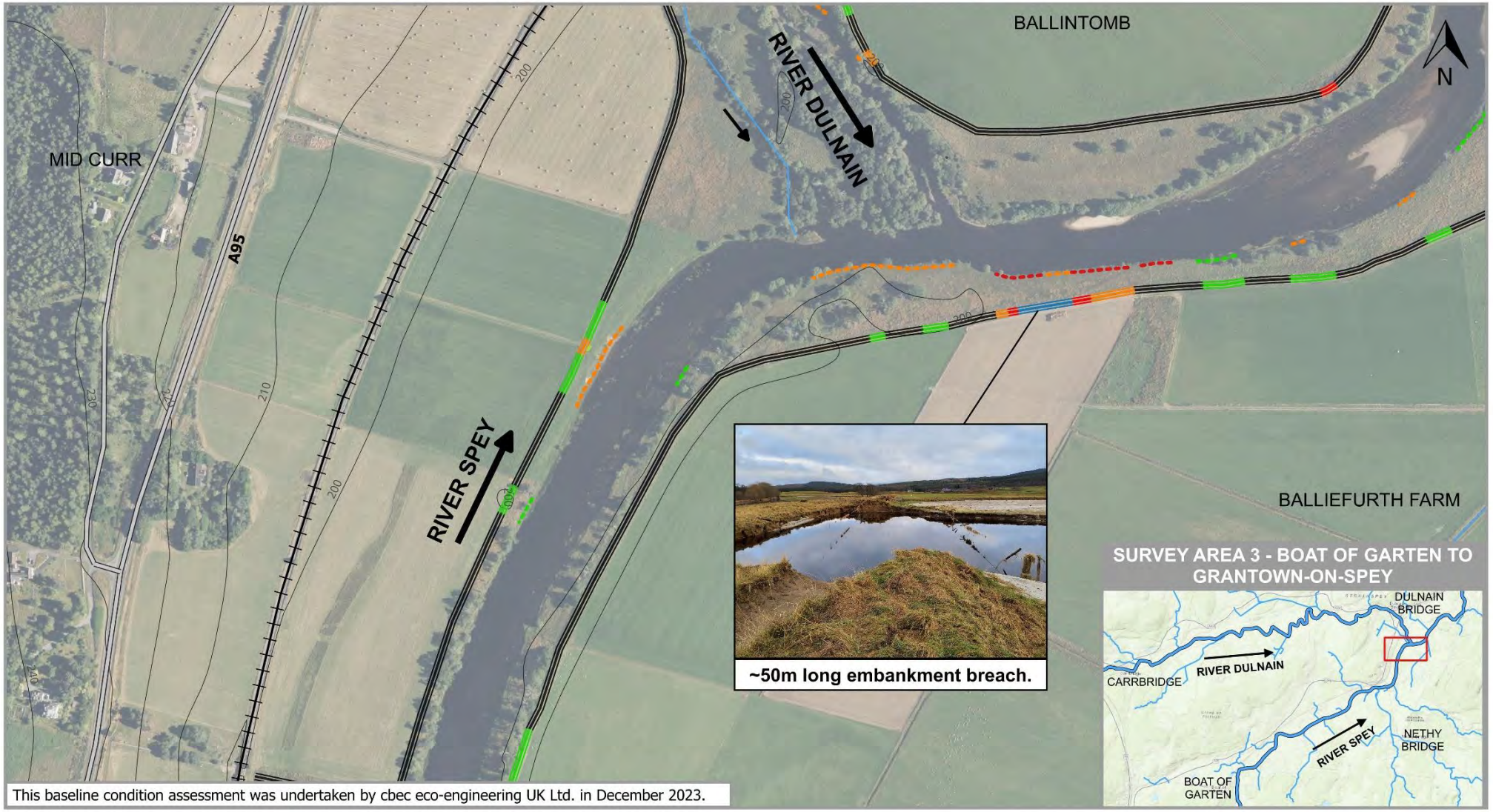
Project no. 2150556
Date 12 JAN 2024
Drawn OS
Surveyed GP & OS
Reviewed GP

Scale @ A4 - 5,000
British National Grid
GCS OSGB 1936



**Figure 3.50 Area 3 – River Spey Map 7 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 8




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
Date 12 JAN 2024
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Reviewed GP

