The use of GIS on large scale infrastructural projects in Ireland.

Excavation, post-excavation and publication.

Maurizio Toscano

Eachtra Archaeological Projects

Association of Archaeological Illustrators & Surveyors

6th September 2008 - University College Cork, Cork, Ireland

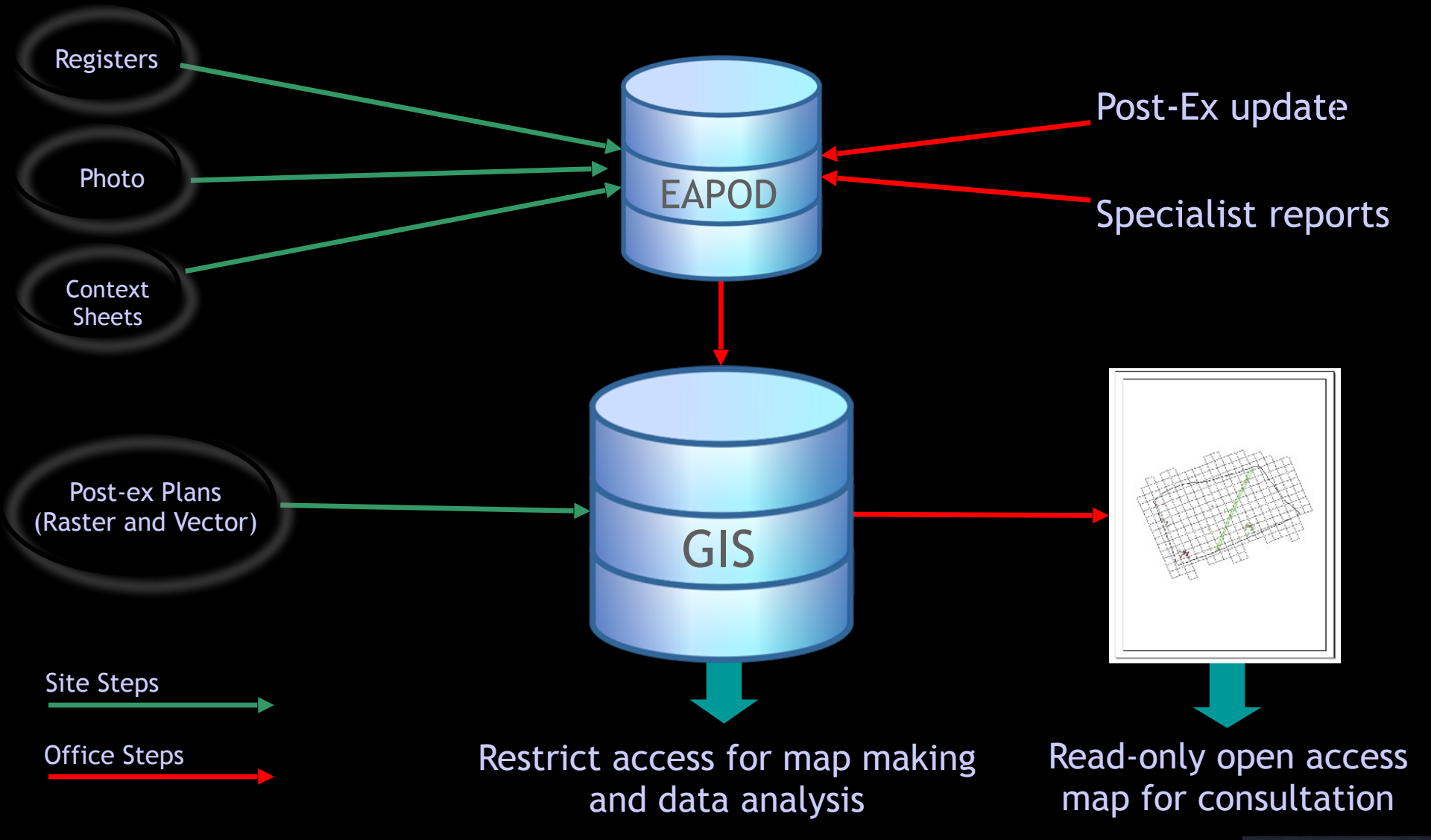
EAP GIS experience

- Eachtra started using GIS in September 2007
- 3 roads schemes involved – GIS implemented at different stages of the projects
- To date all projects still in progress

Roads projects involved

- N8 FM (29 sites): from the post-excavation phase (previously done in CAD/Excel)
- N7 CN (25 sites): from the middle of the excavation phase
- N18 OG (21 sites): from the beginning of the excavation phase

Eachtra Documentation System



Our purpose using GIS

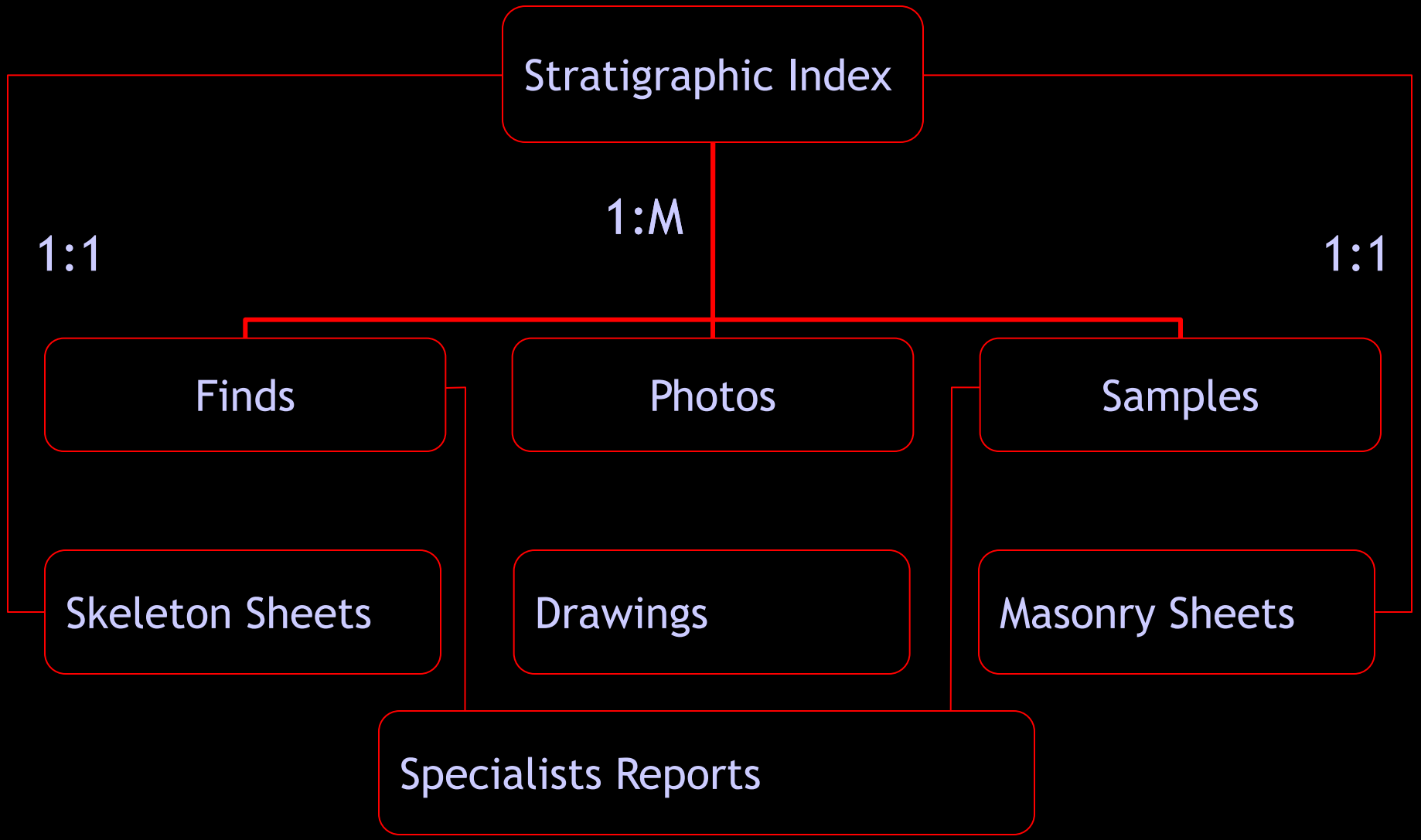
We have chosen to structure our platform based upon Arnoff's definition (1989):

a computer based system that provides four sets of capabilities to handle geo-referenced data:

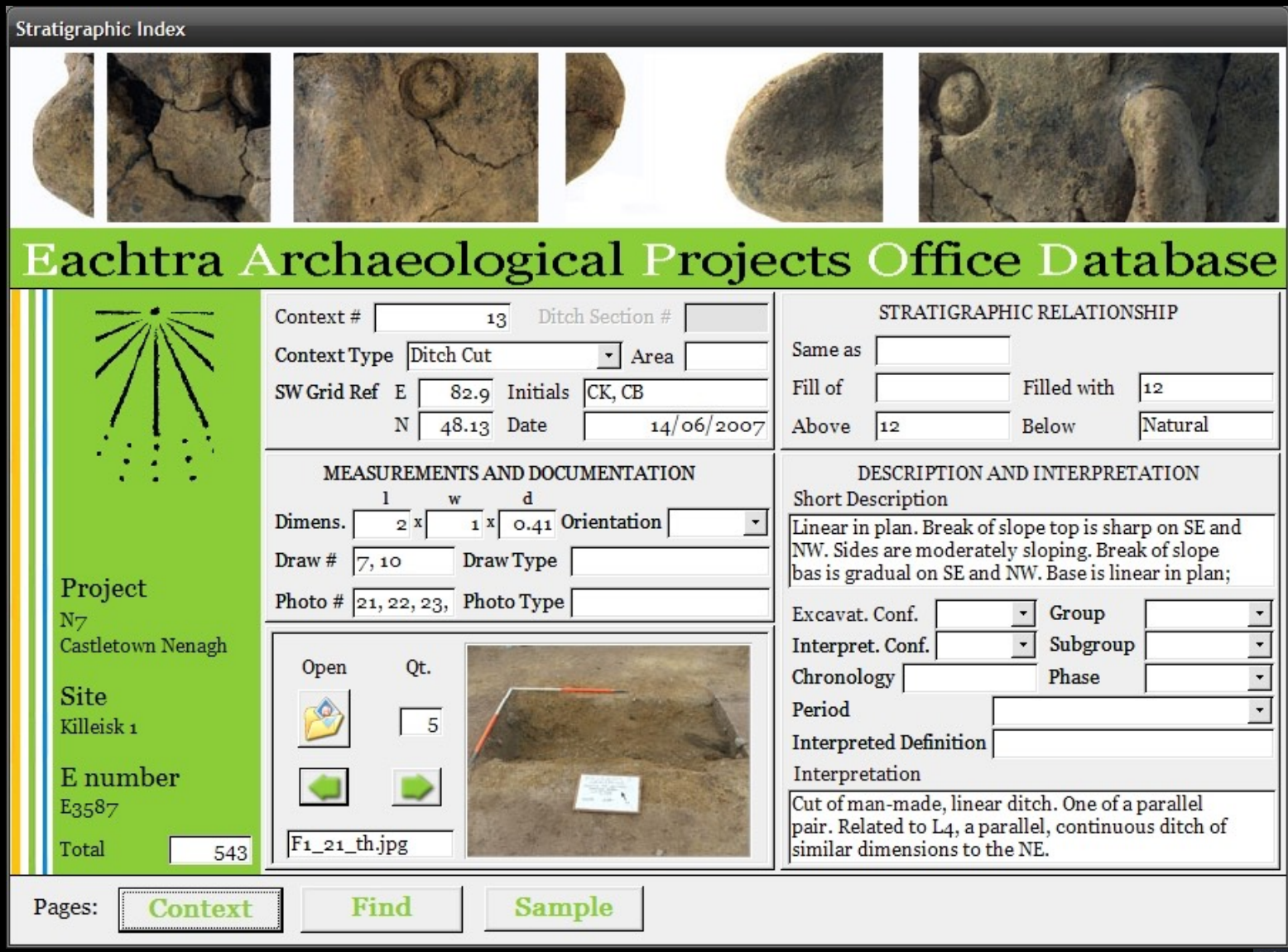
- *data management (data storage and retrieval)*
- *data input*
- *manipulation and analysis*
- *data output*

Data management

Database structure

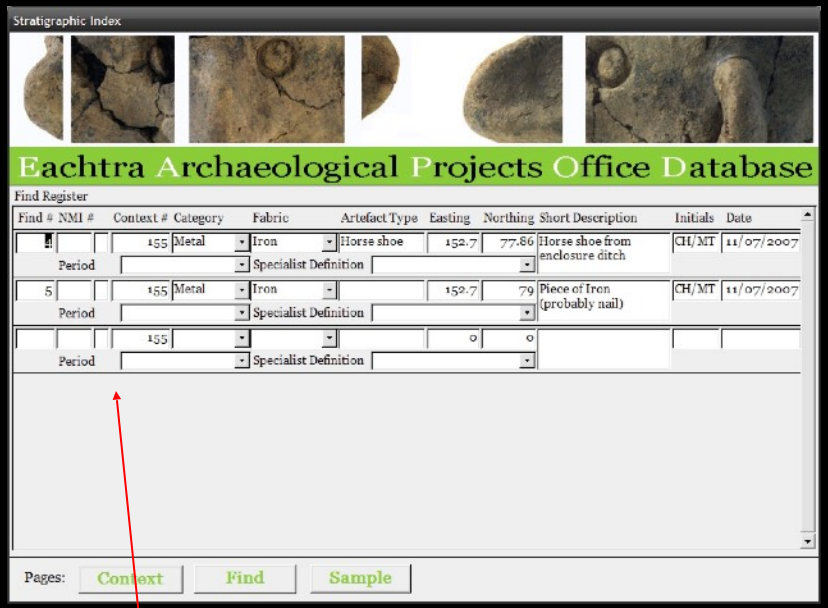


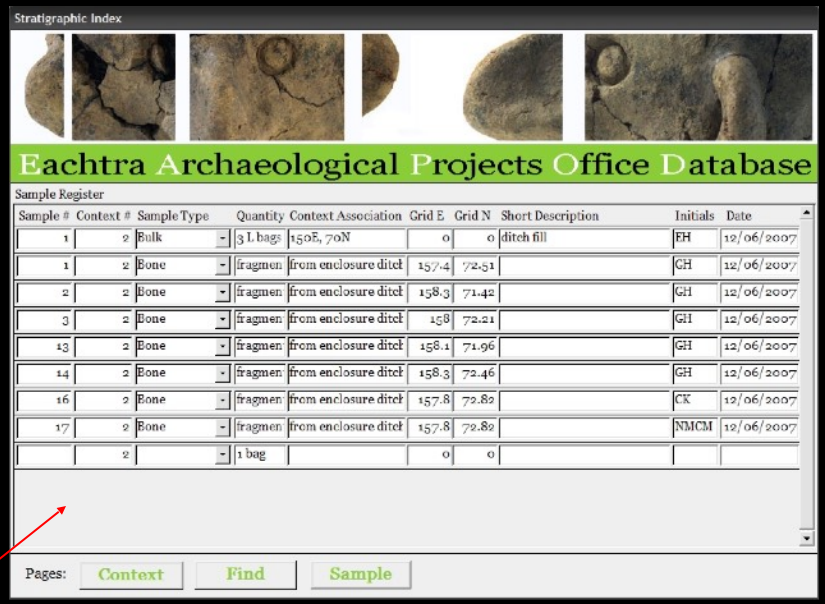
Eachtra Archaeological Projects Office Database

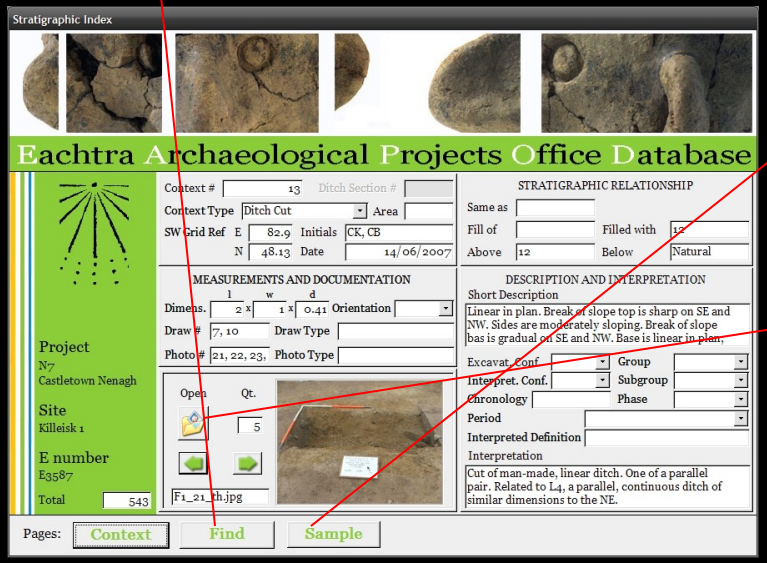


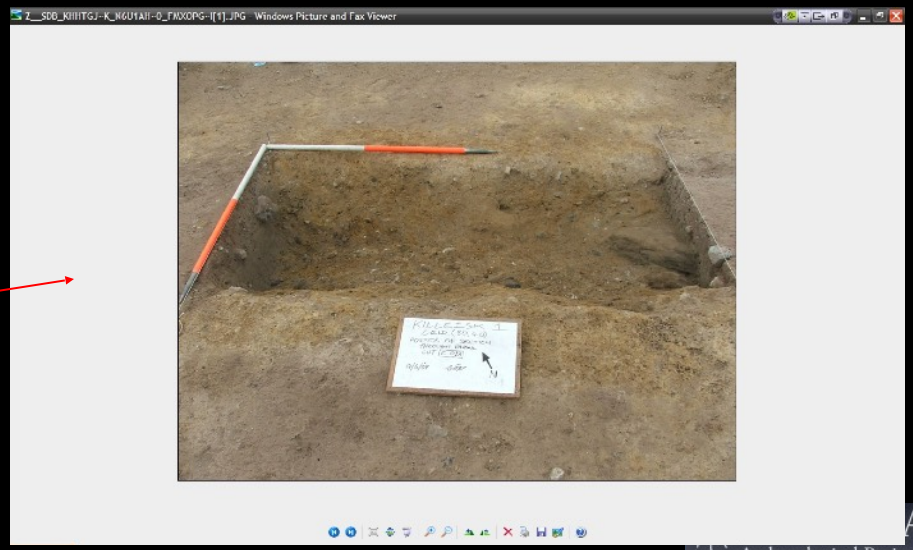
EACHTRA Archaeological Projects

Eachtra Archaeological Projects Office Database









GIS Data Model

Project → Excavation areas, CPO line, OS data, test trenches, chainage

Landscape → Contour, townlands, lake & rivers, RMP sites, roads

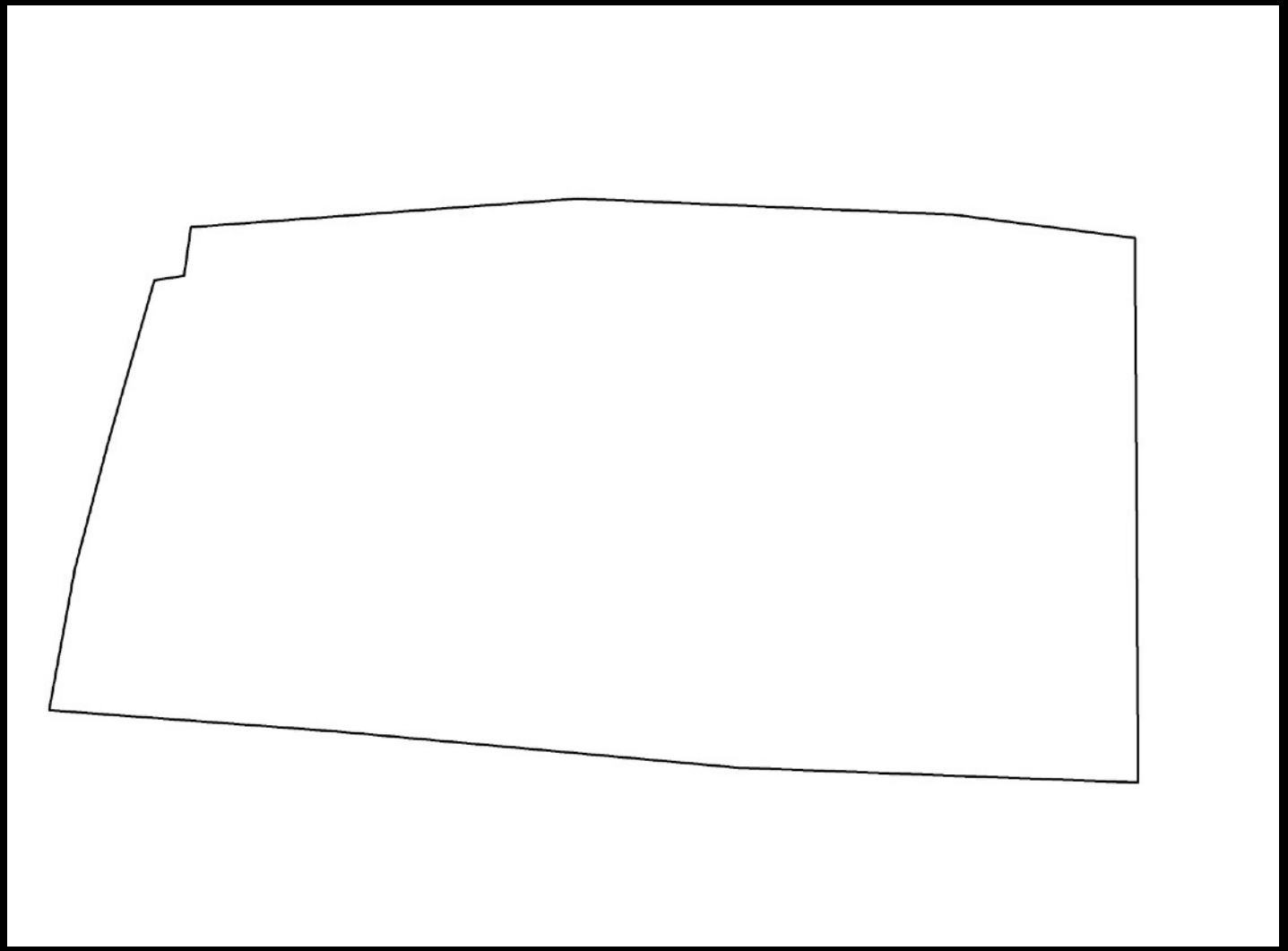
Graphics →
- Negative features (Cut, Furrow, N.A.)
- Positive features (Deposit, Wall, Timber)
- Characterization (Break of slope, stone)
- Section
- Site (Excavation area, grid)

