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Geophysical survey of Roath Mill, Cardiff [ST197779]

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Abstract

Ground resistivity surveys were undertaken on the site of Roath Mill. A single 20m grid square was surveyed at high resolution (0.5m x 0.5m spacing) with 0.5m-sapced mobile electrodes. A larger area was surveyed using 1.0m-spaced electrodes at a 0.5m x 1.0m spacing.

The surveys show an area of elevated ground resistivity broadly, but not precisely, corresponding to the location of the mill building as determined by map regression. The high-resistivity zone is bounded abruptly to the NW by a NNE-SSW boundary roughly parallel to the expected line of the NW side of the mill buildings, but 5-10m further NW. The area is also abruptly bounded to the SW by a narrow elongate zone of low resistivity running slightly oblique to the modern park boundary. The zone of high resistivity grades eastwards more gradually, suggesting a progressive spread of demolition debris, although the presence of former tracks or hard standing to the front of the mill may also contribute.

To the north of the stream some strong featuring was also observed within the resistivity data. Some of these features showed some degree of association with the locations of a footpath and field boundary on the 19th century OS mapping. Two other features of the resistivity data did not correspond to 19th century mapped features. Firstly, a distinct lineation in the resistivity data on a NNE-SSW direction shows a marked resistivity drop to the west of a narrow zone of elevated resistivity. This lineation lies on the same line as that bounding the higher resistivity area to the south of the stream. The second is an abrupt resistivity change across a NW-SE line in the SE corner of the surveyed grid. This high resistivity area may impinge on area within which the park was initially landscaped with a more gentle dip to the stream and with an area of artificial 'rock outcrops' shown on old photographs.

Interpretation of the data is not straightforward. The mill buildings, as mapped in the 1880s, are not delineated in the data. This probably indicates that walls/footings are not preserved (or are not sufficiently differentiated from adjacent materials) at the depths examined (down to 1.5m below surface). This may indicate either that the footings were not substantial, or that the demolition process was fairly thorough. Lineations within the area of high resistivity might be due either to patterns of destruction/demolition or might, just possibly, reflect an earlier layout of buildings/features than those of the 1880s.The strong resistivity low to the south of the survey might equally just possibly be interpretable as an earlier watercourse.

Contents

Methods

Surveying
The surveys were laid-out using a Trimble 4700/5700 survey grade RTK GPS system. An *ad-hoc* arbitrary location was chosen for the Trimble 4700 base station. Surveys were laid out from pre-planned "round-number" 20m intervals of National Grid, uploaded to the GPS system, with the stakeout undertaken using a Trimble 5700 RTK rover unit. The 20m grids were marked by temporary canes. The grid points located by GPS were supplemented with additional points located by triangulation with tapes in areas with tree cover. The marked grids are illustrated in Figure 1. The base-station coordinates were established subsequently by post-processing using RINEX corrections from the closest five Ordnance Survey active stations. The grid peg locations were then post-processed to final coordinates.

In practice, the difference between the initial setup and the post-processed coordinates is very small – allowing the survey plan to be followed closely without the need to establish a base-station in advance of the commencement of survey. In this instance, the as-staked locations were 0.21m west of the designed location and 0.71m north.

The grid pegs were positioned to within 30mm of the correct location reported by the GPS, and should have a recorded accuracy of their as-staked location to within approximately 20mm of National Grid.

The survey was planned and processed within Trimble *Geomatics Office*. Because TGO has a software bug which will not allow it to process GPS baseline surveys conducted after September 2011, the raw GPS base-station data file was converted to RINEX format using Trimble's '*Convert to RINEX*' utility v2.1.2 and then, together with all the OS active station RINEX files, date-adjusted using the '*RinexDates*' utility (v.13), before baseline processing in TGO.

Magnetic gradiometry
Trial data were collected with a *Bartington Grad 601 Dual* fluxgate gradiometer. The data showed that the magnetic disturbance around street furniture and adjacent parked cars precluded meaningful survey on the south of the stream. To the north extremely strong anomalies also occurred, particularly along some of the paths, hinting at major buried ferrous materials, perhaps services. In view of these findings a magnetic survey was not pursued further.

Ground Resistivity
The ground resistivity surveys were undertaken with a Geoscan RM15 resistivity meter, with 3 mobile probes on a PA5 frame at 0.5m spacing.

Initially, the system was operated as two pairs of mobile electrodes (with 0.5m probe spacing - giving the main component of the response from 0.5-0.7m depth) on a PA5 frame, via an MPX15 multiplexer. In this configuration, the mobile electrode pairs had a 0.5m centre spacing, giving a 0.5m effective traverse interval with a 1.0m actual walked traverse interval.