Scale @ A4 - 5,000
British National Grid
GCS OSGB 1936

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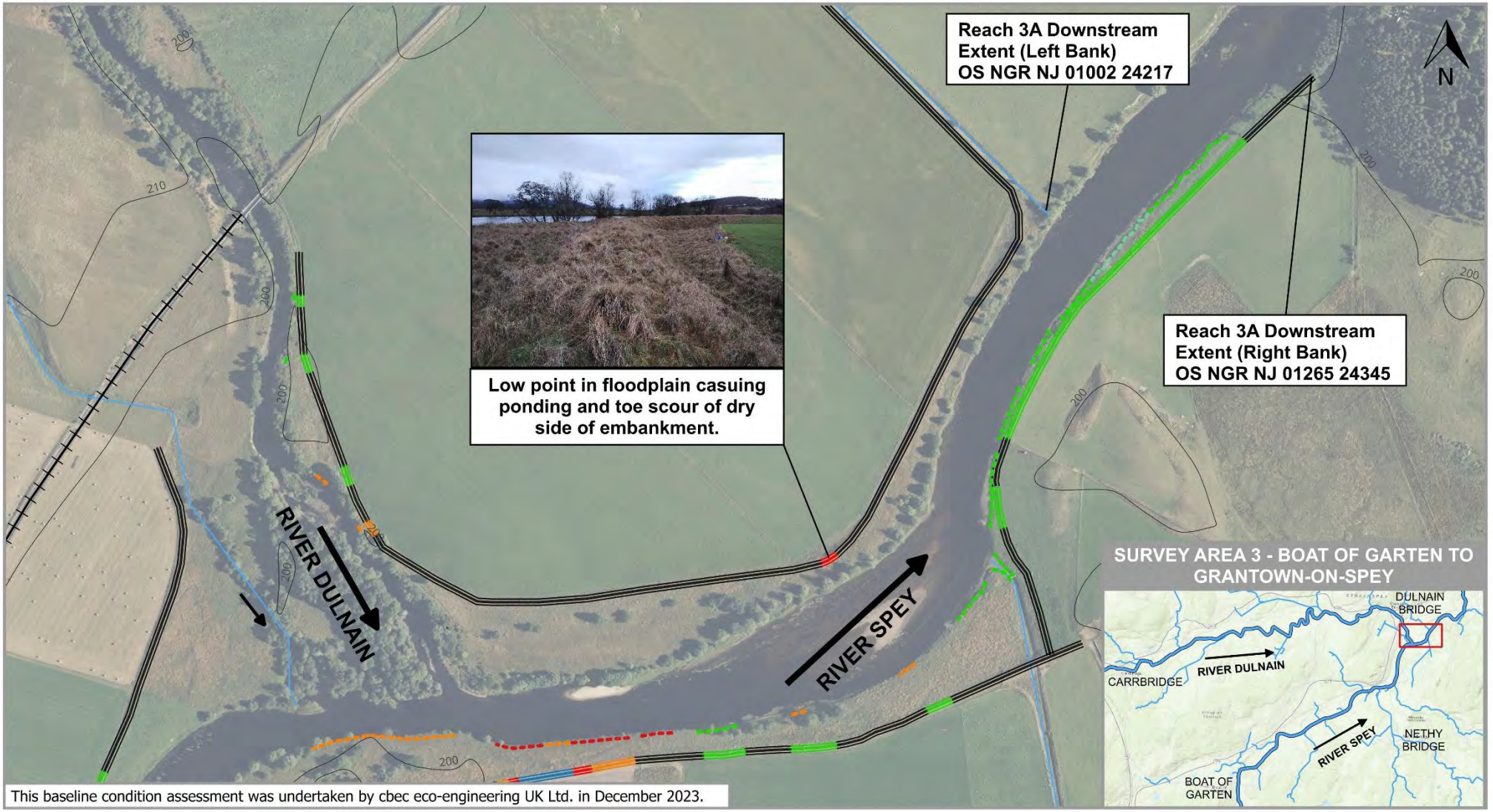
**Figure 3.51 Area 3 – River Spey Map 8 showing the baseline survey results for the River Spey (Reach 3A).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER SPEY - MAP 9




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

Project no. 2150556
Date 12 JAN 2024
Drawn OS
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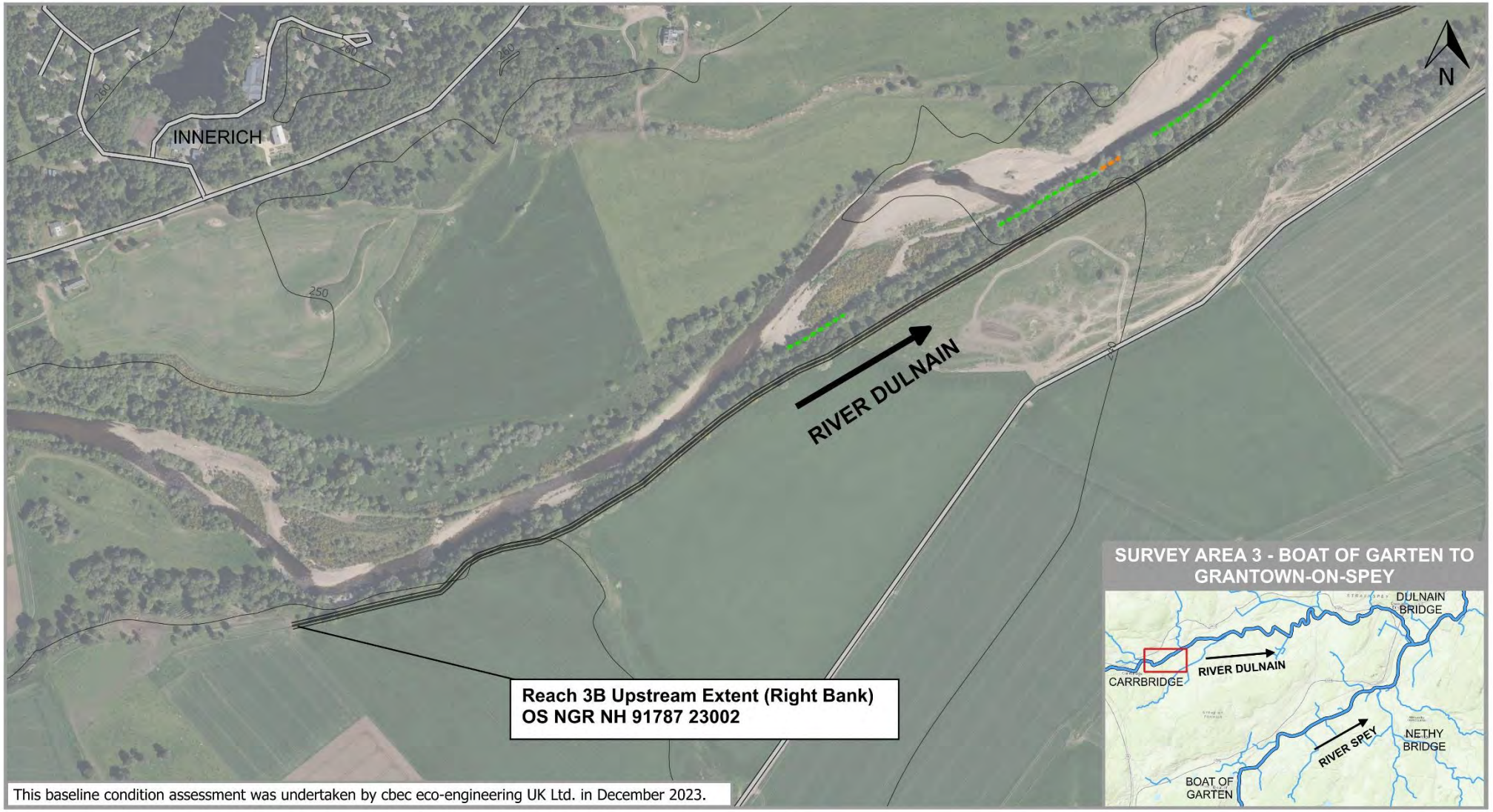
**Figure 3.52 Area 3 – River Spey Map 9 showing the baseline survey results for Reach 3A as well as the lower River Dulnain (Reach 3B).**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 1