Tables → Stratigraphic Index, Finds Register, Samples Register, Photo Register

Relationships →
- Features > Attributes
- Cuts > Fills
- Fills > Finds and Samples
- Features > Photos

Data input

Limit of excavation and local grid



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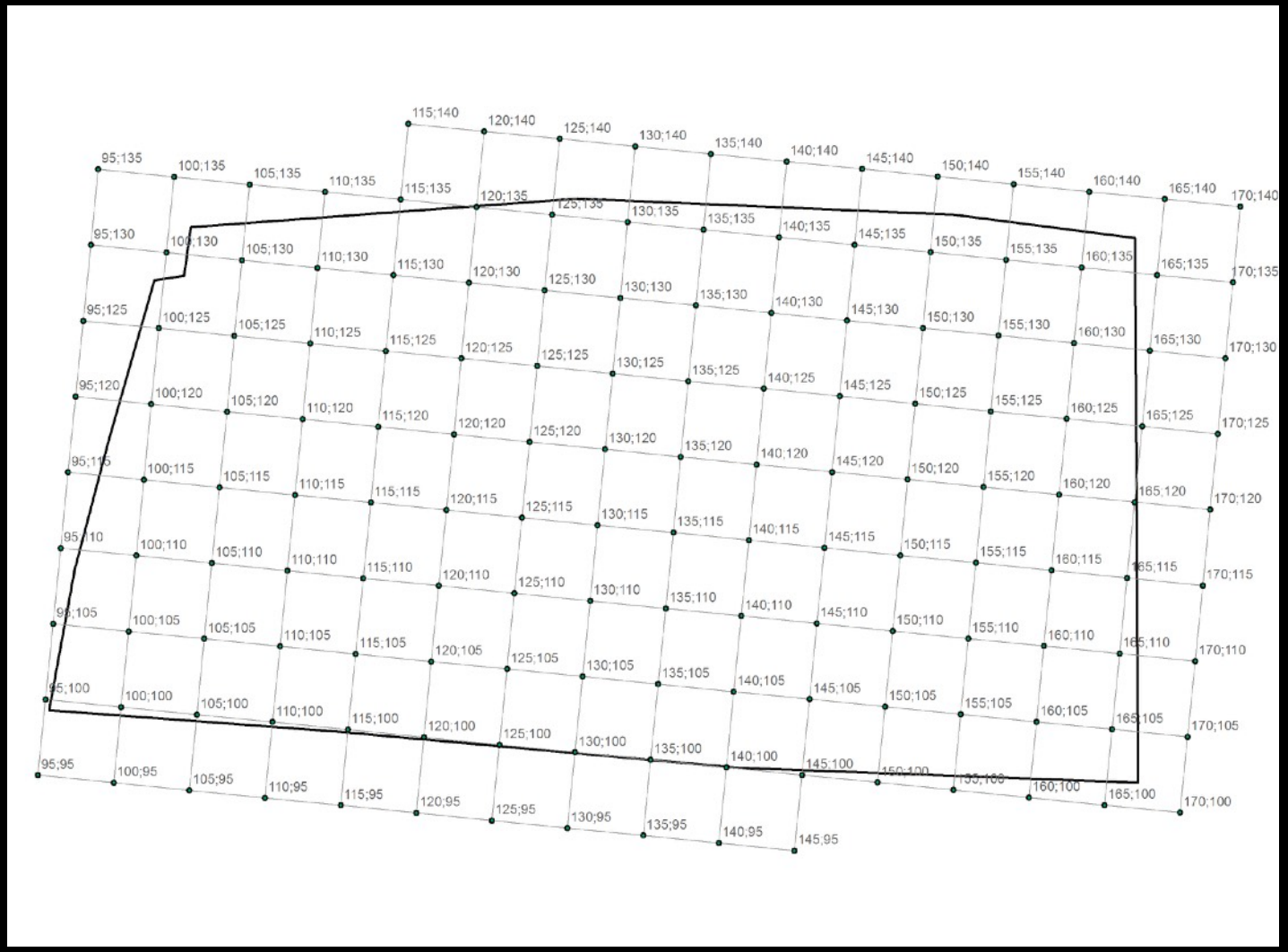
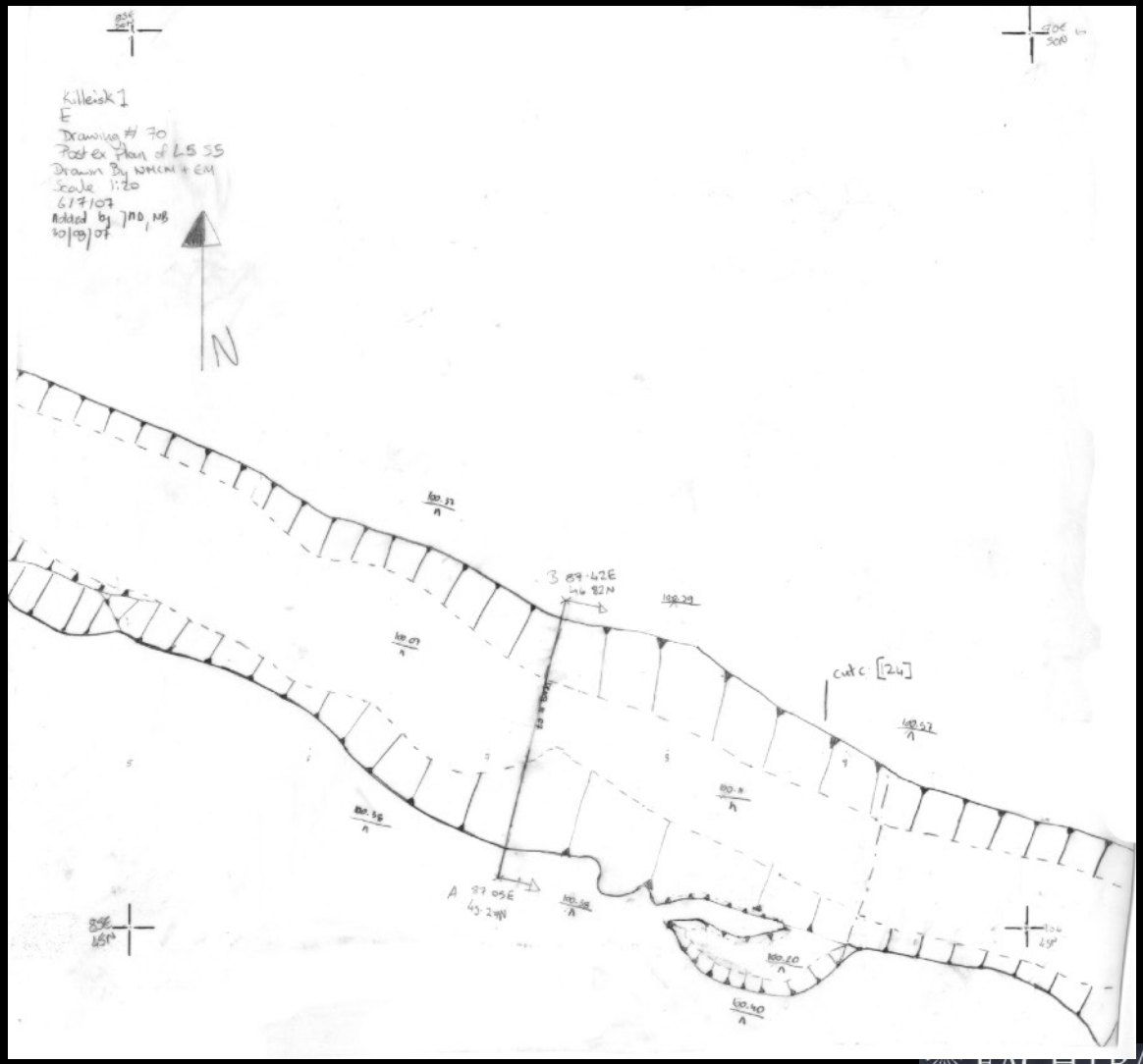


Permatrace plans

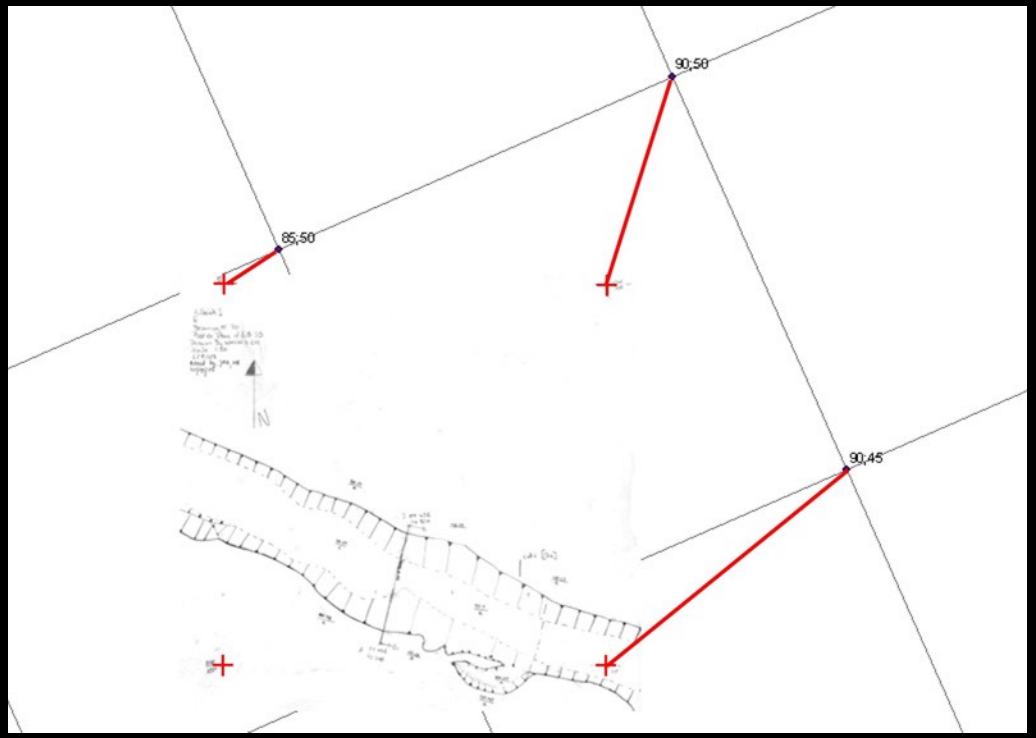
- Individual plans are drawn by grid square (5x5 m.);

- Each grid square plan is then scanned as a raster file.



Permatrace plans

Each grid square plan is then put into place by matching up the grid square points on the permatrace drawing to the corresponding grid square points on the GIS site plan.



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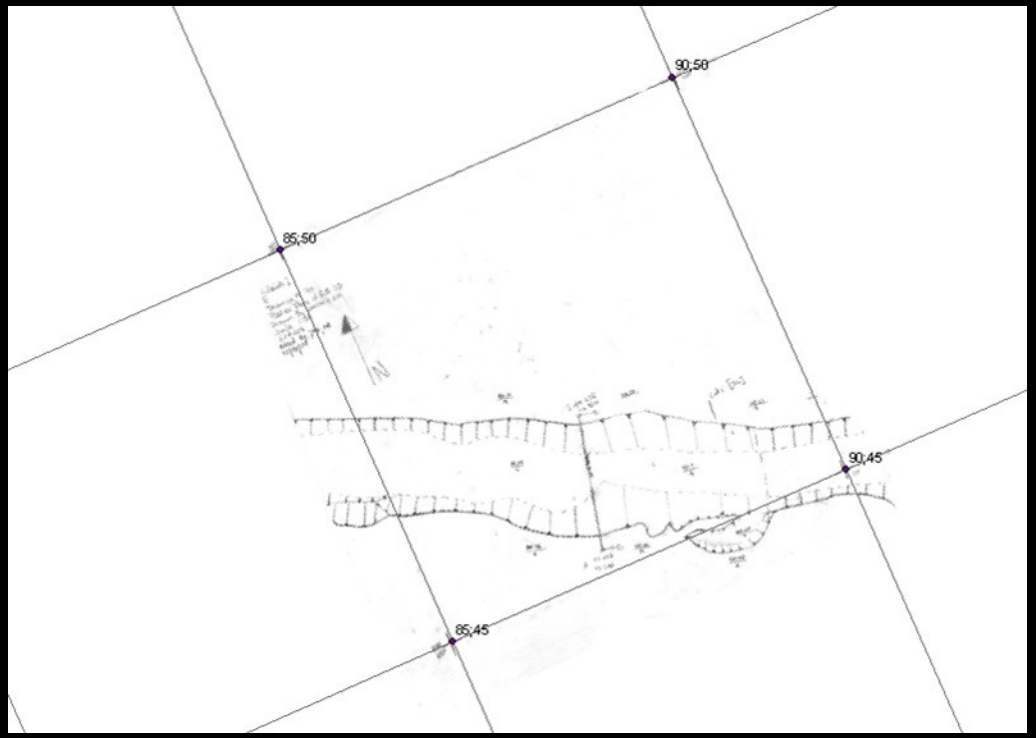

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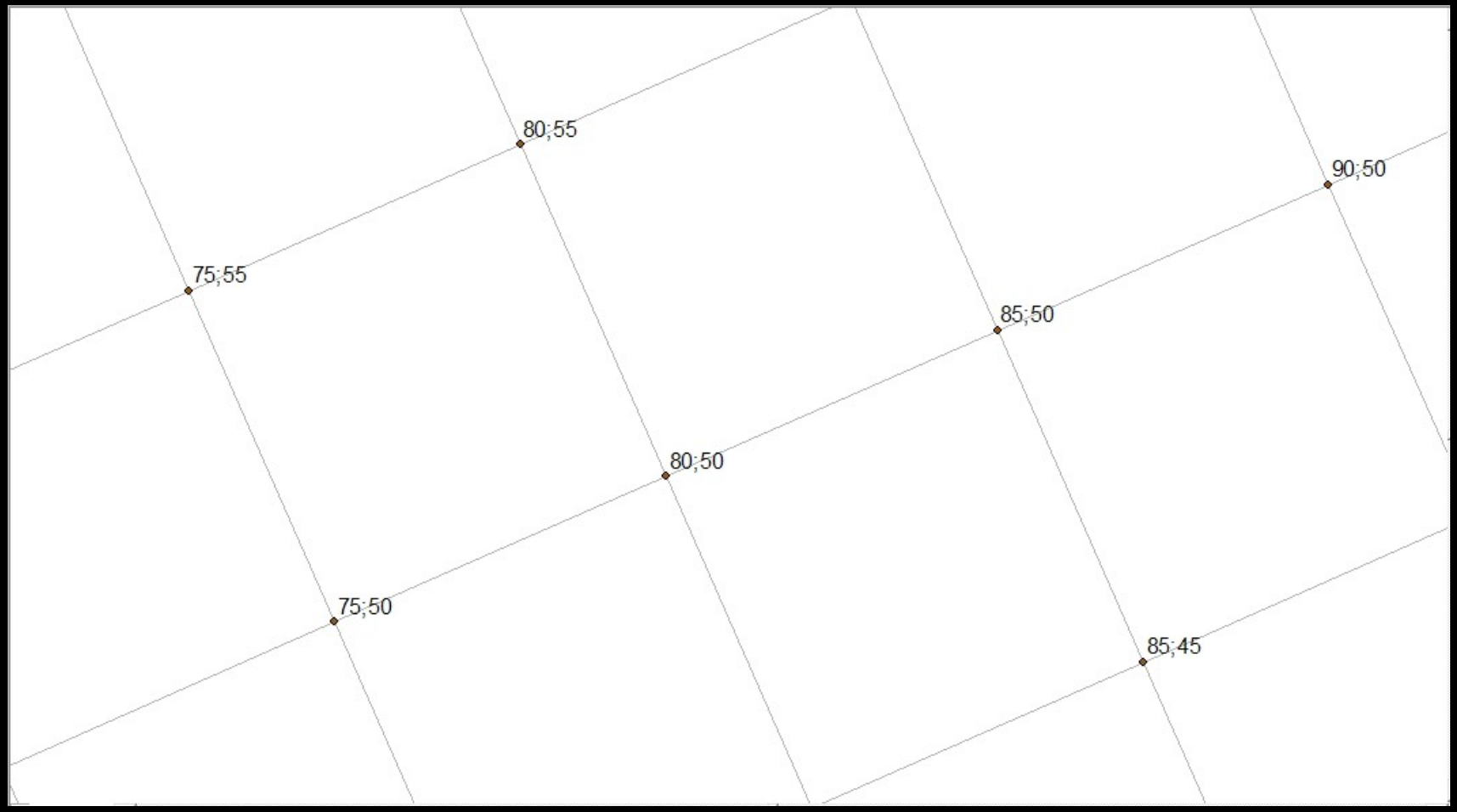