Examination of the data after one grid taken on the presumed site of the mill building did not show conclusive evidence for the structure. The PA5/MPX15 were then reconfigured to use the outer electrodes only, giving a mobile probe spacing of 1.0m. This spacing was then employed for the resurvey of the initial grid and all subsequent ones.

Data were collected on a 20m grids, walked in parallel pattern, with a 0.5m sample interval (i.e. the raw data grid has 0.5 x 0.5m node spacing for the 0.5m mobile probe spacing and 0.5 x 1.0m for the 1.0m mobile probe spacing). Data processing in *Geoplot* was limited to edge matching grids and removal of any minor data spikes (due to poor electrode contact). In addition the position of the survey north of the stream had to be adjusted with respect to that on the south, since it was offset from the pre-determined grid lines by 10m (See Figure 1). Data were exported from *Geoplot* and imported to Golden Software's *Surfer*. The data were gridded by kriging to a node spacing of 0.125m for production of the final image.

Data presentation
All geophysical data are presented following imaging in Golden Software's *Surfer* software, unless otherwise stated. The datasets presented in *Surfer* have had the extent of the modern paths blanked-out. The paths gave very variable, but frequently very high, readings – which detract from the visibility of other anomalies. The standard resolution of fitted surfaces was 0.125m x 0.125m. Site plans have prepared in *CorelDraw*.

The survey was conducted on 17th March, in good, just slightly damp, conditions. This project was conducted on behalf of Cardiff Archaeology Society and was organised by Diane Brook.

Results

The results of the survey are illustrated in raw form in Figure 2 and as interpolated greyscale images on modern and old base mapping in Figures 3 to 6.

The resistivity survey straddles the line of Roath Brook in the area of the former Roath Mill. The surveys north and south of the river were undertaken without standardisation of the measured resistance, because of the practical difficulties that would have been involved in so doing. The absolute values of resistance measured on either side of the brook are not, therefore, directly comparable.

The area to the north of the stream shows a very variable resistivity, broadly decreasing down-slope (apart from a strong resistivity high in the SE corner). There is a possibility that the modern path conceals a resistivity low – perhaps modern services, but this is uncertain.

To the south of the stream parts of three grid squares were surveyed, centred on an area of elevated resistivity broadly corresponding the location of the former mill, discussed in detail below.

Interpretation

The following discussion is illustrated on Figure 7, with the simple linework of the interpretation repeated on modern and old base maps in Figures 8 and 9. A summary interpretation, including some highly speculative suggestions regarding possible early features is presented on Figure 10.

The evidence described above suggests that the data contain no firm evidence for discrete structural elements of the mill building as mapped, photographed and painted in the late 19th century. This suggests that although the south wall of the wheel-pit is preserved in the modern stream bank, other parts of the mill were either thoroughly removed in the demolition process or that they are not of sufficient geophysical contrast to be imaged.

Some of the anomalies within the dataset are associated with aspects of the modern landscape – including the variable, but typically raised resistivity on the line of the modern paths (Figure 2; largely blanked out on Figure 7b and c) and a negative anomaly associated with the side of the raised bank alongside the stream (6 on Figure 7a).

To the north of the stream, it is likely that the variable resistivity records, at least in part, the variable depth of burial of the pre-park topography. The broad coincidence (Figure 9) of the lines over which the resistivity abruptly decreases to the south (2 and 3 on Figure 7a) with the area bounding the 19th century footpath suggests these may be buried topographic features. The northern edge of the area of high resistivity (1 on Figure 7a) corresponds approximately with the field boundary on the 1880s mapping. The SW edge of this resistivity high is strongly marked and abrupt. This might relate to the early park landscaping – but might also reflect an aspect of the construction of the dam, or even (as discussed below) a possible former spillway channel, by-passing the mill.

The broad area of high resistivity around the site of the buildings suggests survival of a spread of demolition debris (area 5 on Figure 7a). Although the walls of the 19th century building were not imaged, there are features within, and bounding, the high resistivity area that require explanation.

The high resistivity zone is bounded to the west by distinct NNE-SSW narrow zone of reduced resistivity (4a on Figure 7a), which appears broadly coincident with the line of a similar zone to the north of the stream (4 on Figure 7a). One possible interpretation for these features is that they are unrelated – (4) representing part of the mapped field-boundary north of the stream and (4a) being perhaps the edge of cultivated land in the mill garden. Faint indications of an anomaly in the west of the area (5 on Figure 7a and its continuation to the north onto the bank) may correspond with the boundary around the mapped garden or orchard to the west of the mill. An alternative explanation is raised below.

The high resistivity is bounded to the south by a rather marked narrow zone of decreased resistivity (9 on Figure 7a). This zone is not parallel to the margin of the park, suggesting it is not a modern feature. Whilst this zone is probably associated with the demolition of the site, an alternative interpretation is offered below.