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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PROJECT SPEY EMBANKMENT SURVEY

0 100 200 m

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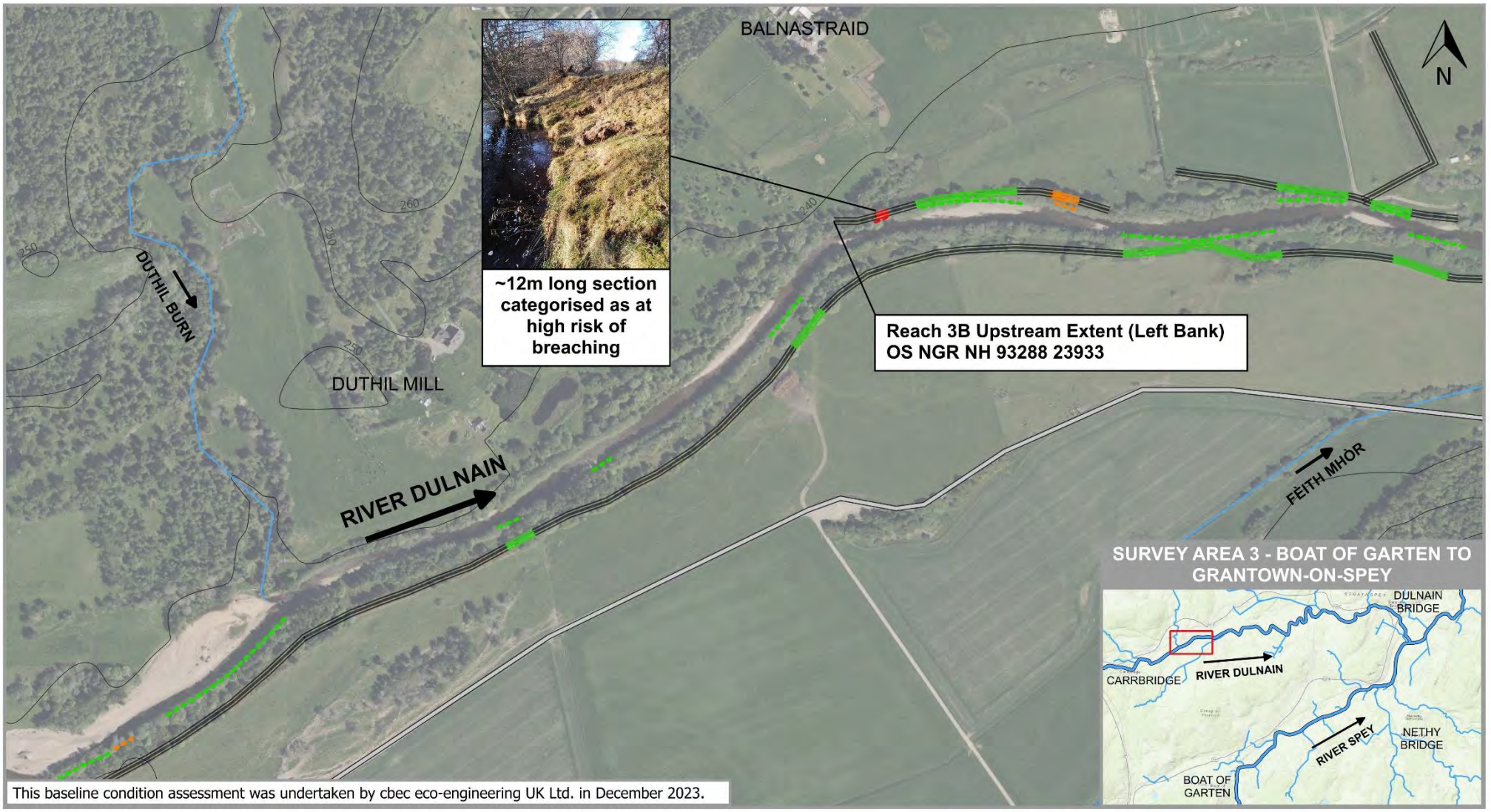
**Figure 3.53 Area 3 – River Dulnain Map 1 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 2