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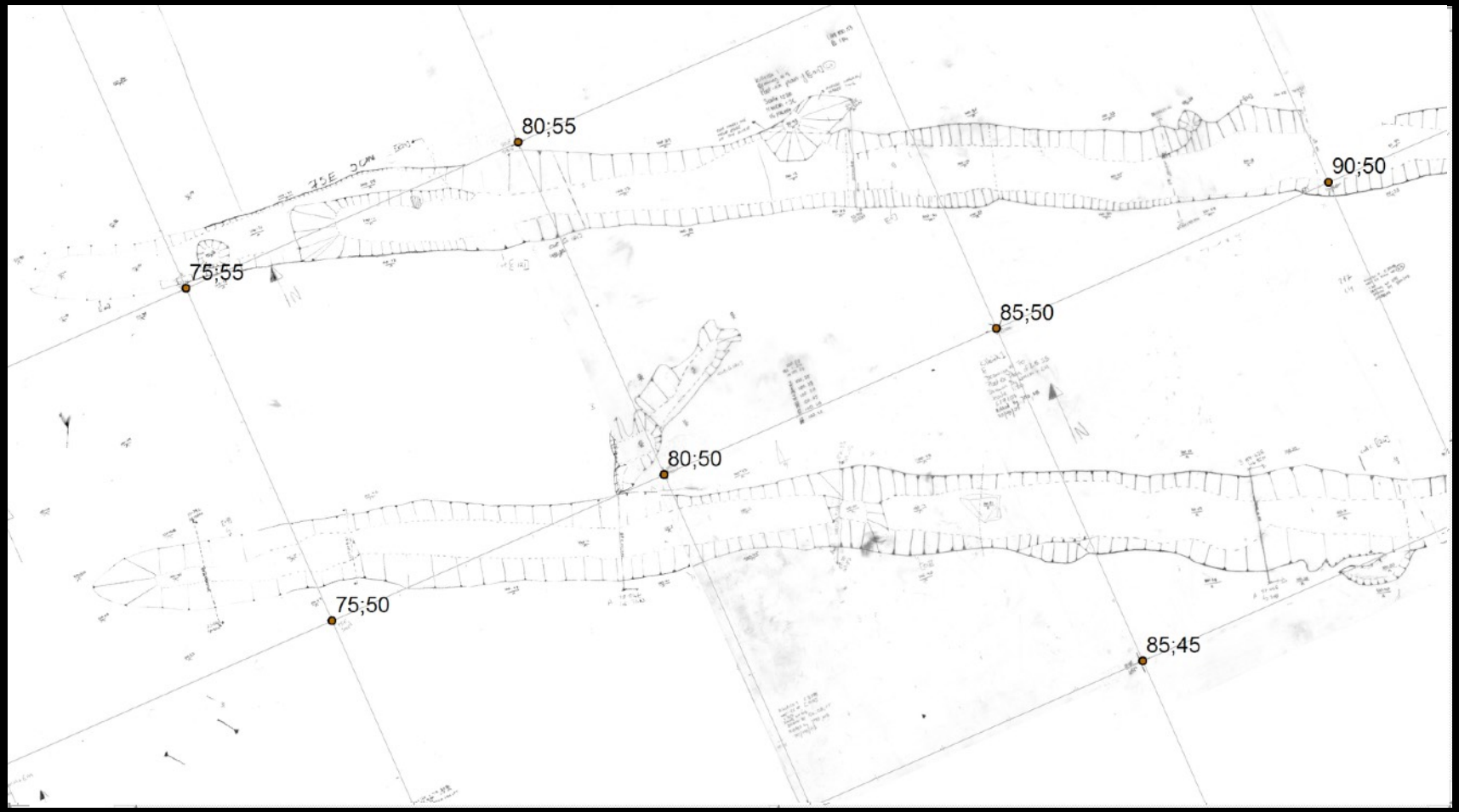
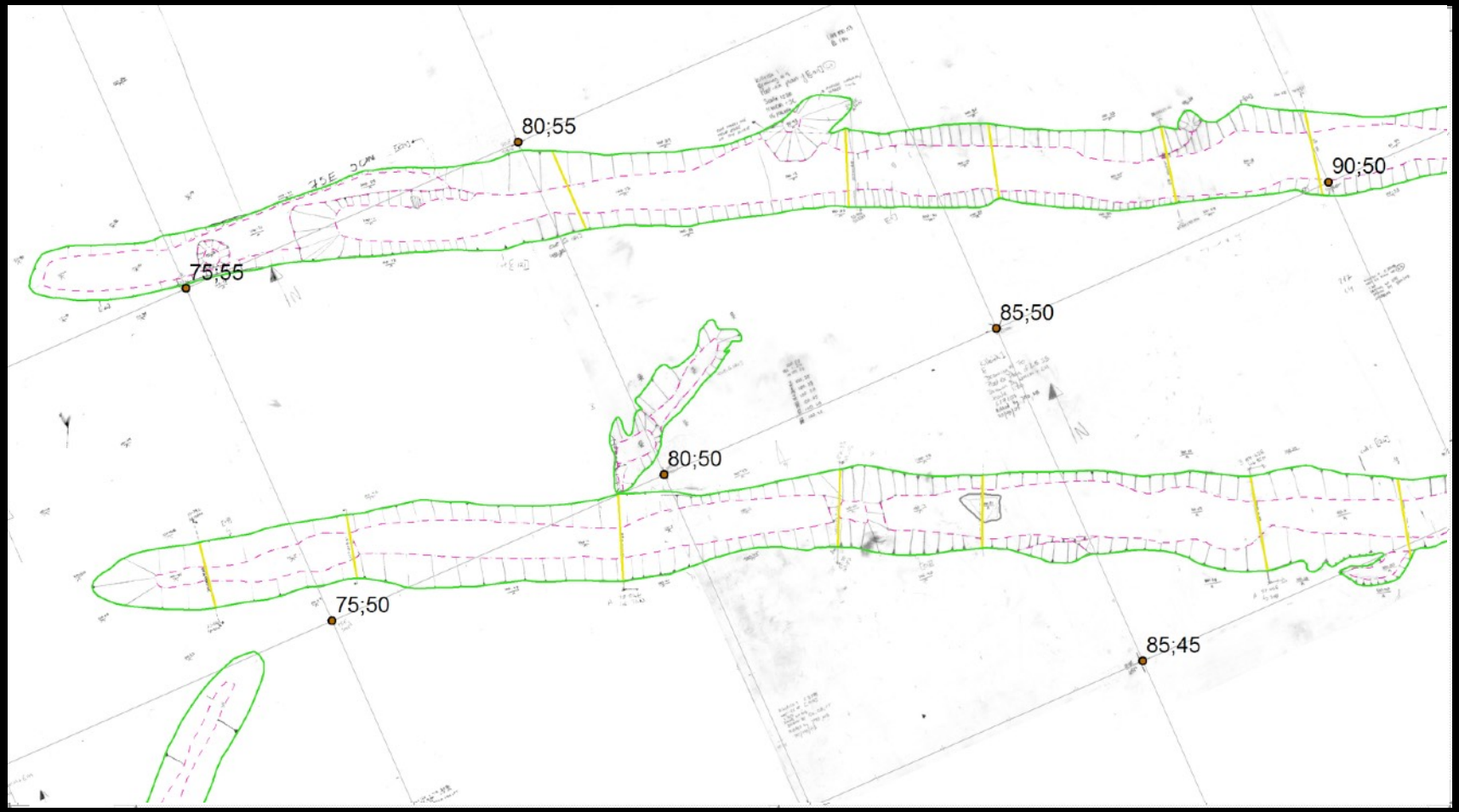


Permatrace plans

Plans ‘stitched’ together



Permatrace plans

The composite raster plan created:

- Makes it easier to see if something is missing / wrong;
- Avoids searching through archive boxes and numerous plans to find the plan you're looking for;
- Stores the Irish grid position and can be placed directly in the right position into others programs / GIS platforms;
- Represents a comprehensive digital archive for all the post-ex sites drawings.

Using this method, unlike when using CAD and a drawing tablet, we can zoom into the plan and digitise up to 1:1 scale, respecting the real shape of the object giving a higher degree of accuracy to the final drawing.

Geometry

All the digitized graphs are stored in the database and classified according to logic scheme previously created;

Stratigraphical units are organized into three types, with relative subtypes, and represented with a specific geometry:

- Positive units like polygon objects, because they represents real surfaces;
- Negative units like linear objects, because of their nature of surface without material consistency;
- Characterisations like linear objects, because they are used just to describe the aspect of the features;
- Section like linear objects, because of their nature of arbitrary boundaries.

Thanks to the connected database, all digitized drawings are “stratigraphically informed”.

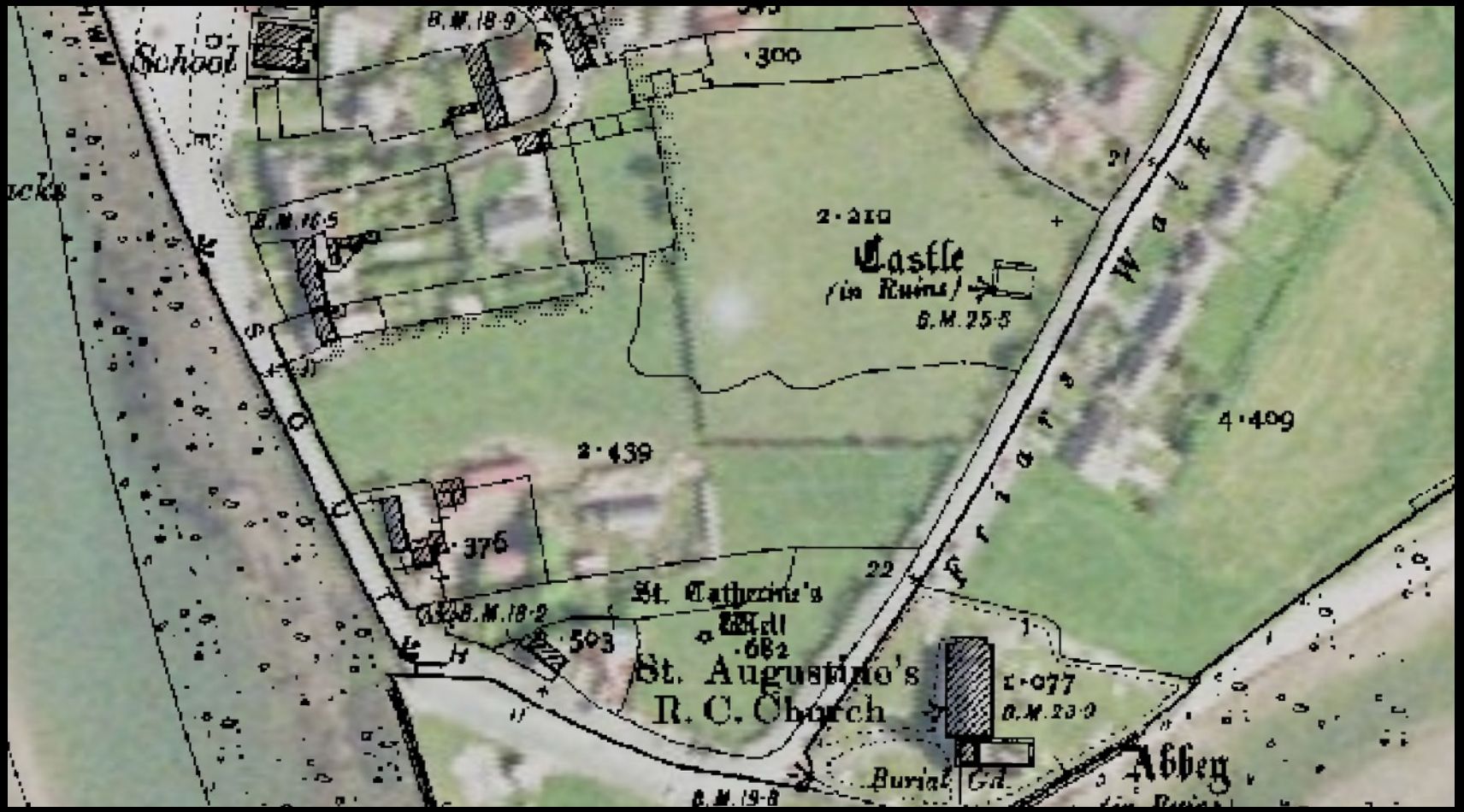
Aerial photo

Enclosure:

Perimeter 220 m.
Area 3.000 sq. m.

Geophysical data

Geophysical data



Geophysical data

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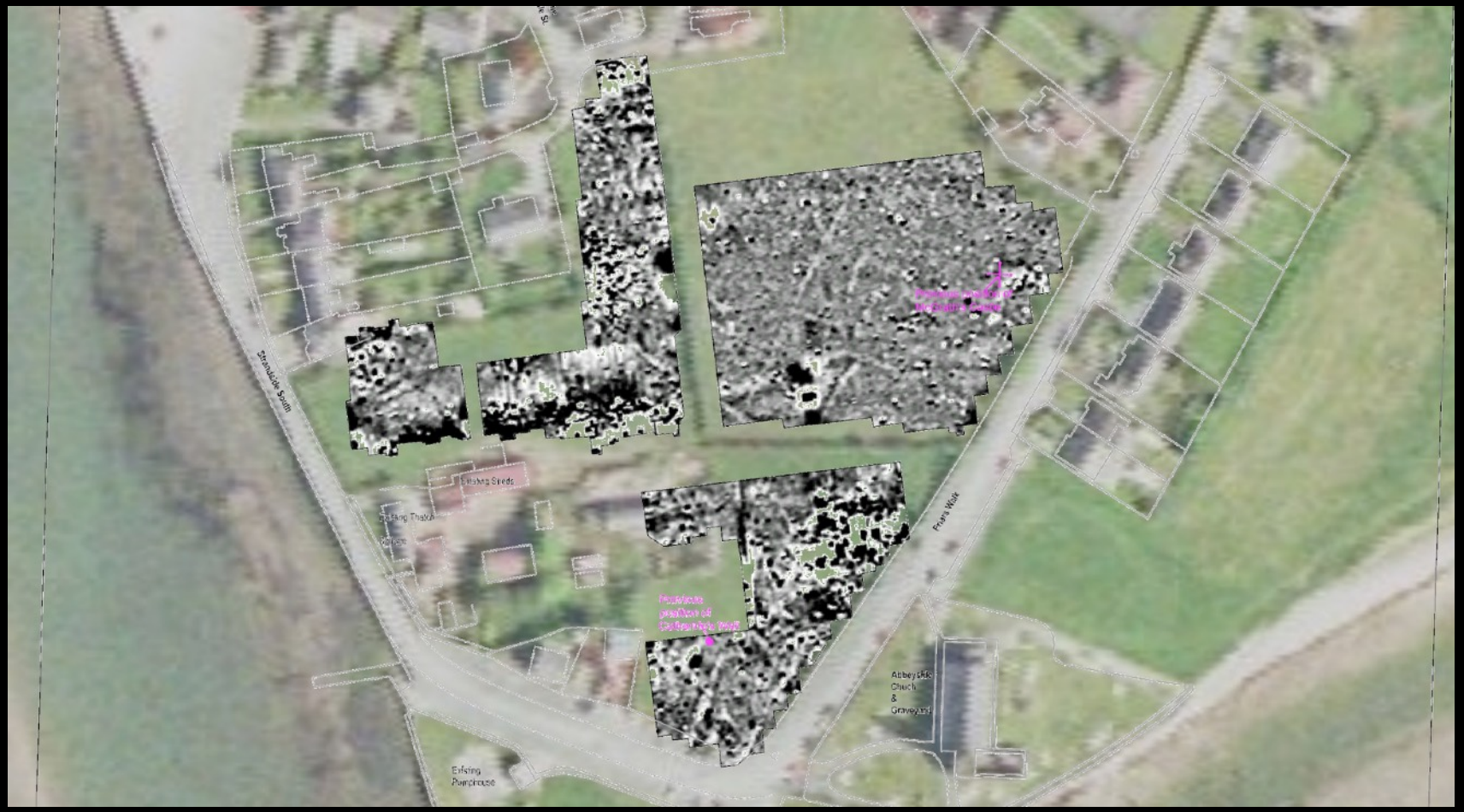
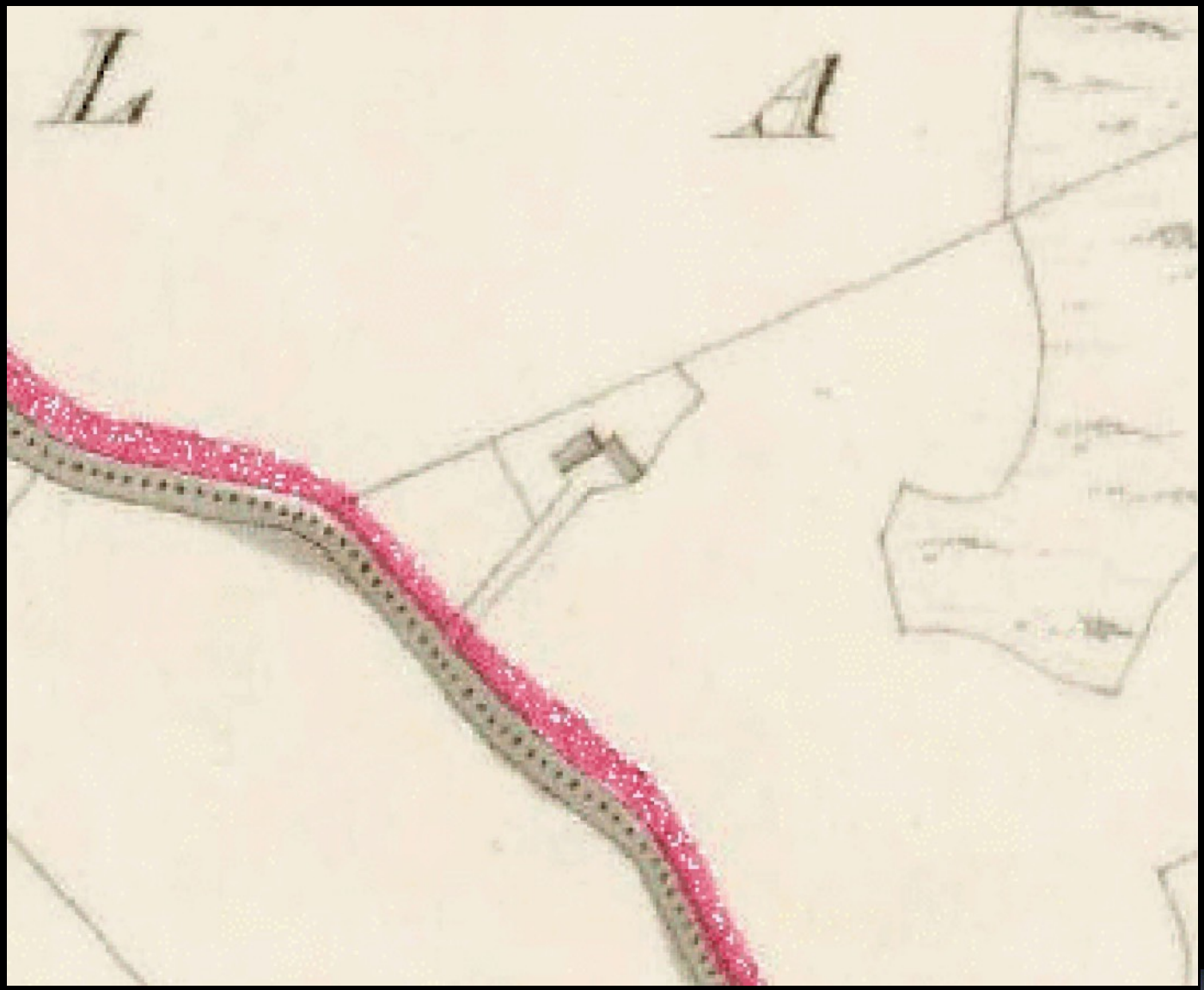


Historical maps



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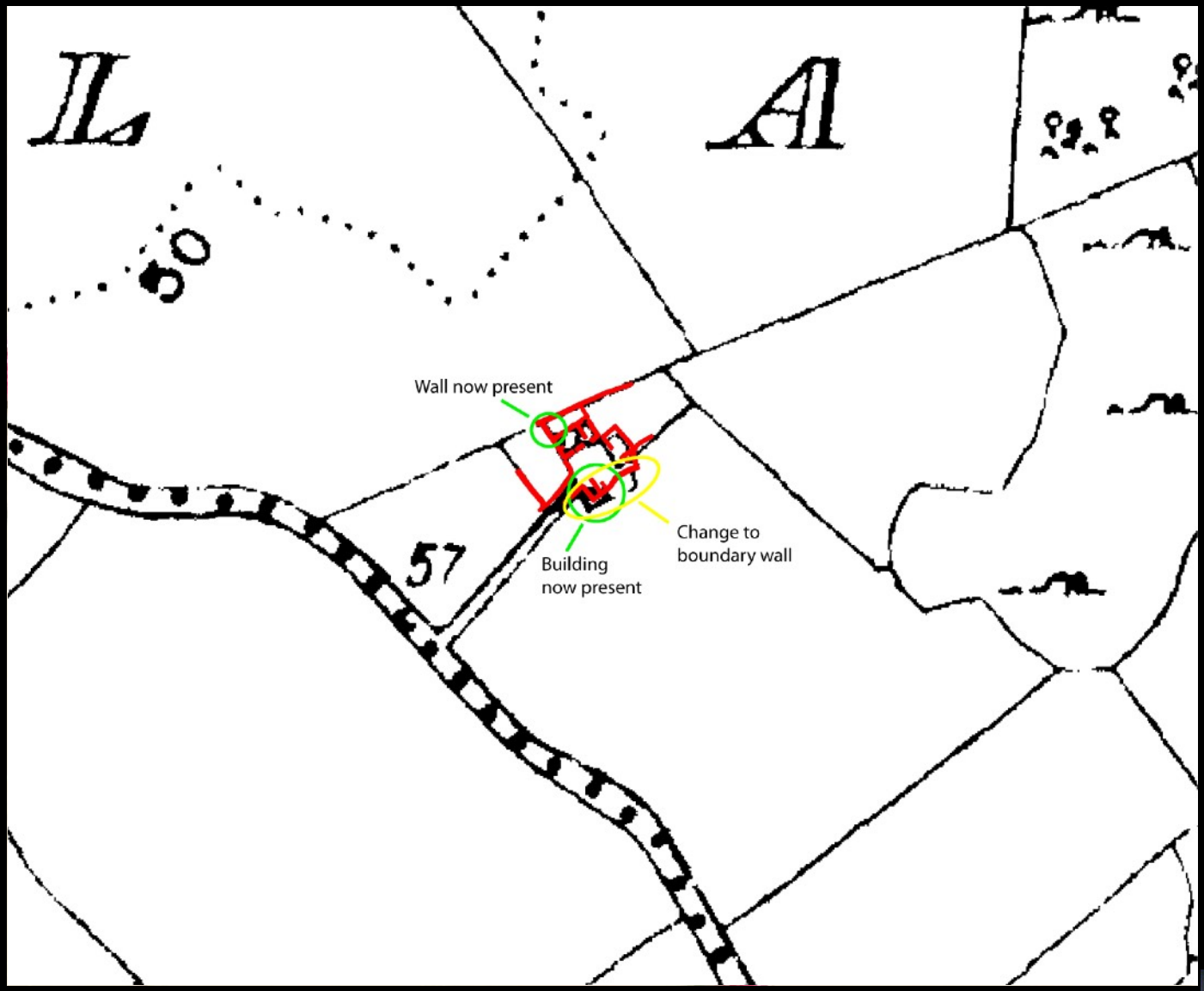


Manipulation and analysis

Overlay

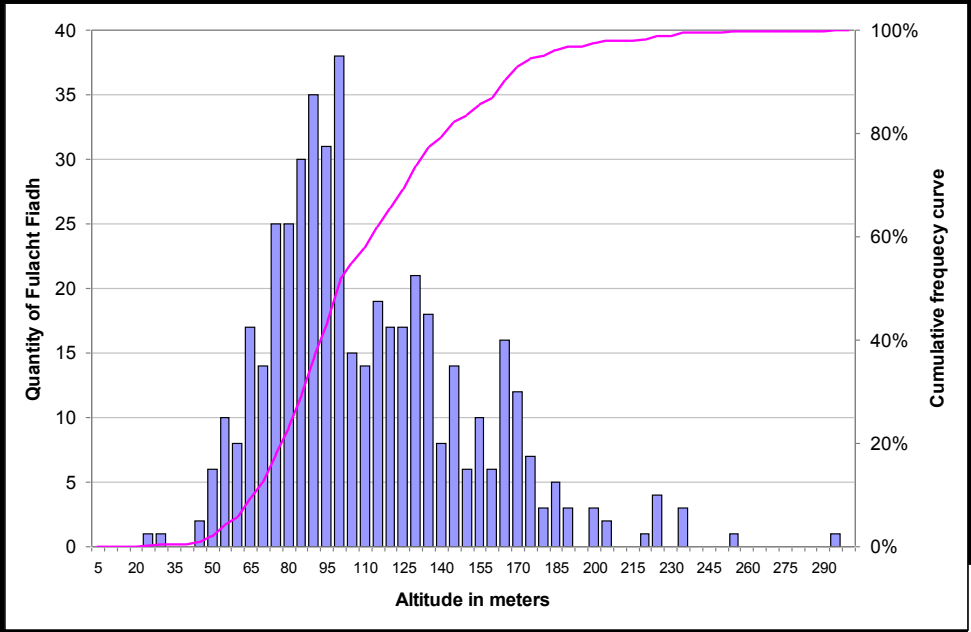
Overlay

Database query

- There are two types of possible queries in a GIS platform: *spatial* and *on attributes*:
  - Spatial queries are used to identify / select objects depending on their mutual position;
  - Query on attributes can be performed using SQL (Structured Query Language) and are used to identify / select objects through one or more of their attributes;
- An example of SQL query:

  SELECT * FROM neg_features WHERE c_type LIKE “stakehole” AND deep > 0.1 AND period NOT LIKE “Bronze Age”
- This query selects all of the stakeholes deeper than 10 cm and that are not of Bronze Age in date.