Within the footprint of the mill there are discrete negative anomalies on the data from the survey with the 0.5m mobile probe spacing (8 on Figure 7a) and a narrow zone of elevated resistivity, seen best on the data from the survey with the 1.0m spaced mobile probes. Neither of these sets of linear anomalies are quite on the anticipated alignment of the mill building. In the case of the negative anomalies, they could be evidence for robbed internal walls, but are more likely to be some facet of the disturbance of the demolition debris. The elevated resistivity anomalies (7 on figure 7a) might be associated with the southern wall of part of the mill – but do not appear quite in the right orientation and there is a slight possibility these might represent an earlier structure. The presence of the potentially best evidence for the survival of walls at the end of the mill away from substantial 3-storey part of the building seen in photographs and paintings is odd. The lack of clear coincidence of these anomalies with mapped walls is also odd.

The close proximity between these strong positive anomalies (7 on Figure 7a) and the elongate negative anomaly (9 on Figure 7a) is tempting to interpret as former mill building with a wheel-pit/tailrace to its south. Such an interpretation would require water to be able to reach the wheel from the north or northwest. This might be achievable either by a launder or, if anomalies 4 and 4a (on Figure 7a) were indicators of a longer earlier dam, directly from an earlier, larger pond. The alignment of these anomalies on either side of the former pond is suspicious, but neither anomaly is very strong. There is no evidence for a former watercourse to the SE of the site, and a wider earlier dam has no supporting topographic evidence. Thus (4) and (4a) may simply be unrelated, may perhaps be a feature of the construction of the extant pond, or just possibly be an indication of an earlier, larger, pond.

A further, highly tentative, piece of interpretation would be that of the curving anomalies in the SE corner of the section of the survey N of the stream as a former spillway channel. The anomaly is very marked, and the line heads towards an embayment in the stream marked on the 1880s mapping. Spillway channels placed against the natural slope are a common feature of mills, but cartographic evidence from the 19th century shows that excess water was taken from the leat via two sluices on its south side well upstream of the mill at that period. An alternative explanation of the features in this area is that they are associated with the rather drastic landscaping shown immediately to the east in old photographs (early 20th century), which entailed a series of artificial rock outcrops running down a gentle slope towards the stream. If any of the large rocks still lie buried below the modern lawn they would certainly be capable of producing the strong positive resistivity anomaly.

The summary of the interpretation is shown in Figure 10. The extent of the mill in the 1880s is shown in black, with the resistivity features interpreted as its demolition debris in pink tone.

The highly speculative aspects of the interpretation are shown in red – the solid red line indicating the anomaly that might be indicative of an earlier dam location, the dashed line indicates the possible spillway at the N end of the dam and the possible tailrace is shown as a dotted line in the south. All of these features have quite feasible alternative explanations, however, and there is no conclusive evidence for an earlier phase.

Acknowledgements

The author is grateful to Diane Brook for making the arrangements for the survey. Members of CAS largely conducted the resistivity surveys.

Figure Captions

Figure 1. Grid layout and relationship to National Grid. Dashed lines indicate features within Roath Mill Park, with blue lines indicating the modern course of Roath Brook.

Figure 2. Ground resistivity survey results. Raw data presented as bitmapped images from *Geoplot*.

a. Data from the survey with the 1.0m-spaced mobile probes. Greyscale 10 ohm measured resistance (black) to 35 ohm measured resistance (white). Note that the readings are not balanced between those N and S of the stream)

b. Data from the survey with the 0.5m-spaced mobile probes. Greyscale 17 ohm measured resistance (black) to 60 ohm measured resistance (white).

Figure 3. Greyscale image of data kriged in *Surfer.* Data from the survey with the 0.5m-spaced mobile probes. Greyscale 22 ohm measured resistance (black) to 60 ohm measured resistance (white). Data displayed on base of modern topography as Figure 1.

Figure 4. Greyscale image of data kriged in *Surfer.* Data from the survey with the 0.5m-spaced mobile probes. Greyscale 22 ohm measured resistance (black) to 60 ohm measured resistance (white). Data displayed on base redrawn after the 1880s OS mapping.

Figure 5. Greyscale image of data kriged in *Surfer.* Data from the survey with the 1.0m-spaced mobile probes. Greyscale 10 ohm measured resistance (black) to 32 ohm measured resistance (white). Data displayed on base of modern topography as Figure 1.

Figure 6. Greyscale image of data kriged in *Surfer.* Data from the survey with the 1.0m-spaced mobile probes. Greyscale 10 ohm measured resistance (black) to 32 ohm measured resistance (white). Data displayed on base redrawn after the 1880s OS mapping.