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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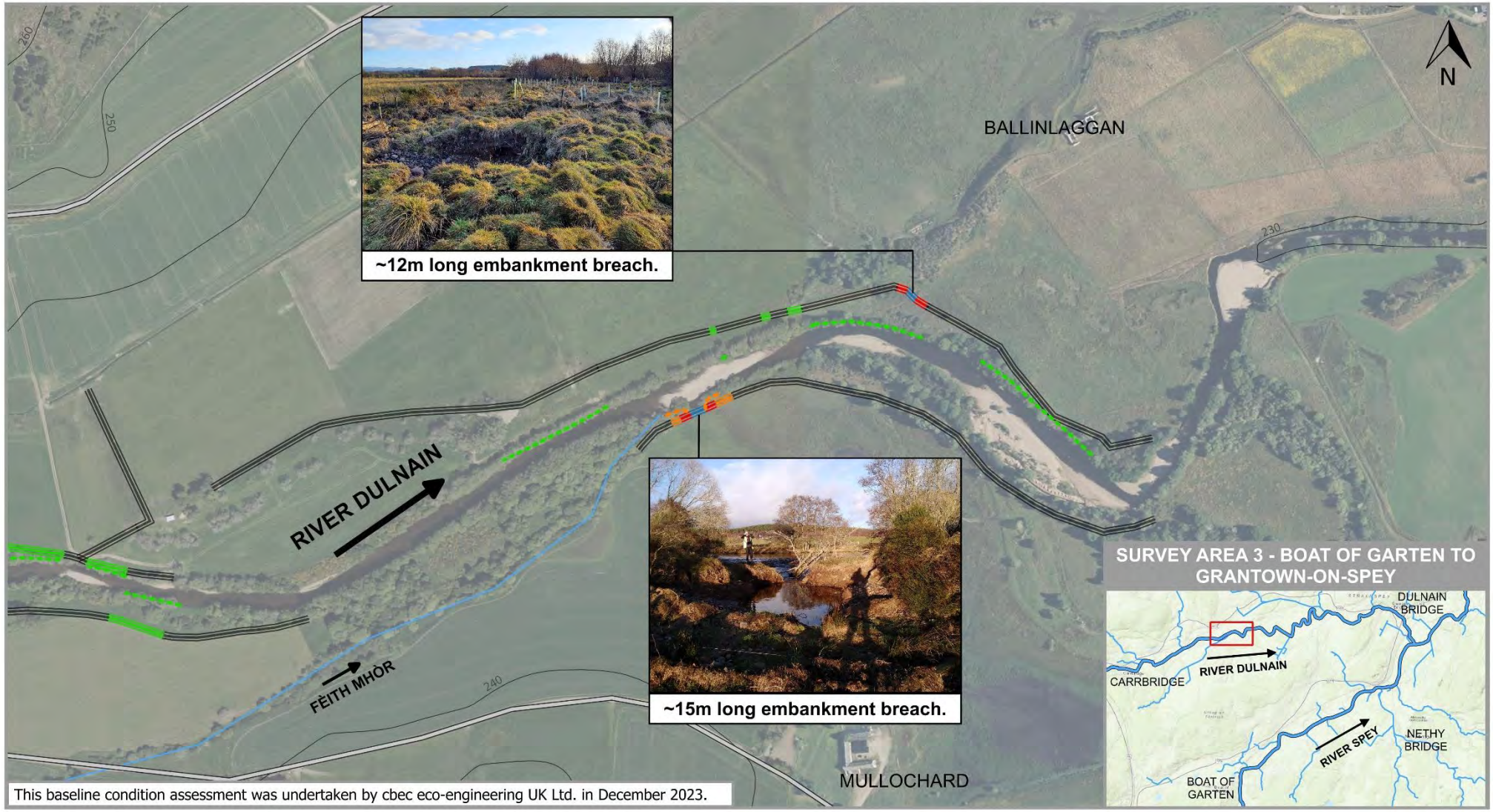
**Figure 3.54 Area 3 – River Dulnain Map 2 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 3




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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**Figure 3.55 Area 3 – River Dulnain Map 3 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 4