Statistical and Tabular Analysis

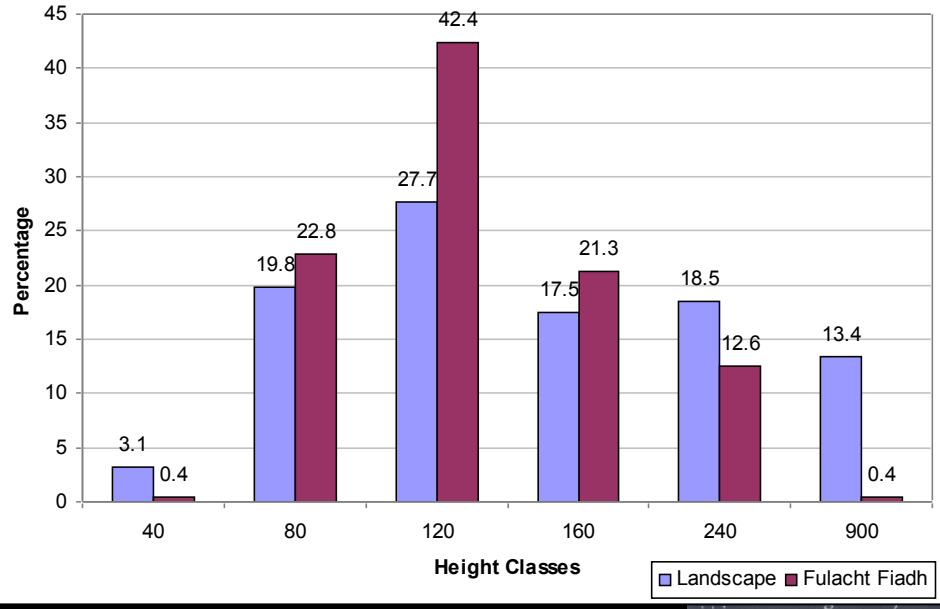


Fulacht fiadh altitude analysis

Mean	109.3
Standard Deviation	39.4
Minimum	24.5
Maximum	290.9
Count	469

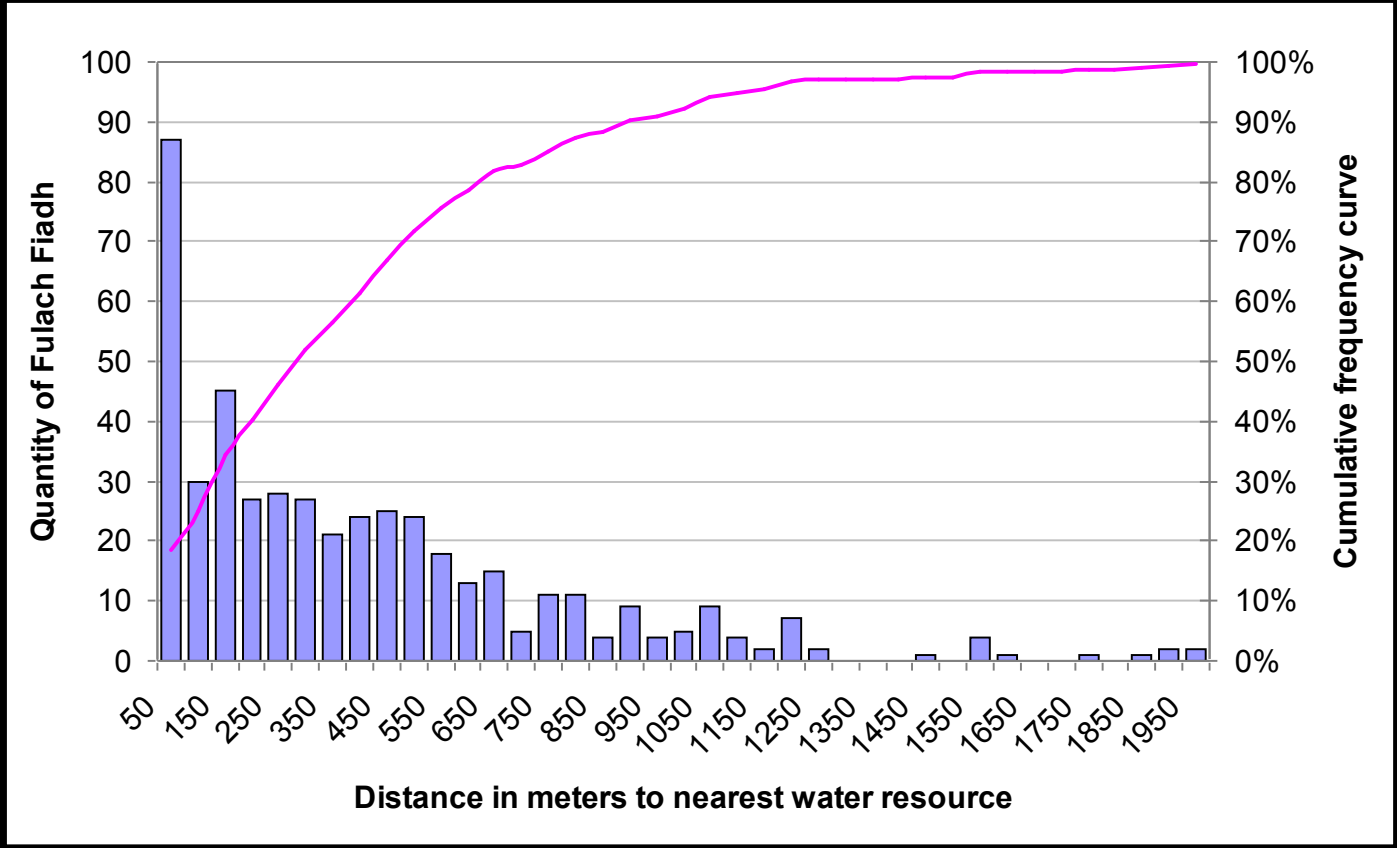
Study Area

Extent	2827.4 km²
Minimum elevation	0
Maximum elevation	904.9
Mean	147.6



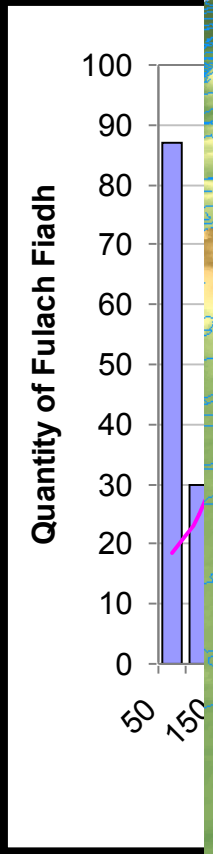
Statistical and Tabular Analysis

Fulacht fiadh river distance analysis



Mean	381.0
Standard Deviation	369.0
Minimum	0
Maximum	1949.8
Count	469

Statistical and Tabular Analysis



381.0

369.0

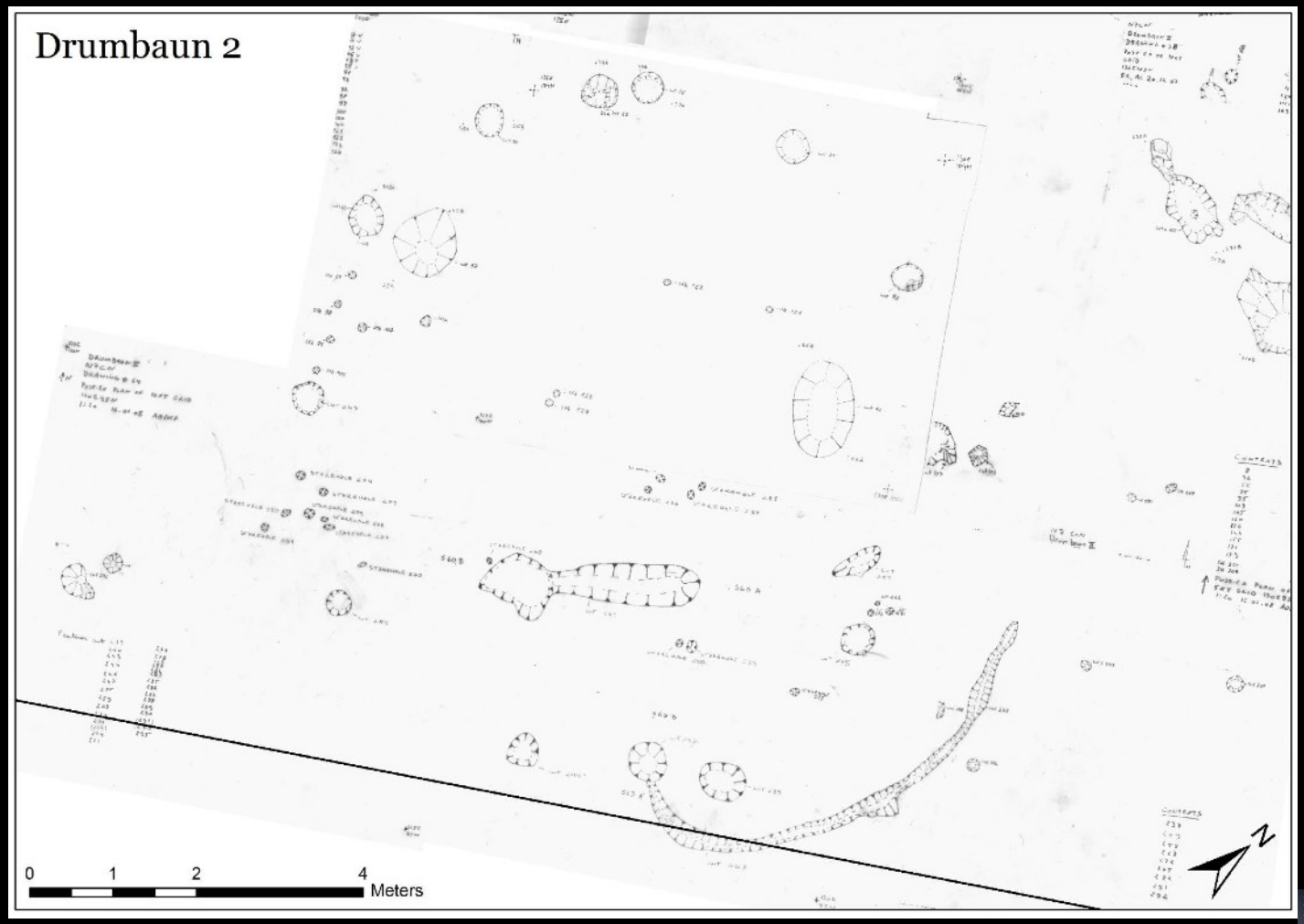
0

1949.8

469

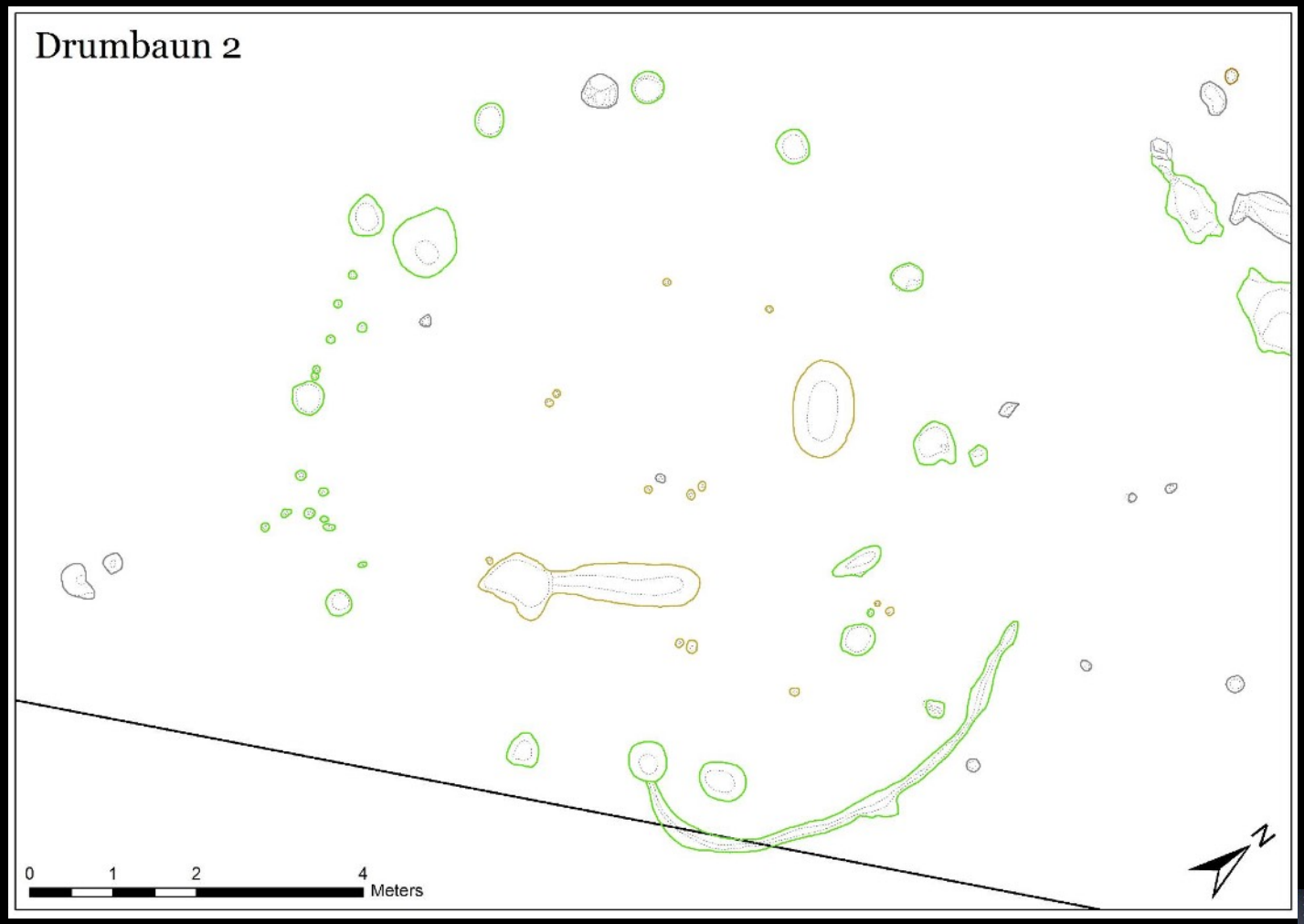
Analysis of dimensions

Site excavation



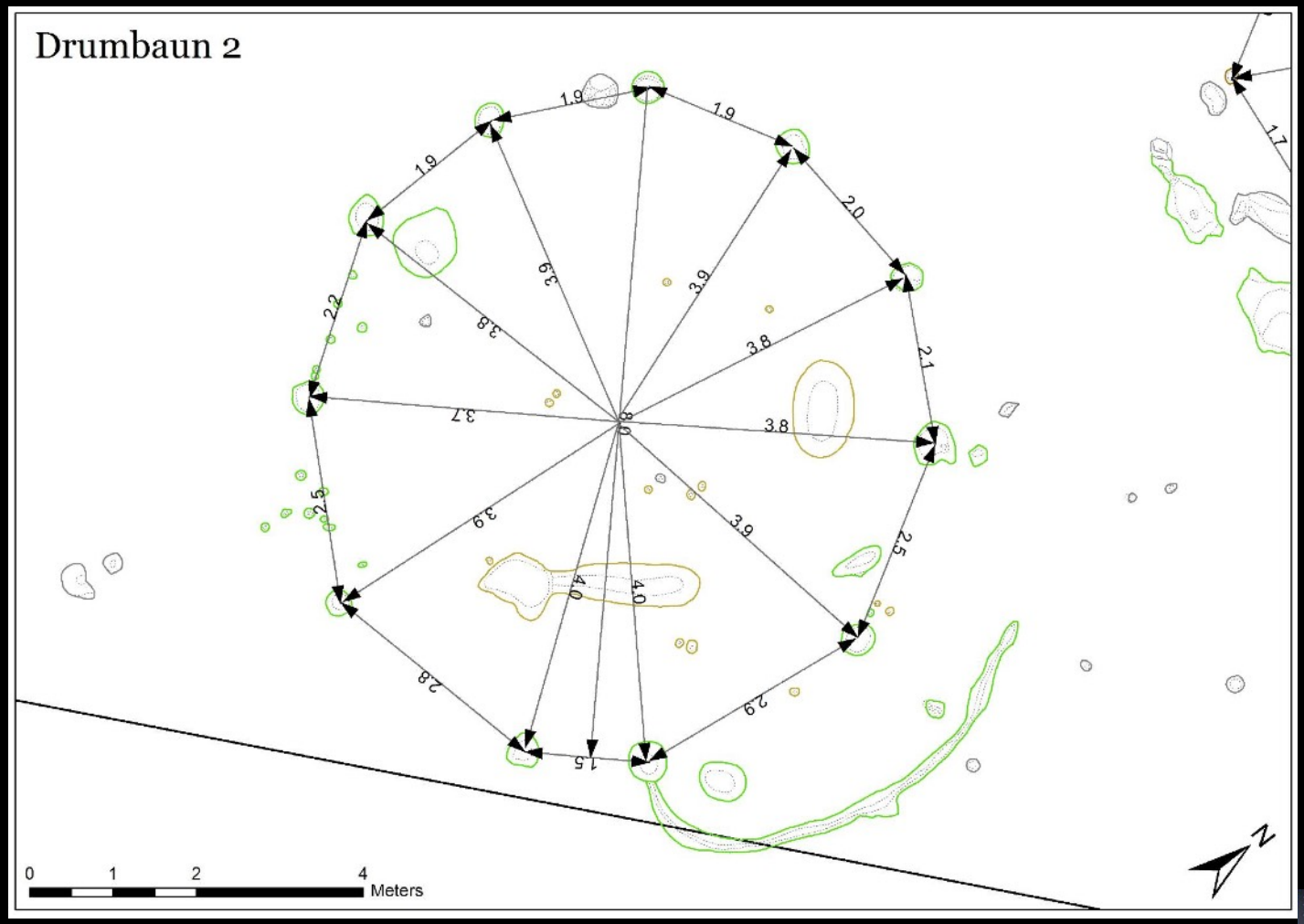
Analysis of dimensions

Digitized plan



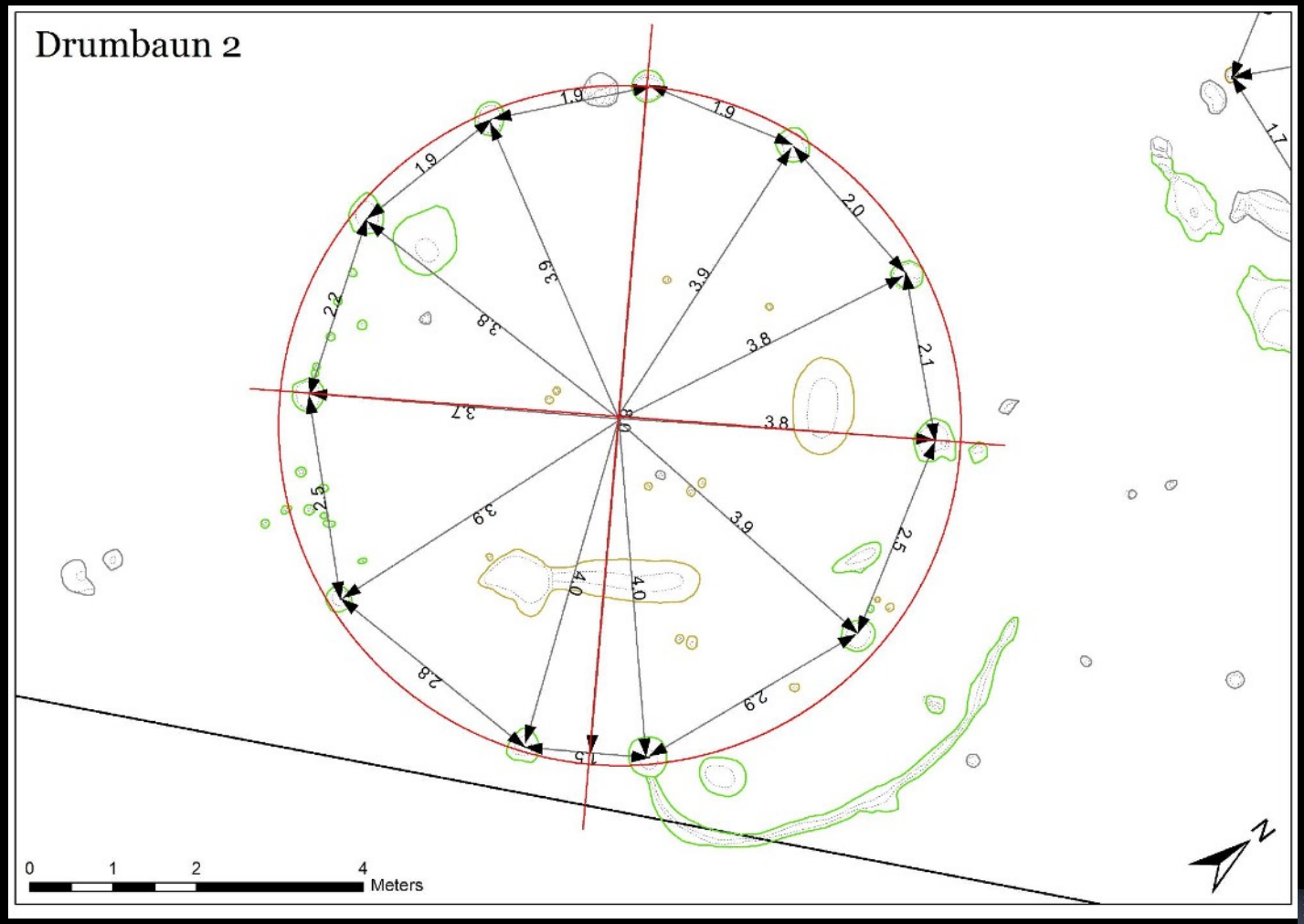
Analysis of dimensions

Analysis of internal geometry



Analysis of dimensions

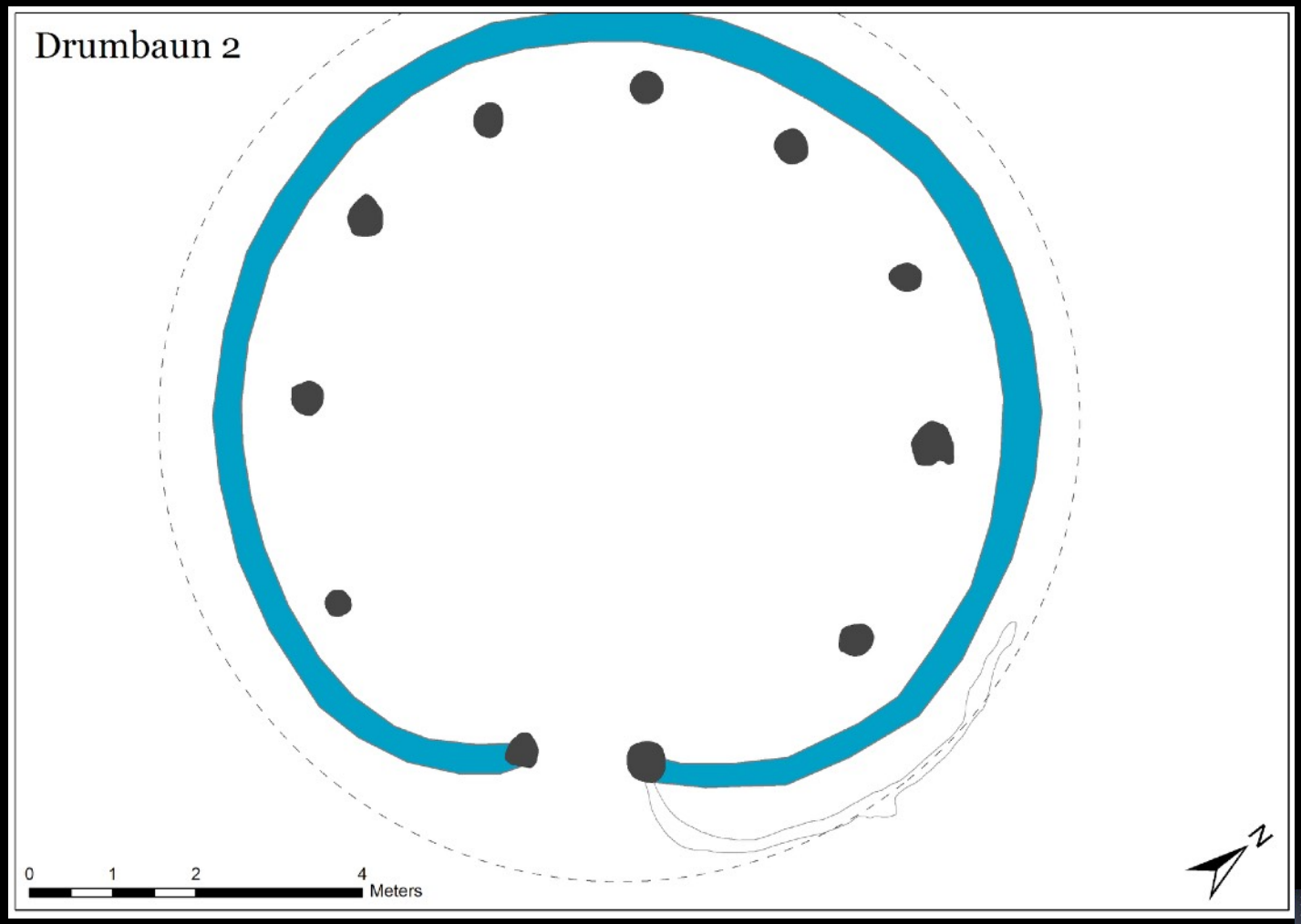
Analysis of internal geometry



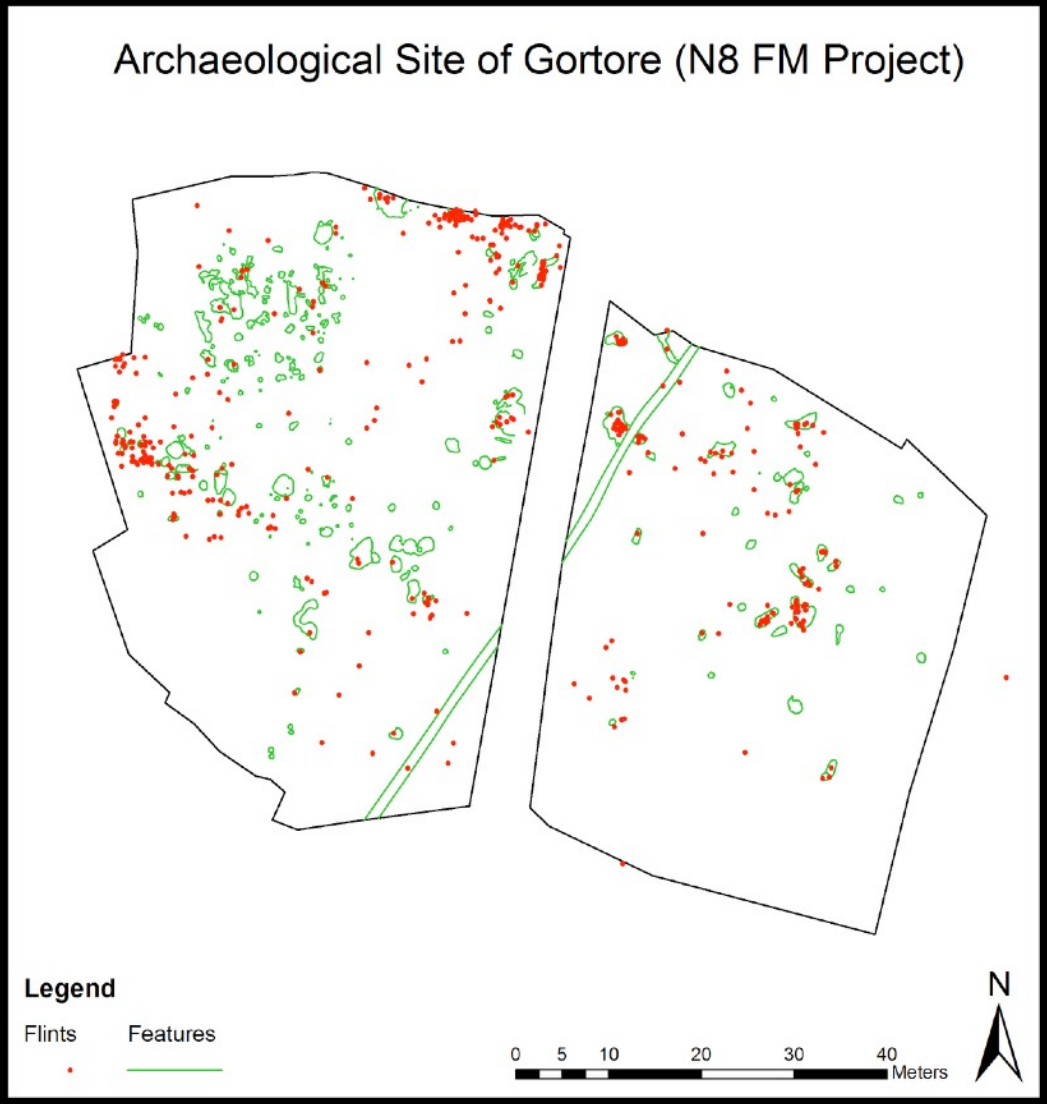
Analysis of dimensions

Hypothesis of reconstruction

Perimeter of post-line 24.2 m.
Area inside post-holes 45 sq.m.
Area inside the wall 63.8 sq.m.



Proximity / density analysis



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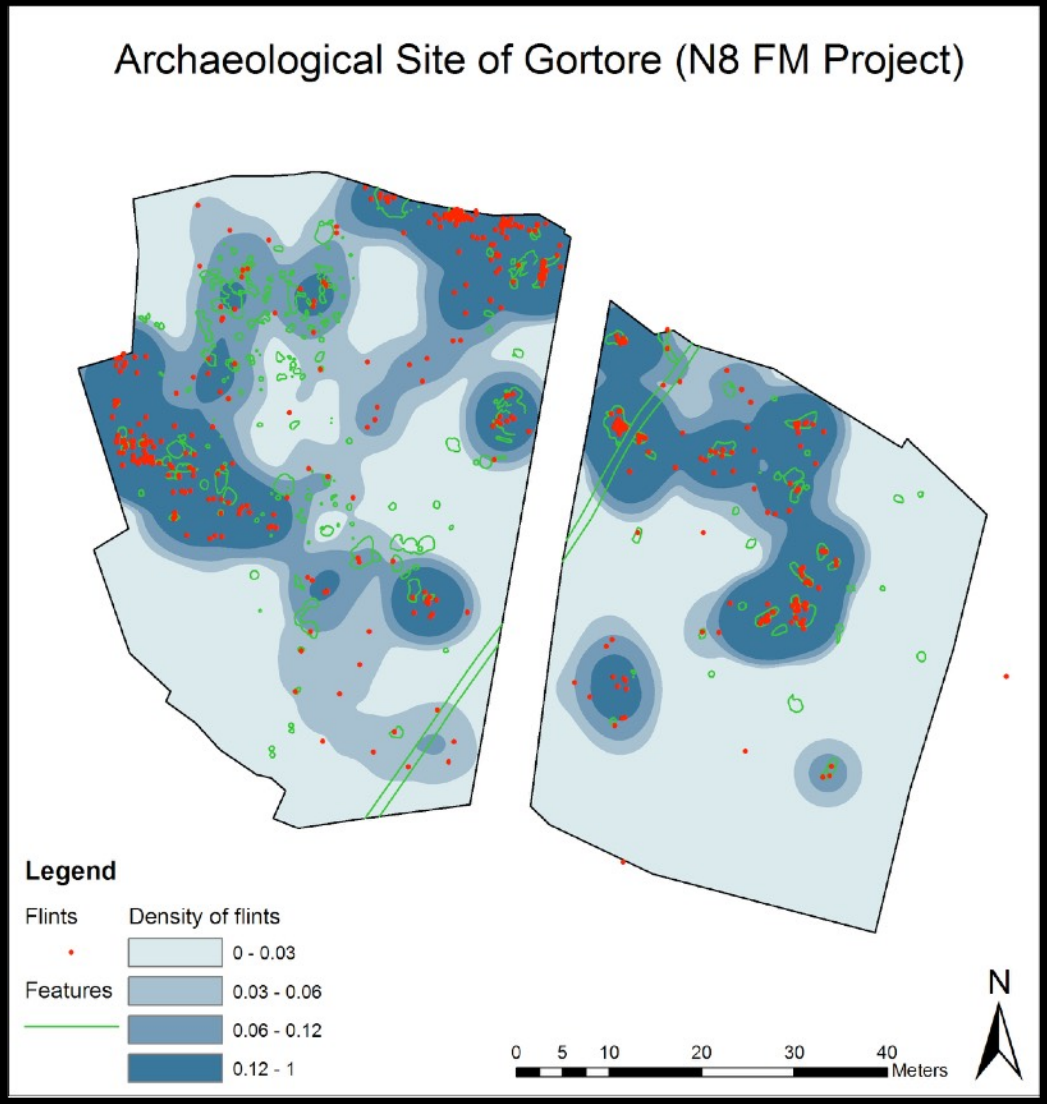
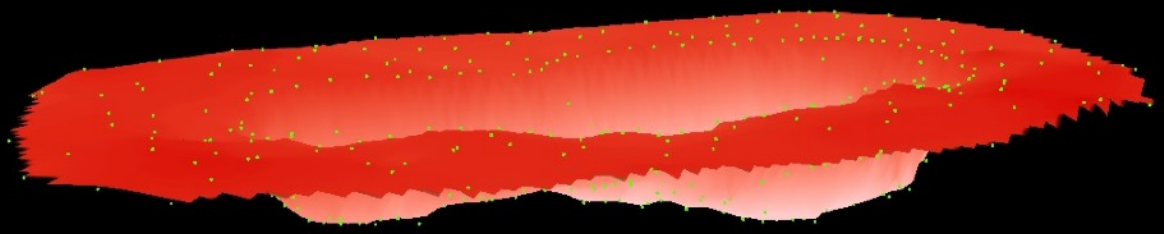


Digital Terrain Model: a kiln

Digital Terrain Model: a kiln



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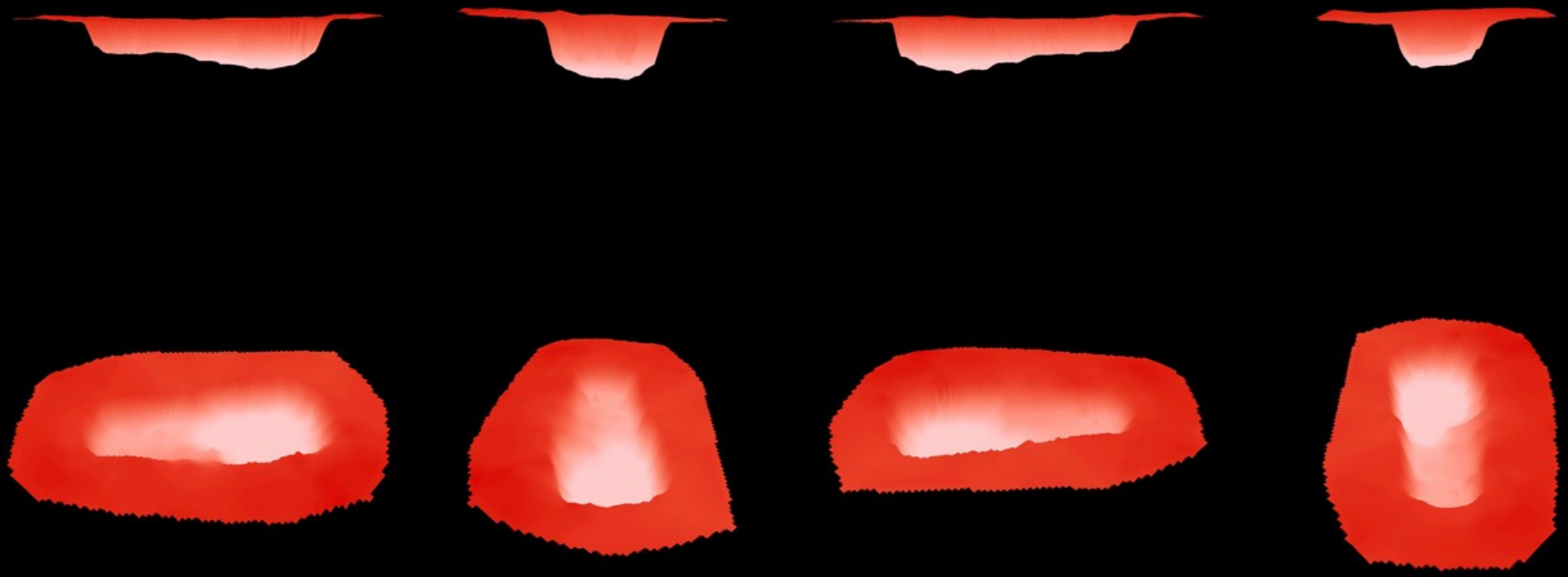
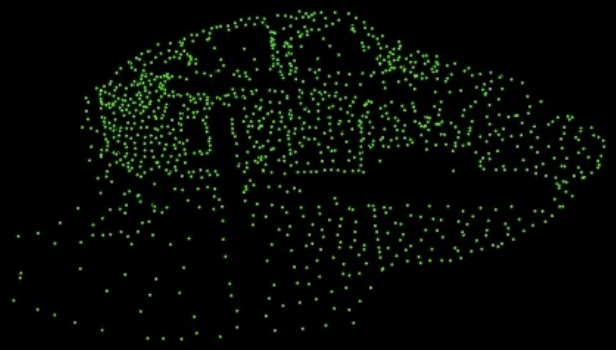