**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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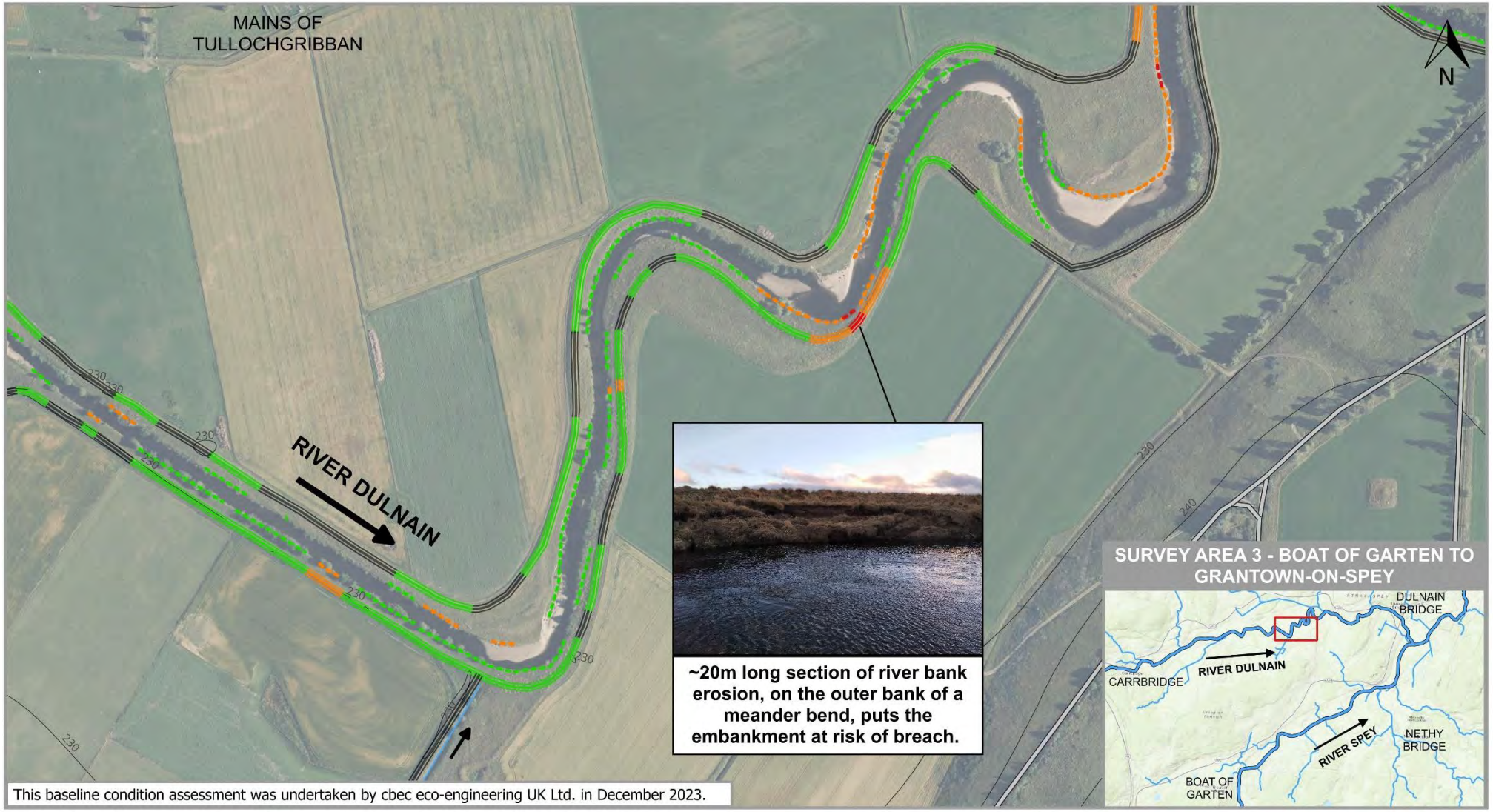
**Figure 3.56 Area 3 – River Dulnain Map 4 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 5