Digital Terrain Model: a site



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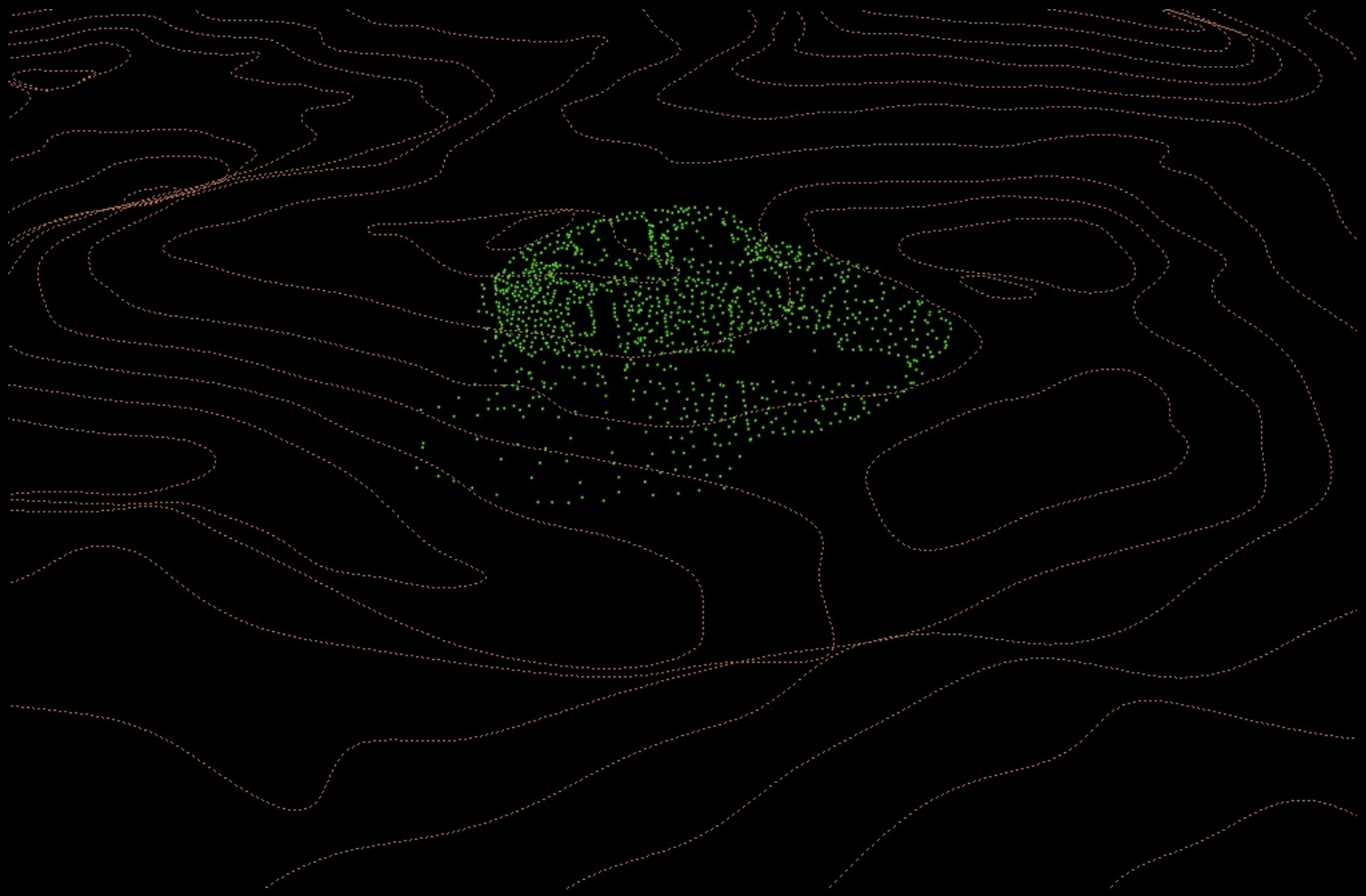

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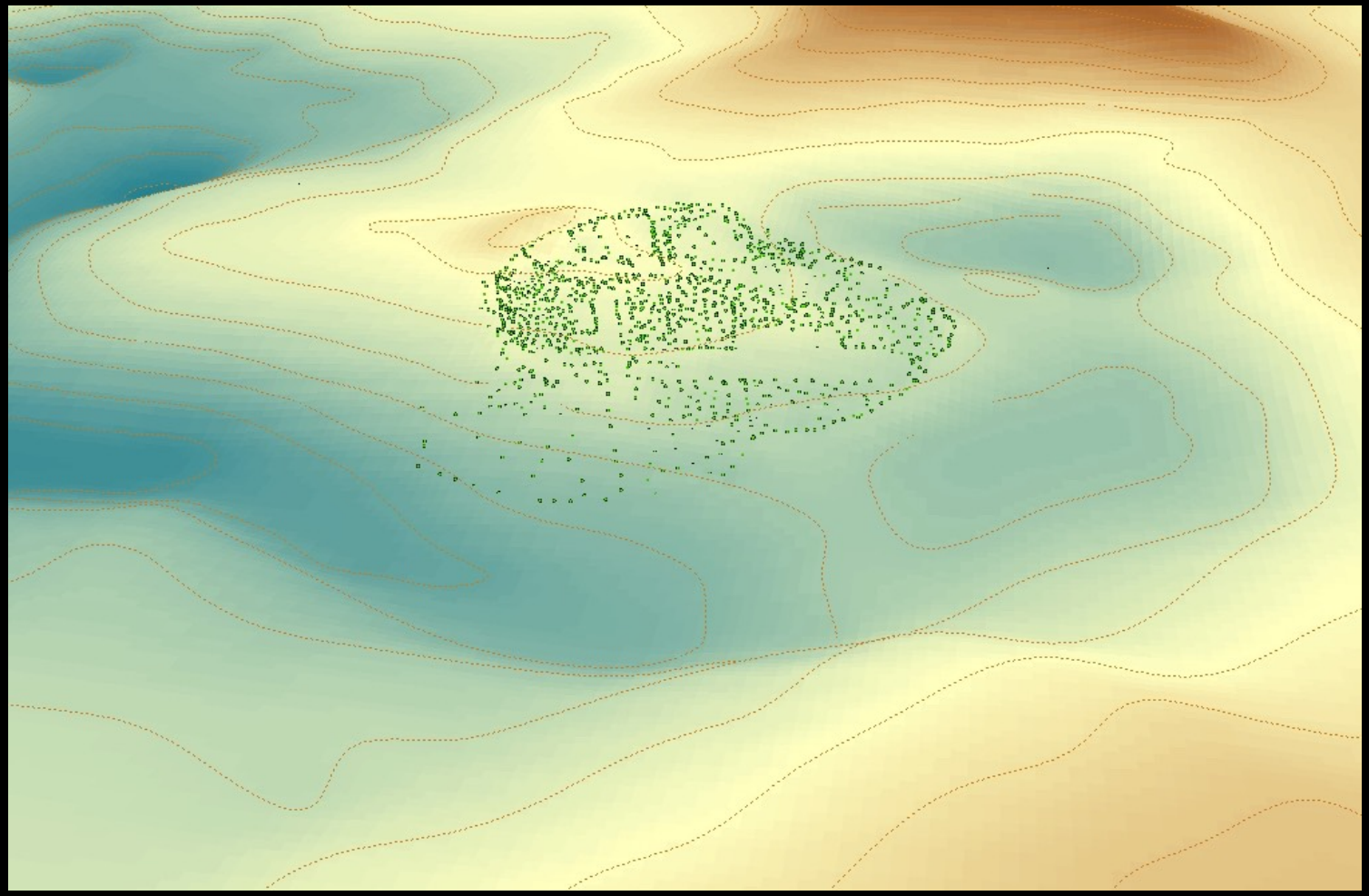


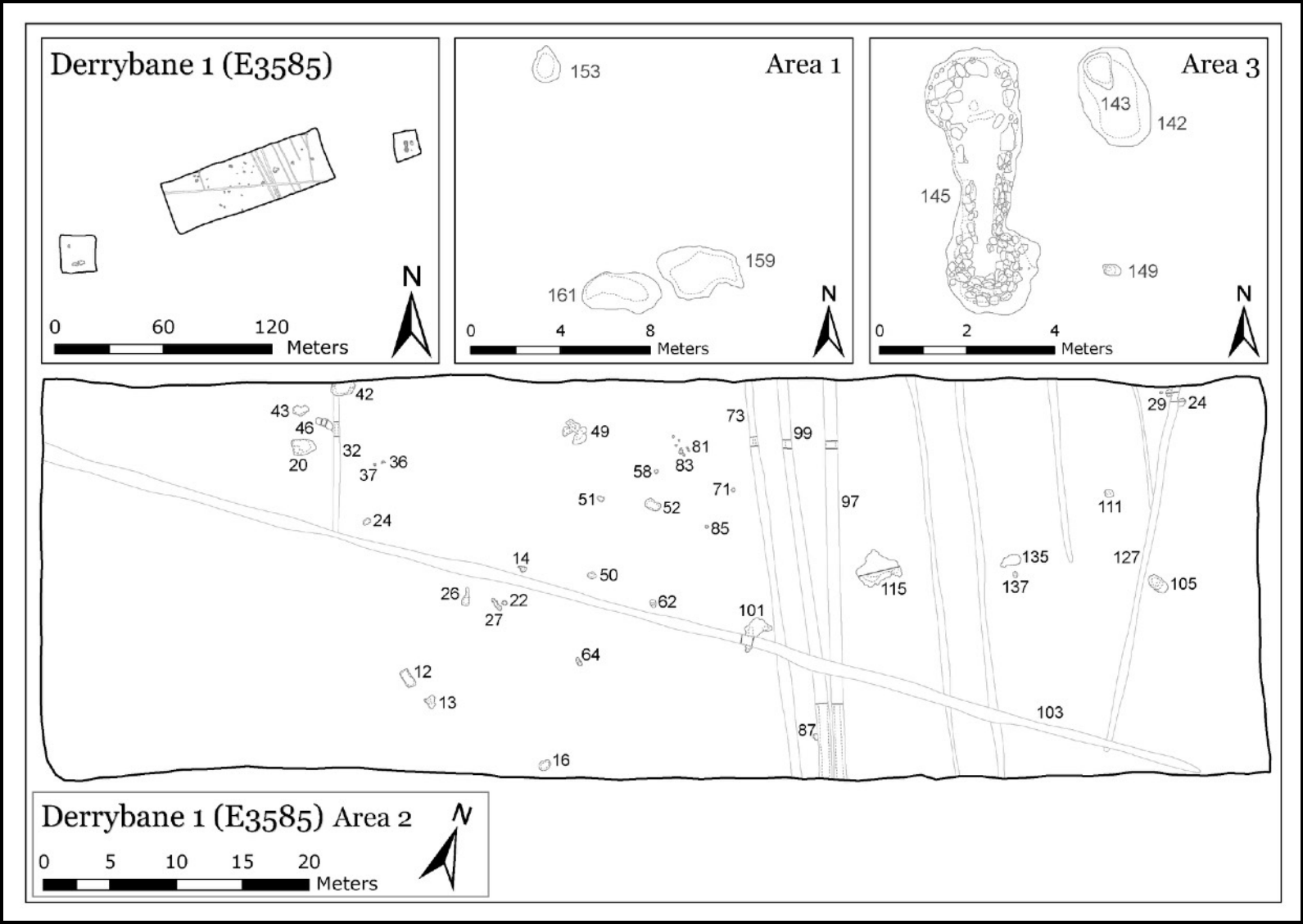
Digital Terrain Model: a site

N18 Ardrahan, Owen Bristy - panoramic view looking south

N18, Owen Bristy - panoramic overview looking south, June 2008

Data output

Post-ex plans



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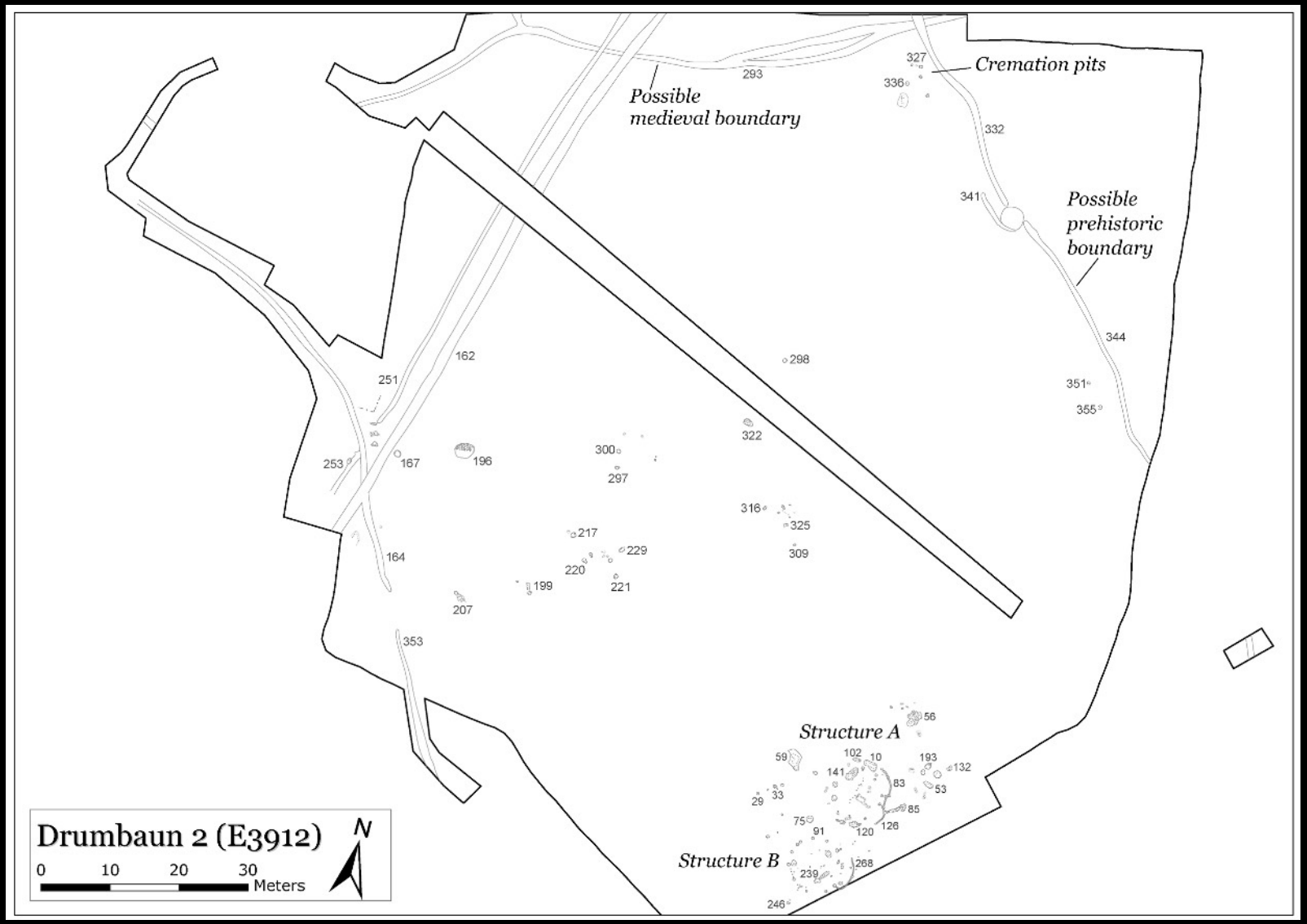

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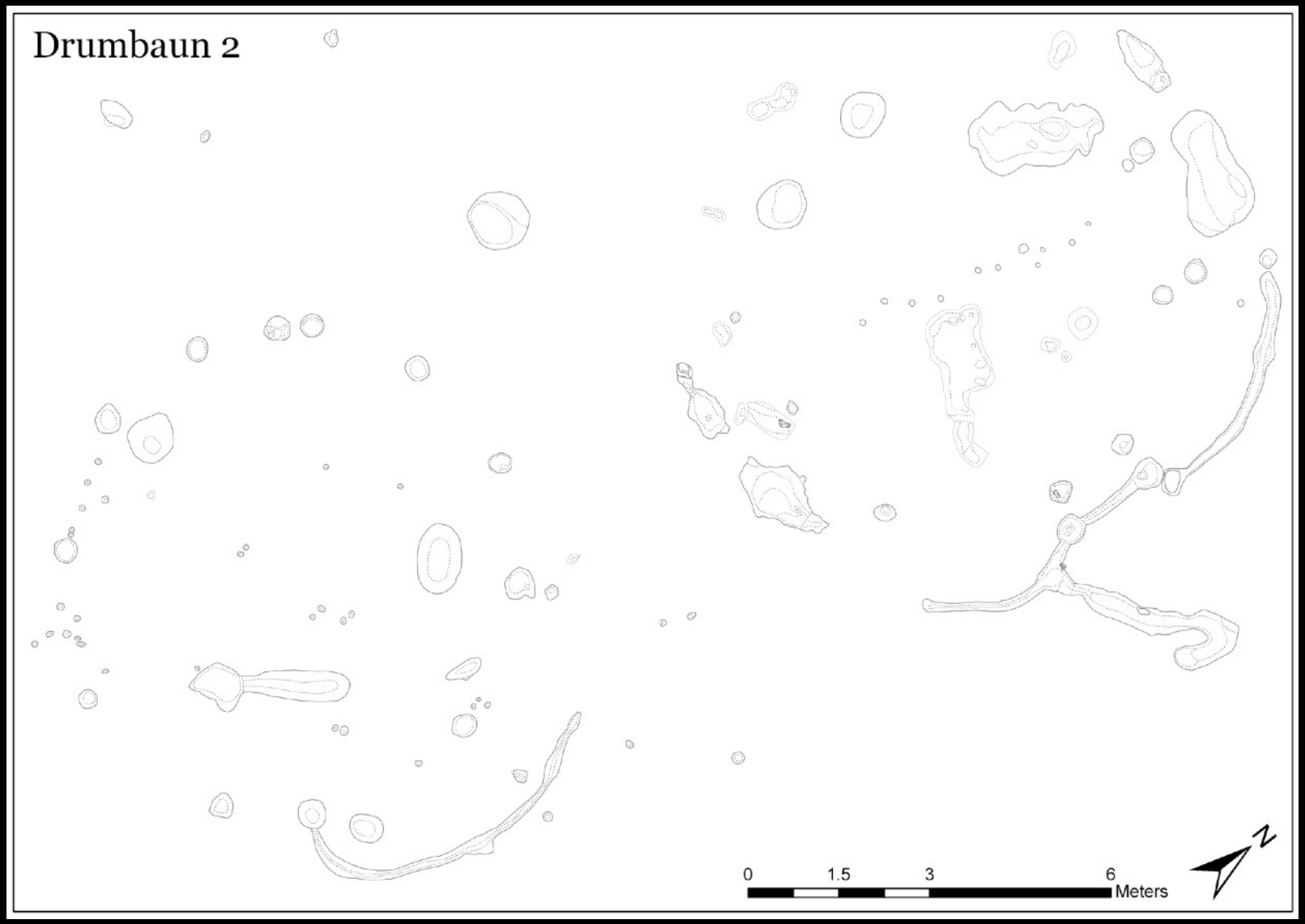
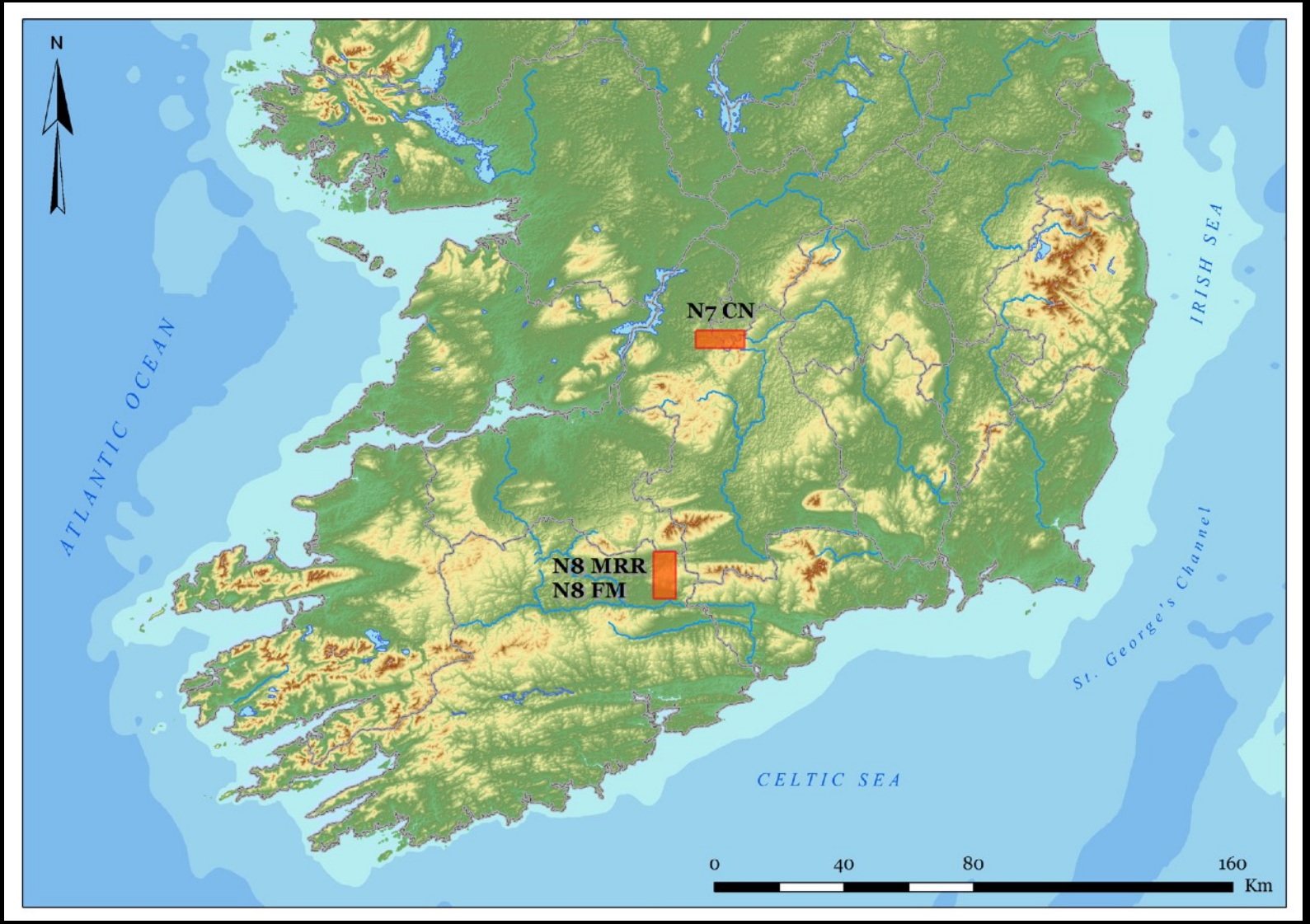


Topographical maps



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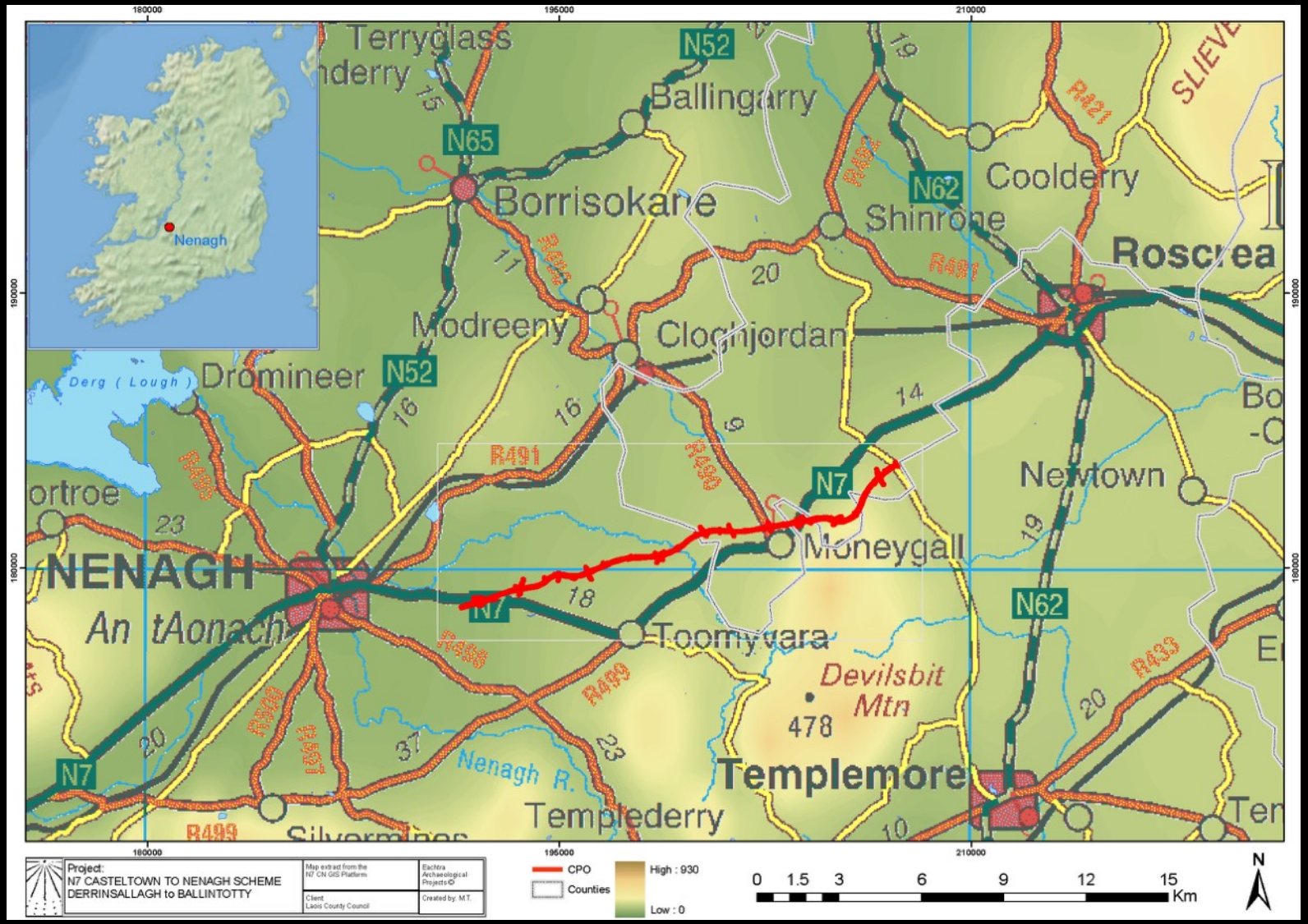

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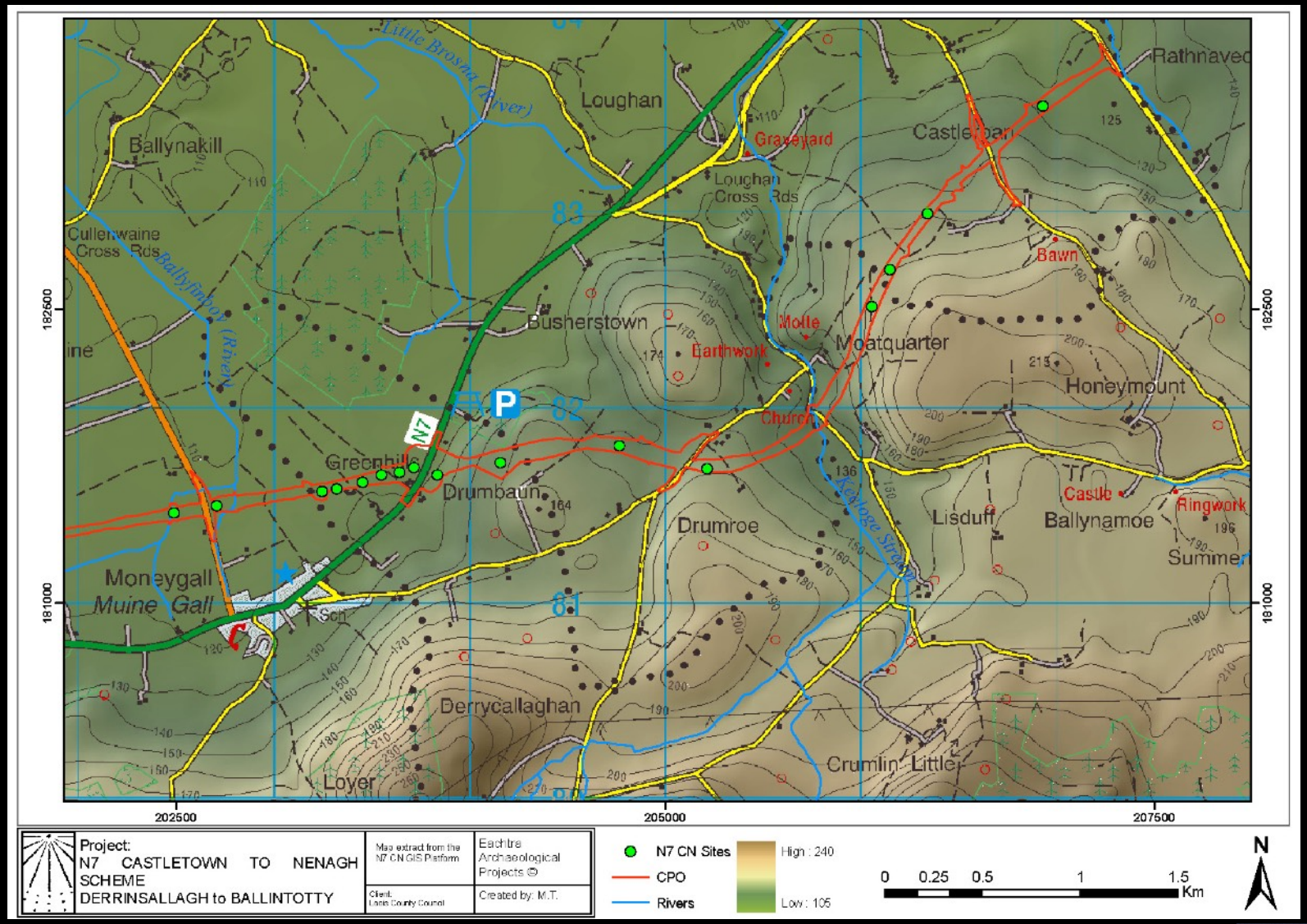

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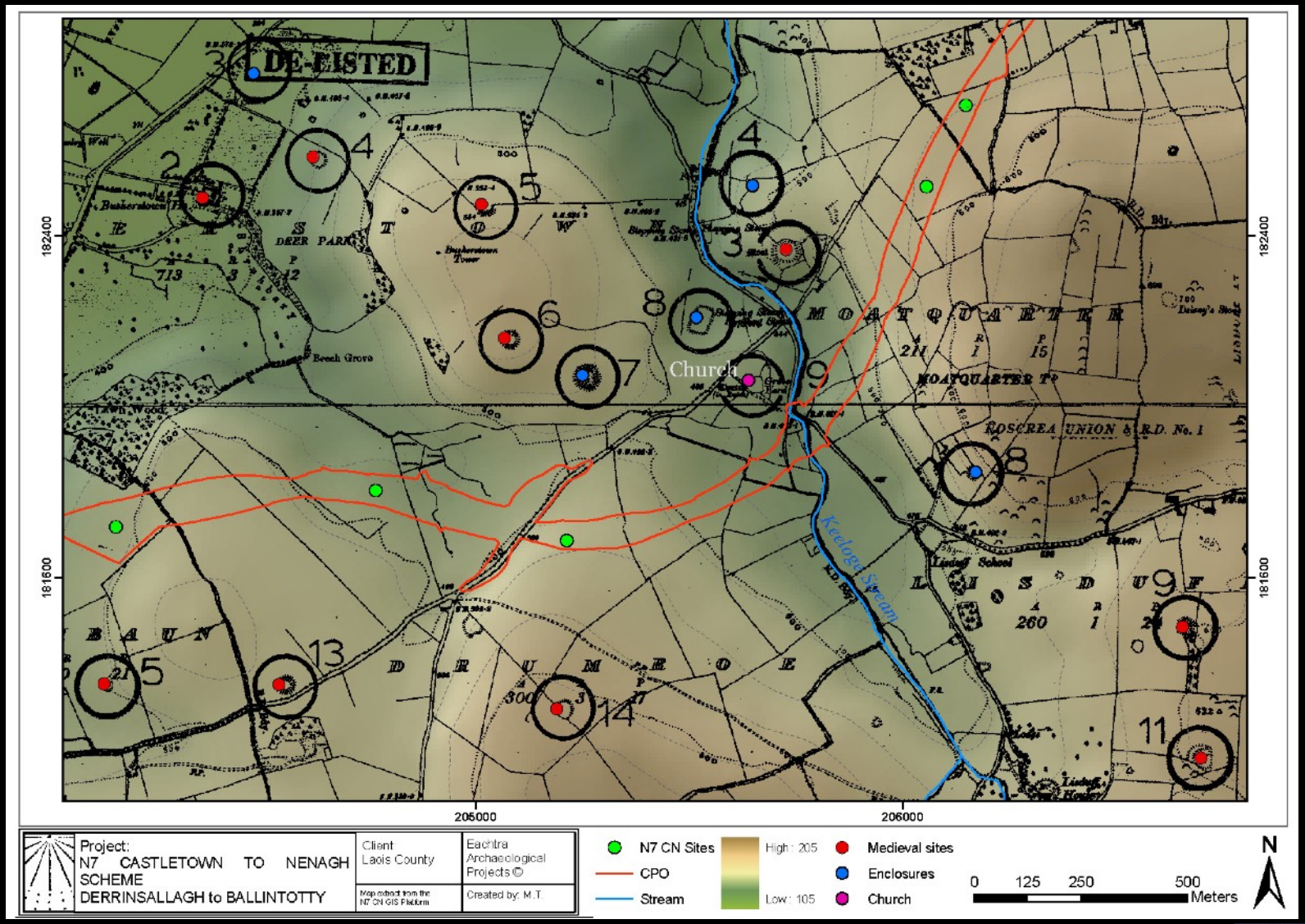

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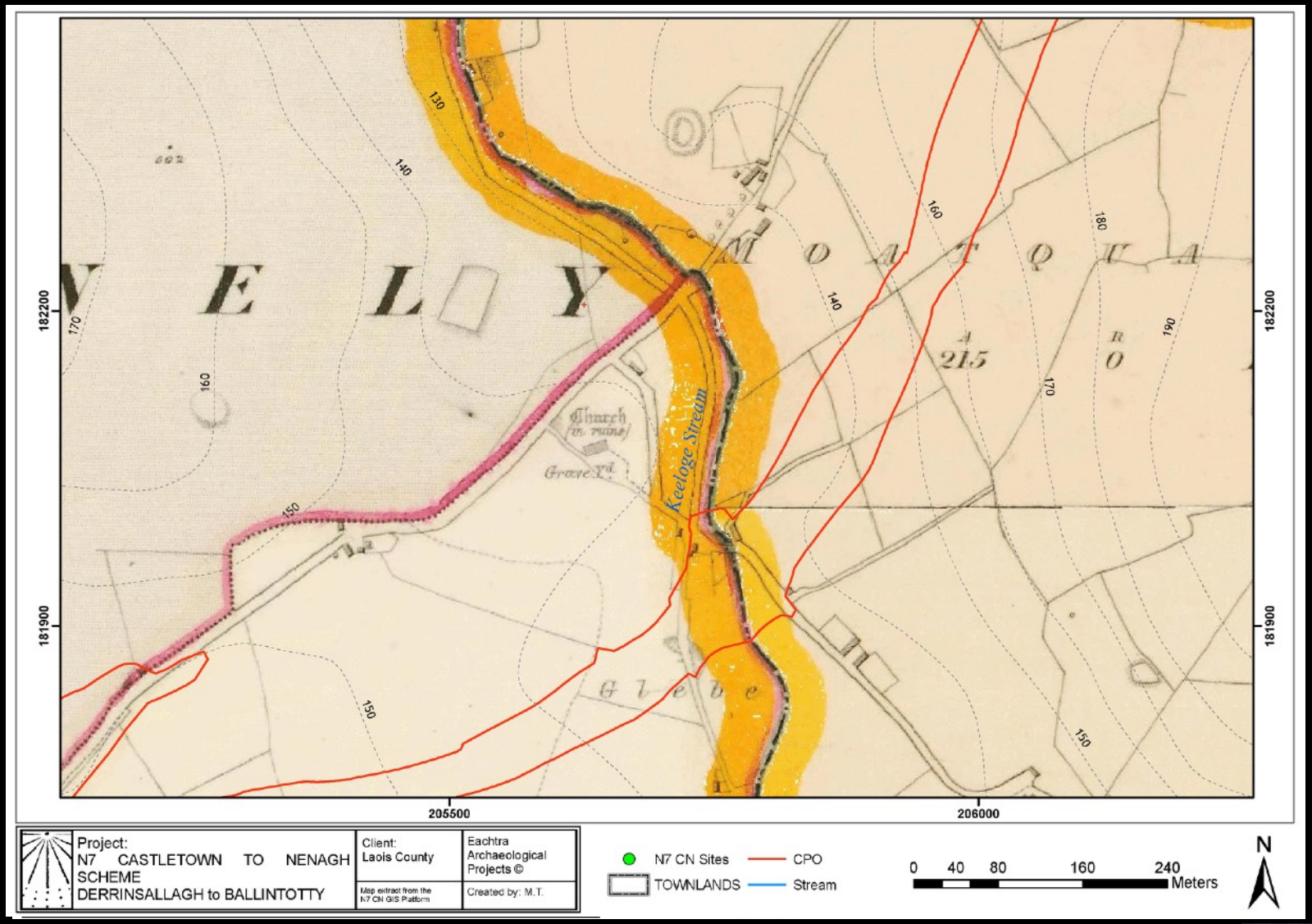
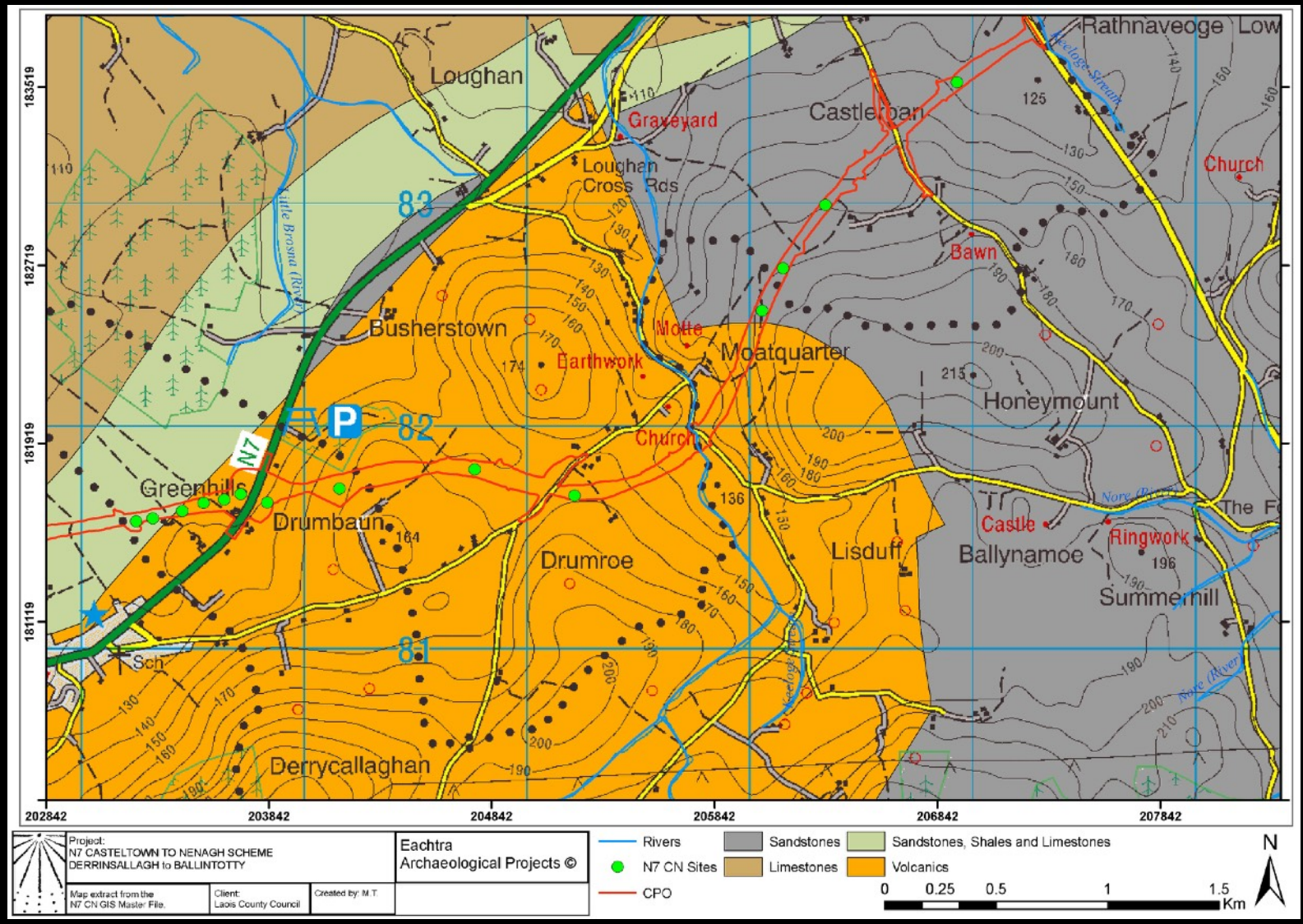