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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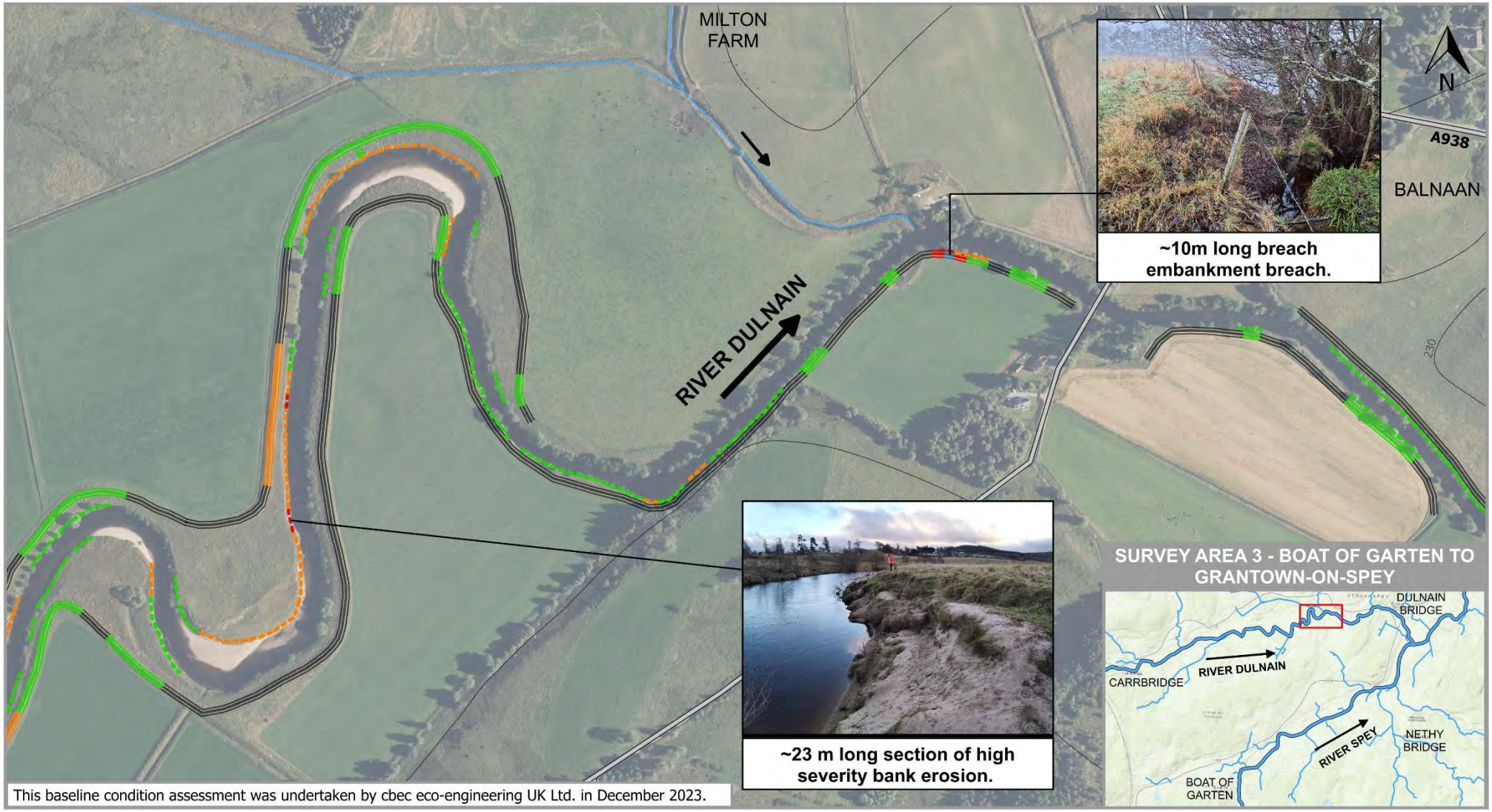
**Figure 3.57 Area 3 – River Dulnain Map 5 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 6




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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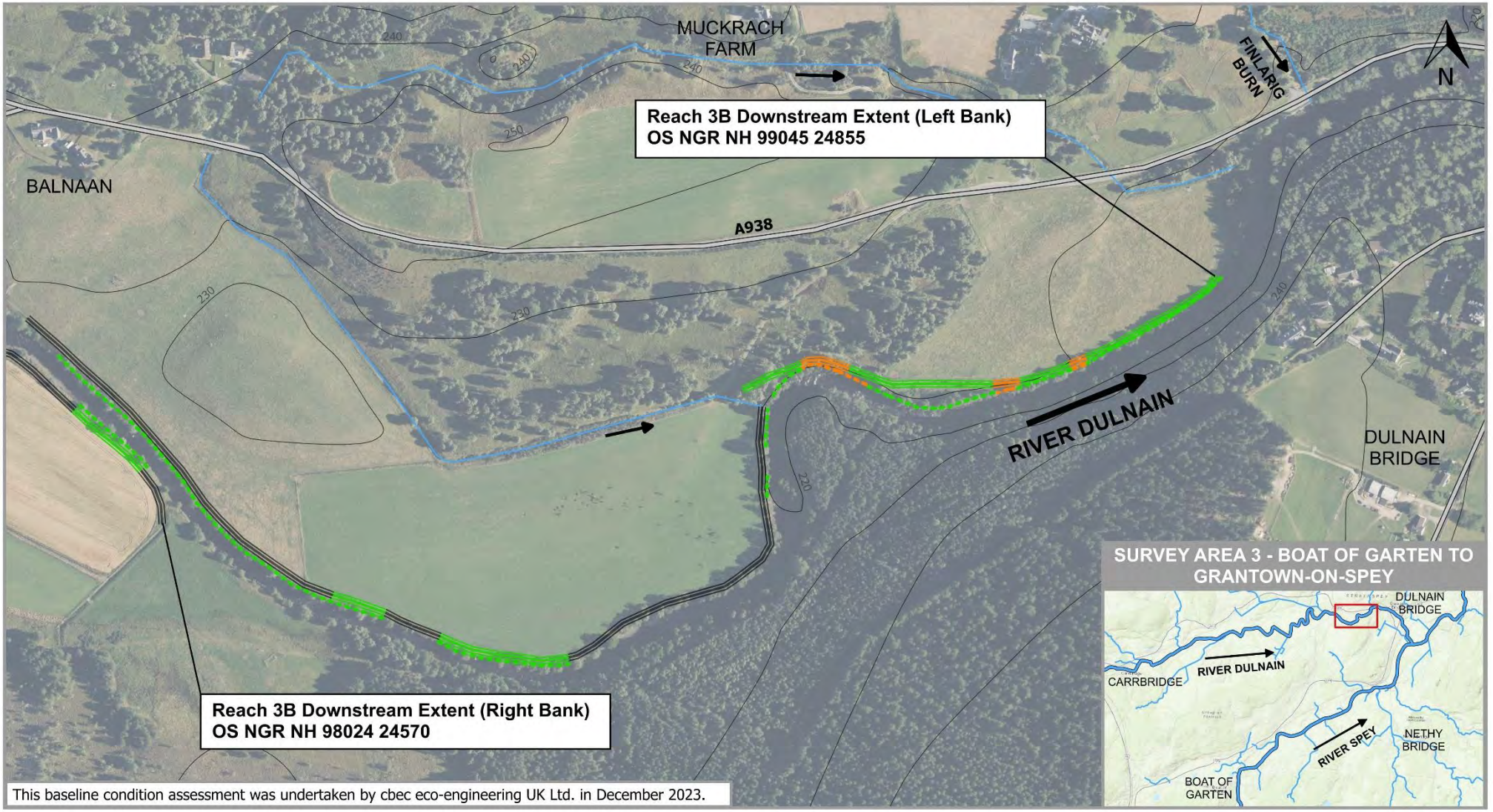
**Figure 3.58 Area 3 – River Dulnain Map 6 showing the baseline survey results for Reach 3B.**

# EMBANKMENT CONDITION ASSESSMENT - SURVEY AREA 3 - RIVER DULNAIN - MAP 7




**Condition Assessment**
- Survey Extents

Bank Face Erosion Severity:
- High
- Moderate
- Low

Embankment Breach Risk:
- Already Breached
- High
- Moderate
- Low
- No Risk Identified

**Other Features***
- A9
- Other Roads
- Railway Line
- 10m Contour Lines
- Tributaries & Field Drains

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**Figure 3.59 Area 3 – River Dulnain Map 7 showing the baseline survey results for Reach 3B.**

## 3.4 RECOMMENDATIONS

The following recommendations for embankment management have been identified as a result of the condition assessment.

- **Fencing** – Trampling by livestock was noted as the primary cause of embankment and riverbank erosion throughout Areas 1 and 2, where fencing was absent or discontinuous along the river corridor. It is noted that fencing along the river corridor is a substantial financial cost to landowners, and flood damage threatens the longevity and sustainability of these boundary lines. Recording the extent and condition of fence lines was not included within the scope of the walkover. However, it was observed that fences positioned on the dry side (i.e. furthest from the channel), directly behind the embankment were in better condition overall (Figure 3.60). This suggests that this positioning shelters the fence lines from the floodwater. Embankments and riverbanks separated from livestock by a continuous fence were found to be in good condition, with continuous vegetation cover and an absence of bare soil or damage/pitting to the ground surface. Therefore, it was concluded that the risk to embankments/riverbanks could be substantially reduced through improved fencing.

  Primarily, it is recommended that fences are installed along the river corridor if absent or set back to the dry side of the embankment if already present, to help reduce erosional pressure on the embankment in reaches with moderate and high breach risk/erosion severity. However, continuous fencing along the river corridor throughout the study areas would provide the greatest benefit for erosion and breach prevention. Livestock drinking stations may also need to be installed in combination with this fencing work if the river is currently used as a drinking point.

  The introduction of bank top and bank face vegetation, as well as fencing to protect the channel margins from livestock trampling, is necessary to facilitate the development of a more sustainable, long-term solution to bank erosion. These adjustments to existing land management practices would help to provide longer-term resilience against bank erosion and prevent further loss of valuable agricultural land as a result of this.
- **Remedial works** – High erosion risk or already breached locations should be prioritised for remedial works to prevent further deterioration or expansion of these sections. Remedial works could include formalisation of the existing breach for Natural Flood Management (NFM) benefit, as outlined in the point below, or reinstatement of the embankment to pre-breach conditions (which could include embankment face protection such as that observed along a ~25 m section of embankment near West Lodge; Figure 3.61). Remedial works may be essential in some locations to facilitate access or land management practices, such as the road through Blargie Estate (Figure 3.14). However, it is recommended that some existing breaches are formalised to facilitate temporary floodplain storage and deliver NFM benefits. Remedial works are noted to have already been carried out for a breach at Balliefuth Farm (Reach 3A) and to repair a section of eroding embankment surface at Tomachrochar, upstream of the dismantled railway embankment on the river right side of the Spey. For increased longevity of such remedial works, it is recommended that the surface vegetation of the embankment is removed as sheets of turf, the damage to the embankment infilled and compacted with an excavator bucket, before being re-turfed to ensure stability.
- **Natural Flood Management within the study area** – Two existing examples of how NFM could be implemented within the study site were noted during the condition assessment; (1) two

sections of the embankment have been lowered and reinforced with stone or concrete to form floodwater spillways at Breakachy Farm (Figure 3.18) and (2) a naturally formed embankment breach at Cluny Farm (Figure 3.20 and Figure 3.62). Anecdotal evidence suggested that the latter is thought to be providing flood alleviation benefits to neighbouring landowners, by enabling temporary floodplain storage within the field behind the breach.

This approach of localised embankment lowering or formalising existing breaching could be used in other locations to promote floodplain storage and control, to some degree, the flow pathways utilised by flood water during spate events. Once overtopped, flood water is retained behind the embankments, providing temporary storage of water and flood alleviation benefits downstream. This could benefit landowners by providing a degree of predictability to the movement of floodwater, for example, targeted breaches of the embankment could help constrain floodwater inundation patterns, enabling landowners/tenants to plan and move livestock and machinery, accordingly, thus reducing future flood damages while understanding that flooding cannot be mitigated completely.