Thematic maps



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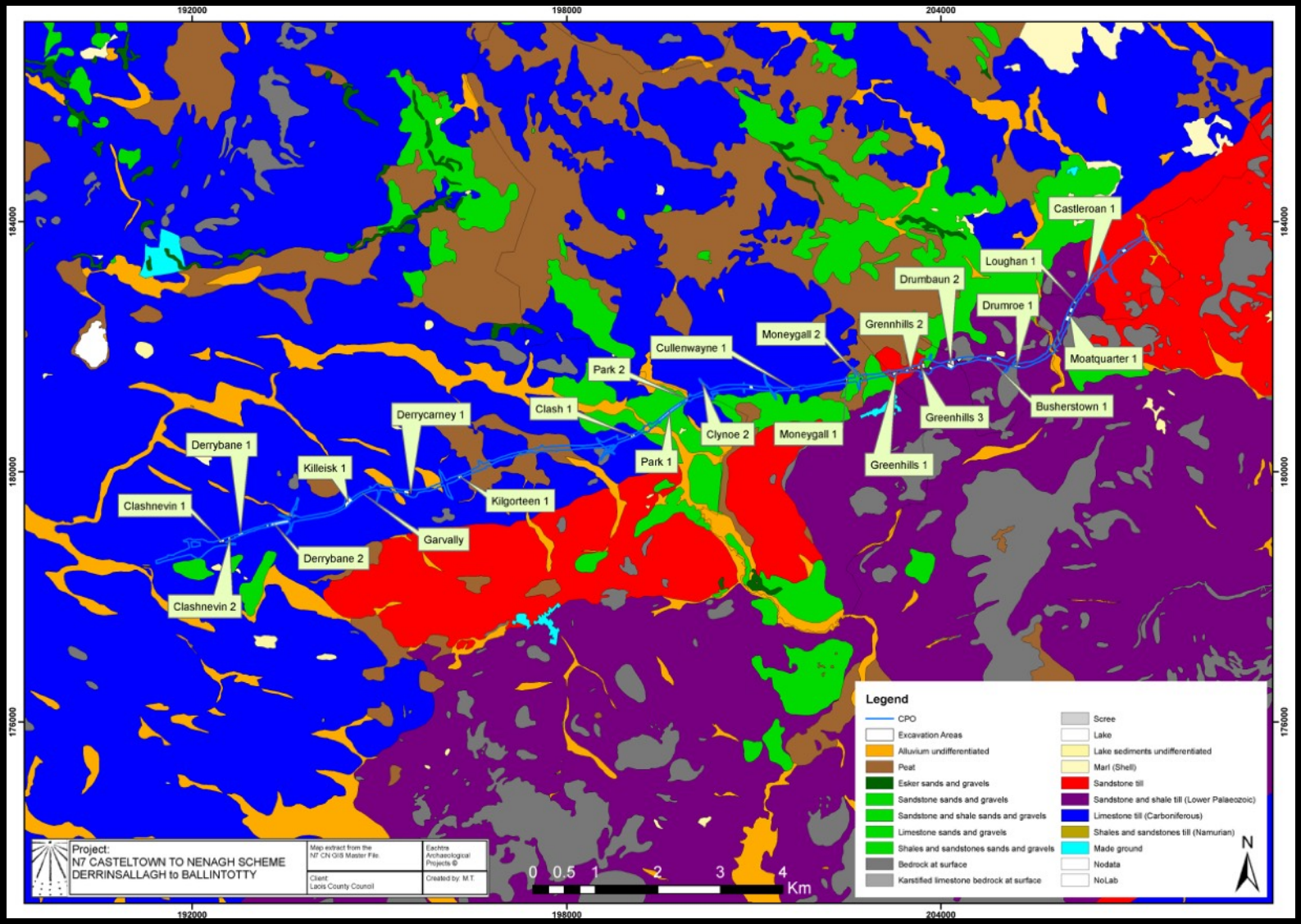
Thematic maps



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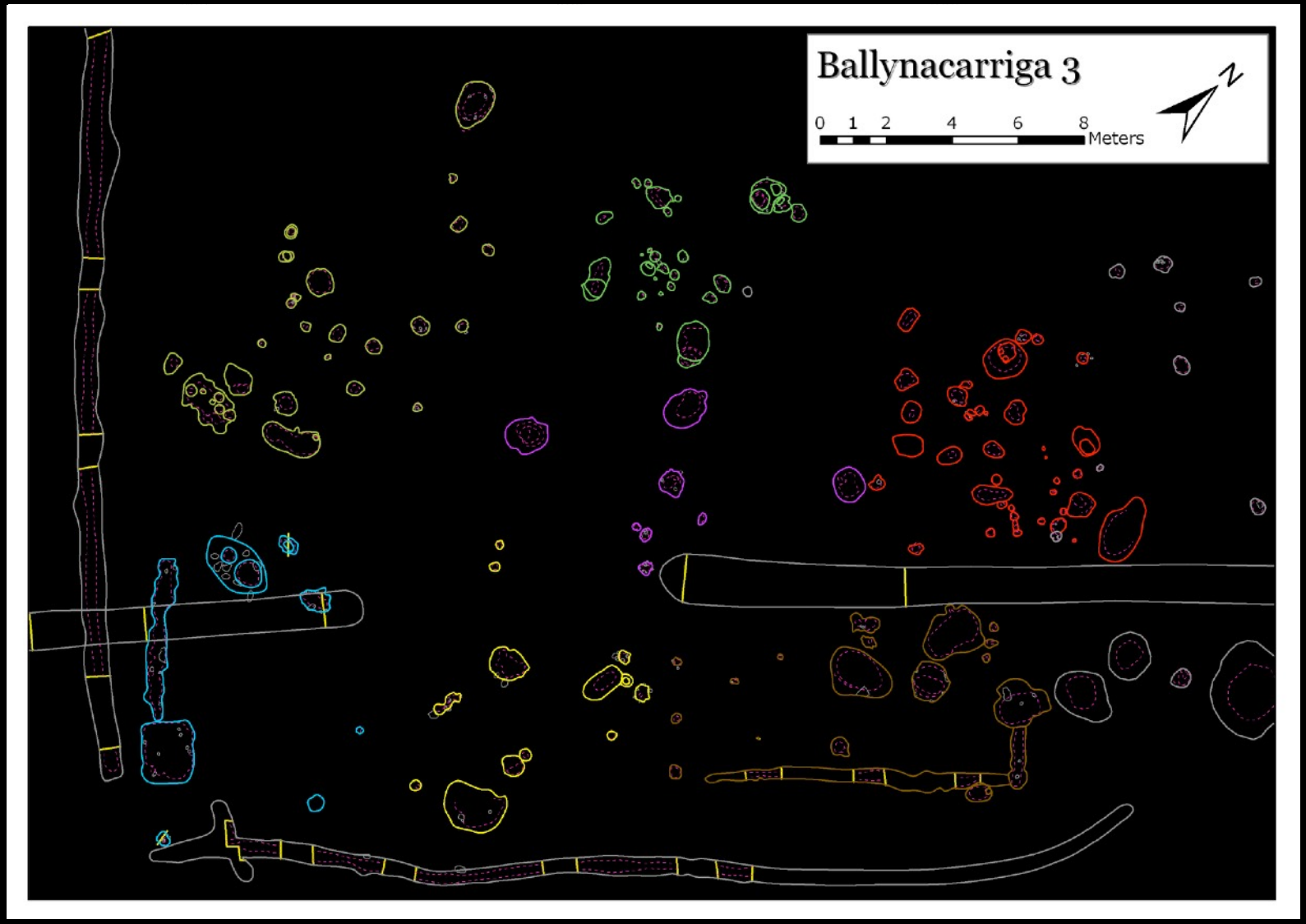
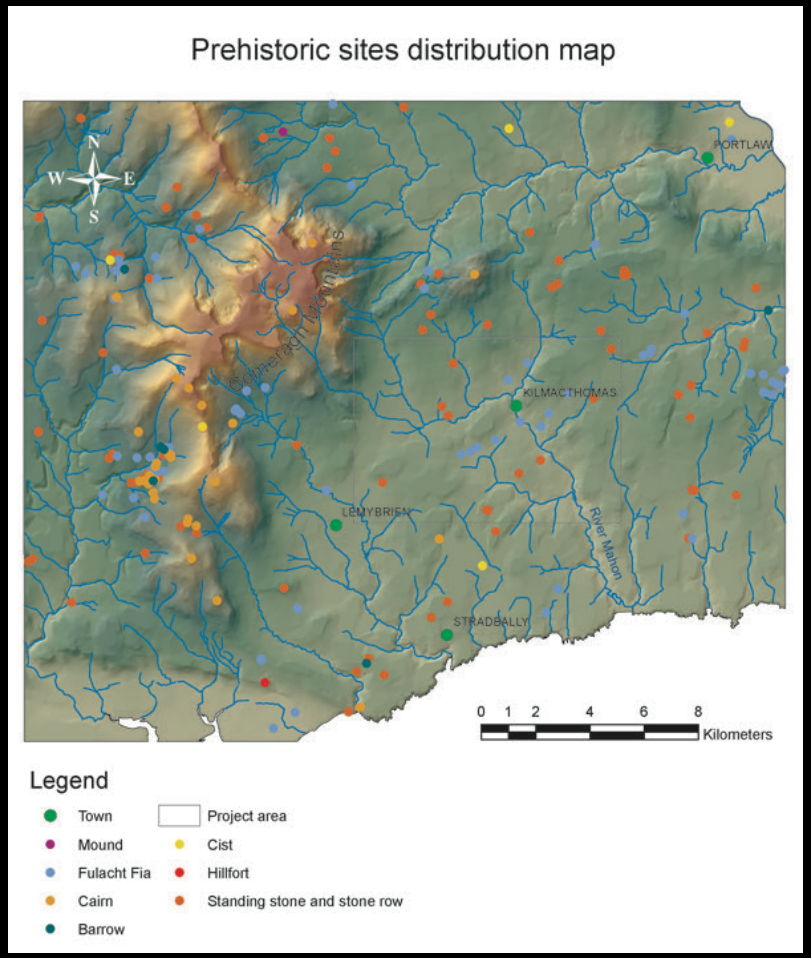
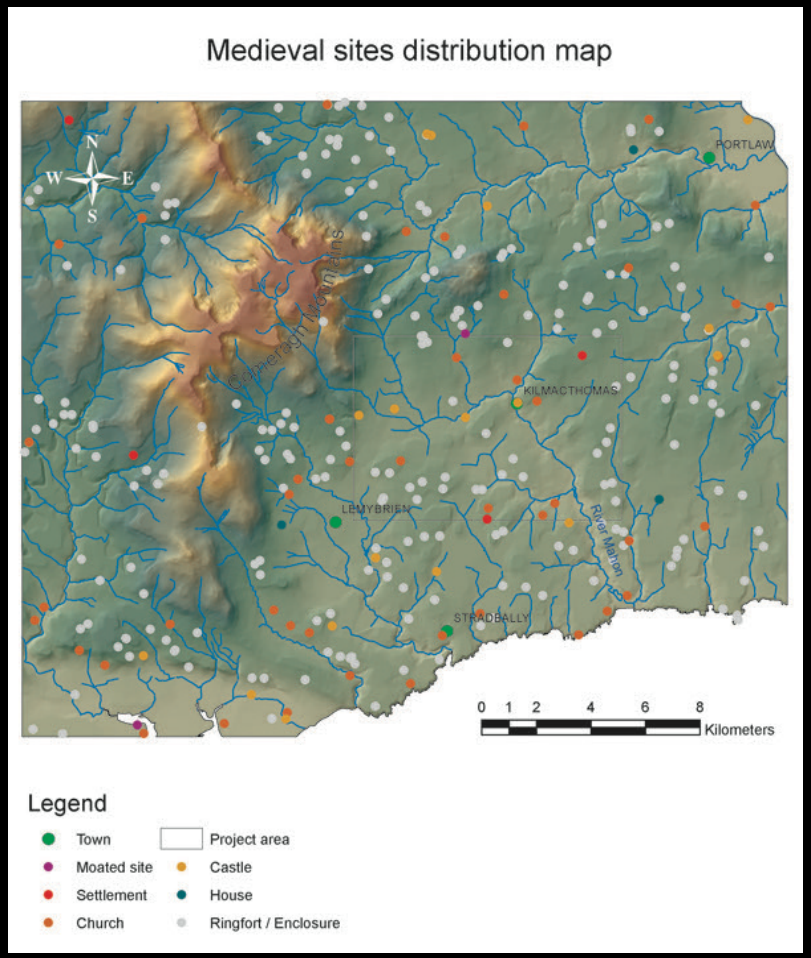


Distribution maps





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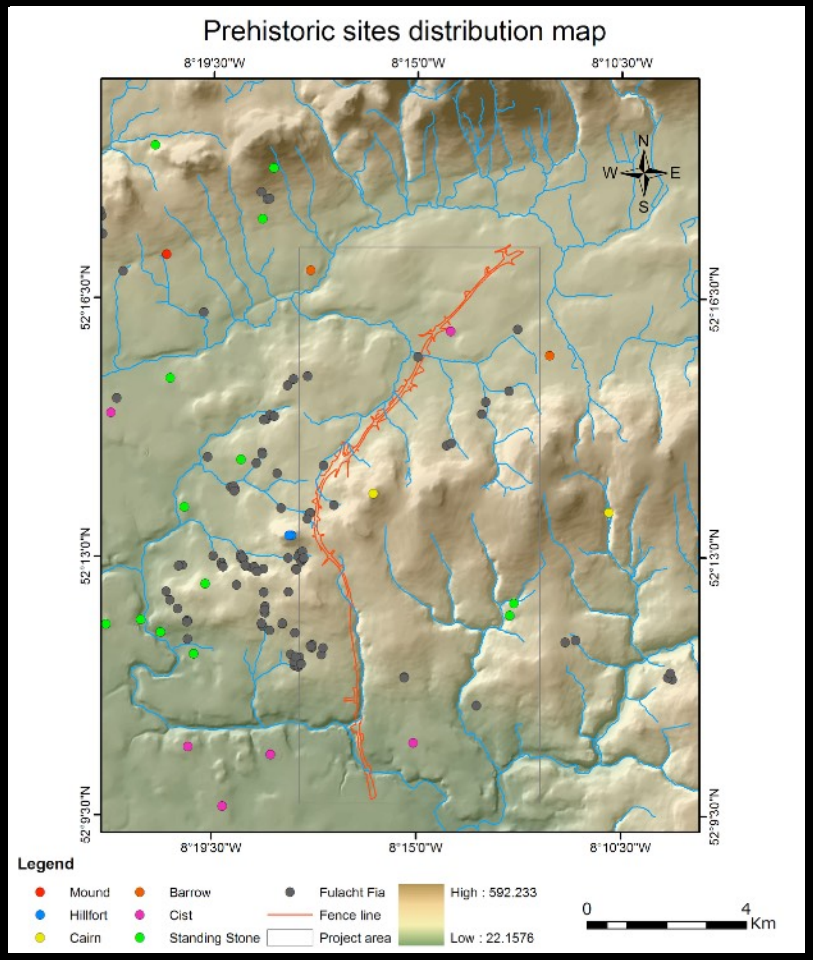
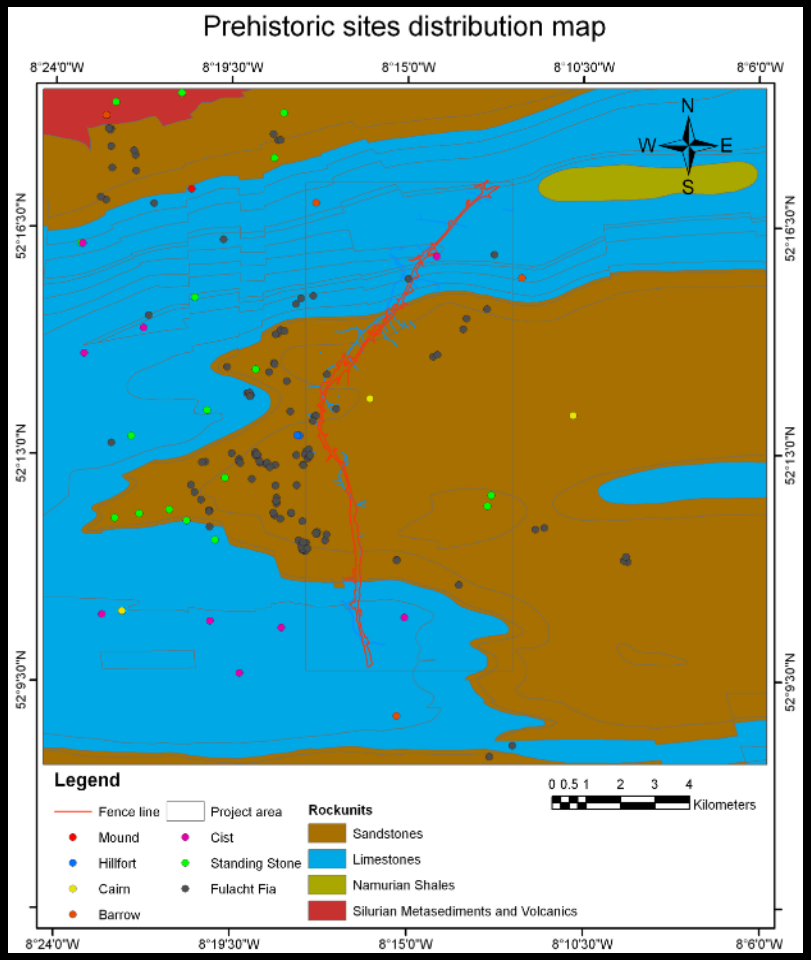
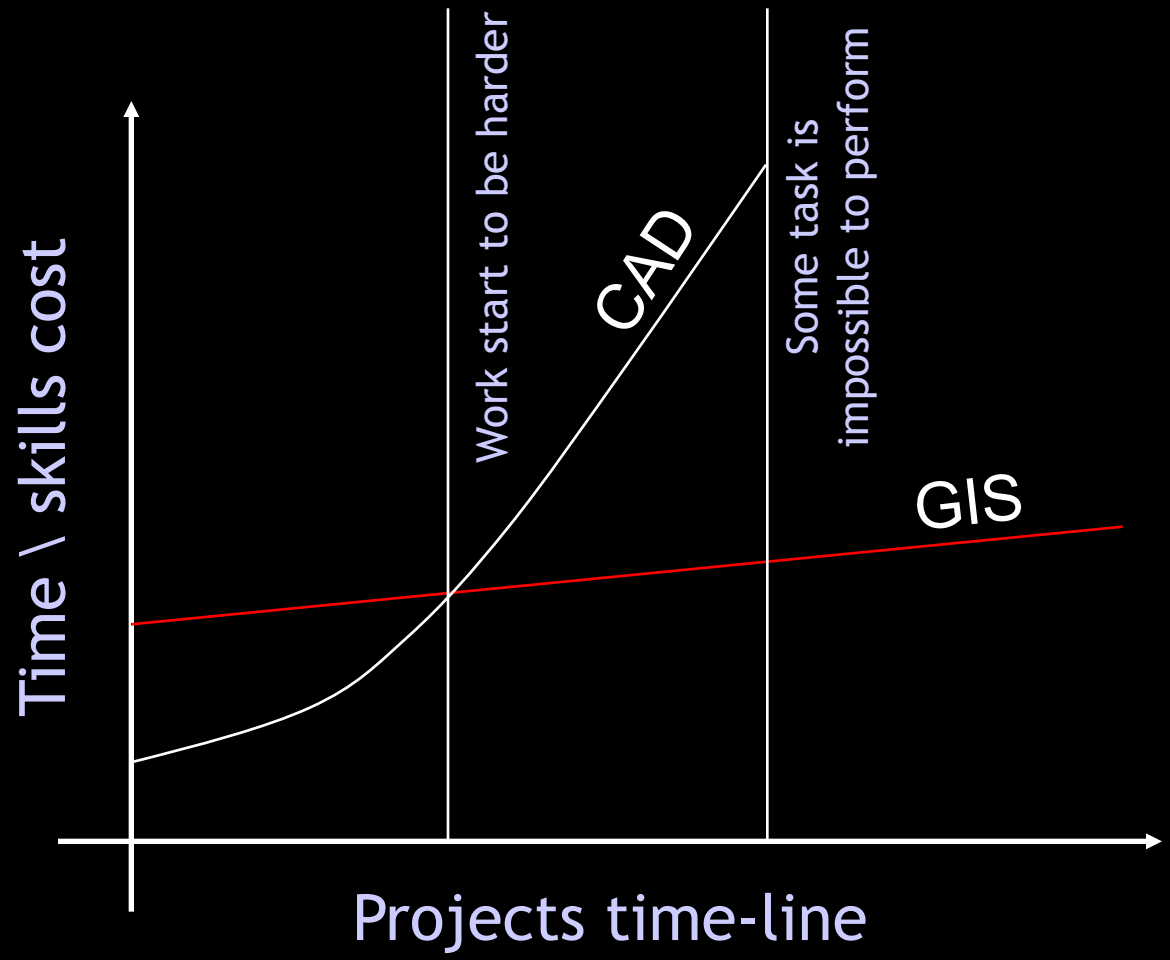




Benefits of GIS

GIS vs. CAD in a road project



GIS - CAD: choose the right tool

- A complete representation of the archaeological features on a site requires both geometric and attribute data: an object is mute without its attributes.
- GIS is rooted in data management and can therefore allow us to treat drawing entities as information that we can manage and interpret.
- The majority of data about the Irish landscape, provided by various organizations, (elevation, soil, subsoil, landuse …) is in GIS format.

GIS - CAD: choose the right tool

- CAD is excellent for drafting geometric data, very useful to engineers and architects;
- all tasks done in CAD by an archaeologist (drawing plans, manage survey data, take measurements) can be successfully done in GIS;
- when dealing with coordinates, CAD systems use a simple Cartesian grid view. This is not adequate if we are dealing with a large area of study.

GIS main advantages

- GIS methodology requires an organised and standardised approach to everything undertaken, involving all workflow from data-recording techniques to on-site data entry and digital storing;
- Ideally, any kind of archaeological data can be input and manipulated in a GIS platform;
- GIS approach transform plans from an illustration of something already completed to an instrument of research;

GIS main advantages

- Archaeology produces a vast amount of data, often underused because of difficulties to access and relating to them;
- At the end of the project, the GIS platform represents a complete digital archive, giving post-ex researchers a powerful tool to improve the degree of accuracy of site interpretation;
- Vector data are suited to transfer into paper publication but also ready for amalgamation with other datasets as our future needs require.

There may be a reluctance to adopt a GIS platform to replace a CAD/Illustrator approach. Firstly a GIS technician is required and a certain amount of time is needed at start-up, but carrying out the project, time to perform different tasks will be reduced and results can be better.