Flood modelling would be required to identify the most beneficial locations and optimal lengths of spillway required to maximise the NFM benefits. During landowner liaison with Breakchy Farm it was noted that one spillway functions more effectively than the other, highlighting the importance of hydraulic modelling to ensure the functionality and optimisation of these formalised breach points.

It is recognised that the majority of the study site is managed for agriculture, and NFM opportunities will only be appropriate in locations where land use allows. A NFM study of the site is therefore recommended, with landowner liaison central to this process, to identify patterns of flood water inundation and areas where temporary flood water storage may be amenable to current land management practices. As part of this study, existing breach points or high erosion risk areas could be considered for development into formalised floodplain storage areas to temporarily hold back and slow the movement of flood water downstream.

- **Natural Flood Management within the wider catchment** – As outlined within the introduction, climate change is expected to increase the frequency and magnitude of high and low flow events within river systems across the UK. For effective flood management within these changing conditions, management should consider measures in the wider catchment to slow the movement of water during flood events (high flow) and provide drought (low flows) resilience through increased upland storage (e.g. wetlands). It is recommended that an NFM study is undertaken for the upper Spey catchment to identify opportunities which may provide a flood risk benefit to the study site and areas further downstream. This may include wetland and/or peatland restoration to increase upland storage of water and native tree planting to intercept rainfall and surface water run-off. Implementation of such measures is dependent on site- and catchment-specific details as well as landowner interest.
- **Culverts with flap valves** – Consideration could be given to the installation of flap valves/culverts within the embankment to improve the drainage of flood water back to the channel, particularly around high-breach-risk locations. Tullochgorum Farm's (Study Area 3; surveyed in 2023) embankment was constructed with a series of drainage channels and associated flap valves/culverts within the embankment, enabling surface water to recede back to the Spey following flood events and helping to maintain the stability of the embankment. During the 2024 survey, culverts were only noted within the embankment on Drumgask Farm (Survey Area 1; Figure 3.16). Erosion around the culvert inlets indicates that the pipes may be

undersized for the volume of water received (Figure 3.63). Riverbank erosion at the outlet could be reduced by tapering the bank line away from the outlet or extending the pipe to discharge into the River Spey at the bank toe, rather than set back into the bank (Figure 3.64).

- **Vegetation management** – Influence of vegetation cover on the stability of an embankment is dependent on the species, age, distribution and diversity of plants present. These factors vary throughout the study area. Depending on the vegetation assemblage present one of the following management measures could be undertaken.
    - Planting – Species rich, well established riparian vegetation (i.e., including grasses, scrub and trees) can help to stabilise the embankment, providing stability throughout the height of the bund due to the variety of root depths from the different species. A continuous coverage of vegetation is recommended to further promote stability and slow the movement of flood water over the embankment, reducing the erosional power of the water and potential damage to the embankment caused.
    - Vegetation clearance – occasional or sporadic tree or scrub plants can loosen the structure of the embankment, as the roots grow, leaving areas vulnerable to erosion by flood water (Figure 3.9 and Figure 3.10). These individual plants can be torn from the ground during flood events removing material from the embankment along with the roots. This risk can be mitigated against through clearance of these sporadic plants, or planting, as outline above, to provide continuous coverage and stability.

  In several areas, mature trees were noted along the embankment, for example on the river right (eastern) bank of the Spey from Doune Farm downstream to the pond by Corrour House (Reach 2G; Figure 3.65). Livestock sheltering around these trees has led to degradation of the embankment condition and crest height. Further degradation could be mitigated against by the erection of a fence line between the fields and river corridor within this area, as outlined above. These locations were noted to be set back from the top of the bank and may thus be at lower risk of breaching from other factors such as river processes and beaver burrowing.
- **Monitoring** – Annual monitoring of the flood embankment and riverbank condition will be undertaken until 2028, to allow for comparison with the baseline studies (2023 to 2024). The next survey is scheduled for autumn 2025. Repeat surveys will target moderate- to high-risk areas primarily, with attention given to any areas of degradation highlighted by landowners since the previous survey. Any worsening of erosion-risk locations and/or additional breaches will be recorded, as well as changes to embankment/riverbank condition caused by future flood events, land management practices and/or biological factors such as mole hills and potential beaver burrowing. Target areas for the monitoring surveys will be discussed and agreed with CNPA, with input from the CCFC, as required.

## Recommendations

**Figure 3.60. Fencing positioned along the dry side (furthest from the channel) of embankments and river corridors to mitigate against trampling by livestock.**

**Figure 3.61 Example embankment breach remedial works. Large wood (trunks with root plates still attached) installed to protect the embankment face (OS NGR NH 88320 09028).**

**Figure 3.62. Lowering of the embankment crest to form a spillway (formalised embankment breach) at Breakachy Farm (OS NGR NN 64187 93793).**

**Figure 3.63 Culvert through the embankment with erosion around the inlet at Drumgask Farm (OS NGR NN 61927 94037).**

**Figure 3.64 Culvert with erosion around the outlet at Drumgask Farm (OS NGR NN 61927 94037).**

**Figure 3.65 Example of mature trees growing on the embankment and erosion caused by sheltering livestock.**

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