Figure 7. Interpretation of the resistivity data

a. location of anomalies described in text

b. Greyscale image of data kriged in *Surfer.* Data from the survey with the 1.0m-spaced mobile probes. Greyscale 10 ohm measured resistance (black) to 32 ohm measured resistance (white).

c. Greyscale image of data kriged in *Surfer.* Data from the survey with the 0.5m-spaced mobile probes. Greyscale 22 ohm measured resistance (black) to 60 ohm measured resistance (white).

Figure 8. Linework from the interpretation (after Figure 7a) displayed on modern topographic base (as Figure 1)

Figure 9. Linework from the interpretation (after Figure 7a) displayed on base redrawn after 1880s OS mapping.

Figure 10. Summary interpretation.

Blue tone – 19th century millpond
Green tone – 19th century retaining bank
Black lines – features of 19th century OS mapping.
Pink tone – high resistivity area – demolition rubble.
Red lines – high speculative aspects of the interpretation – for details see text.

Figure 1

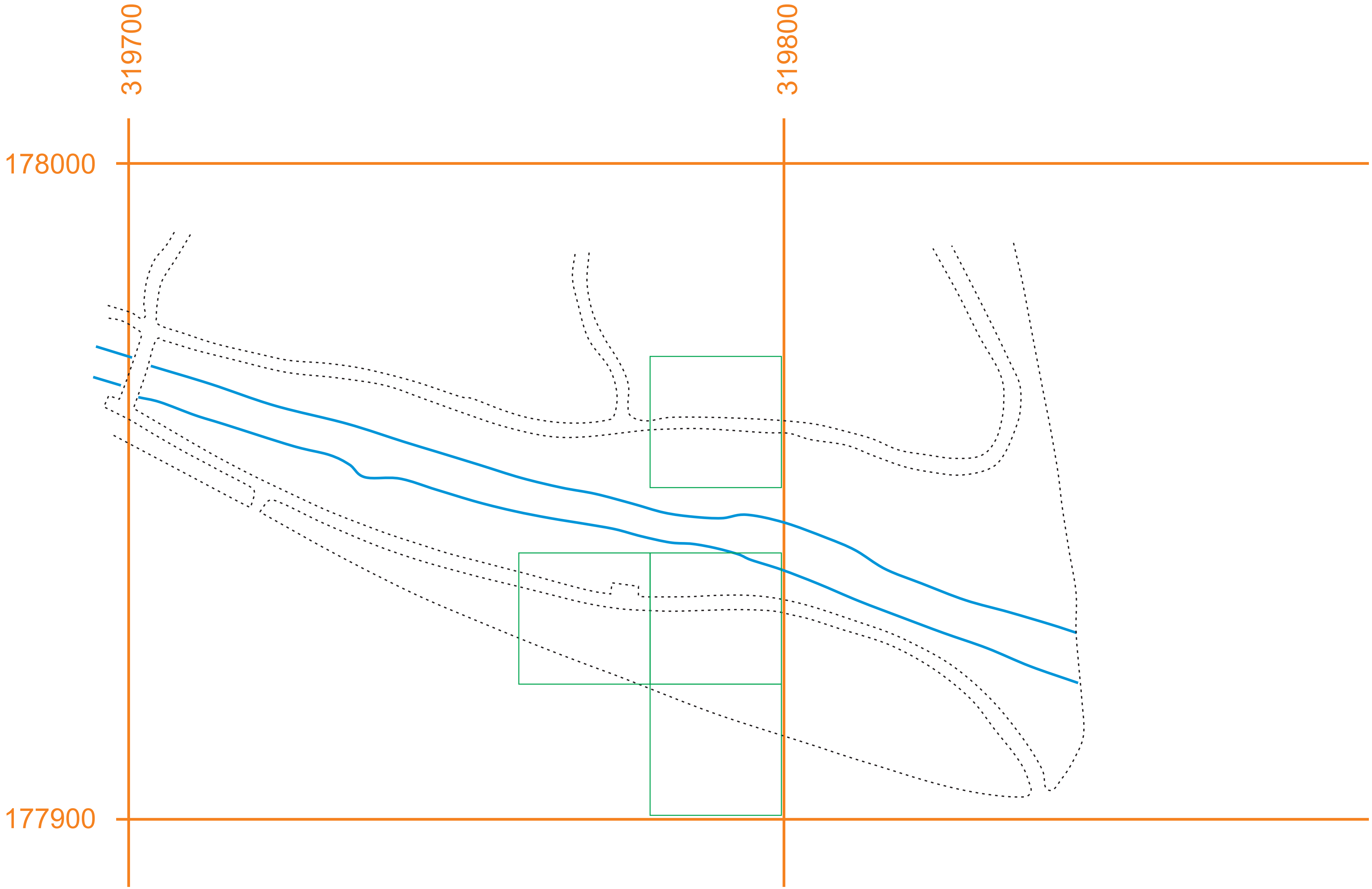


Figure 2

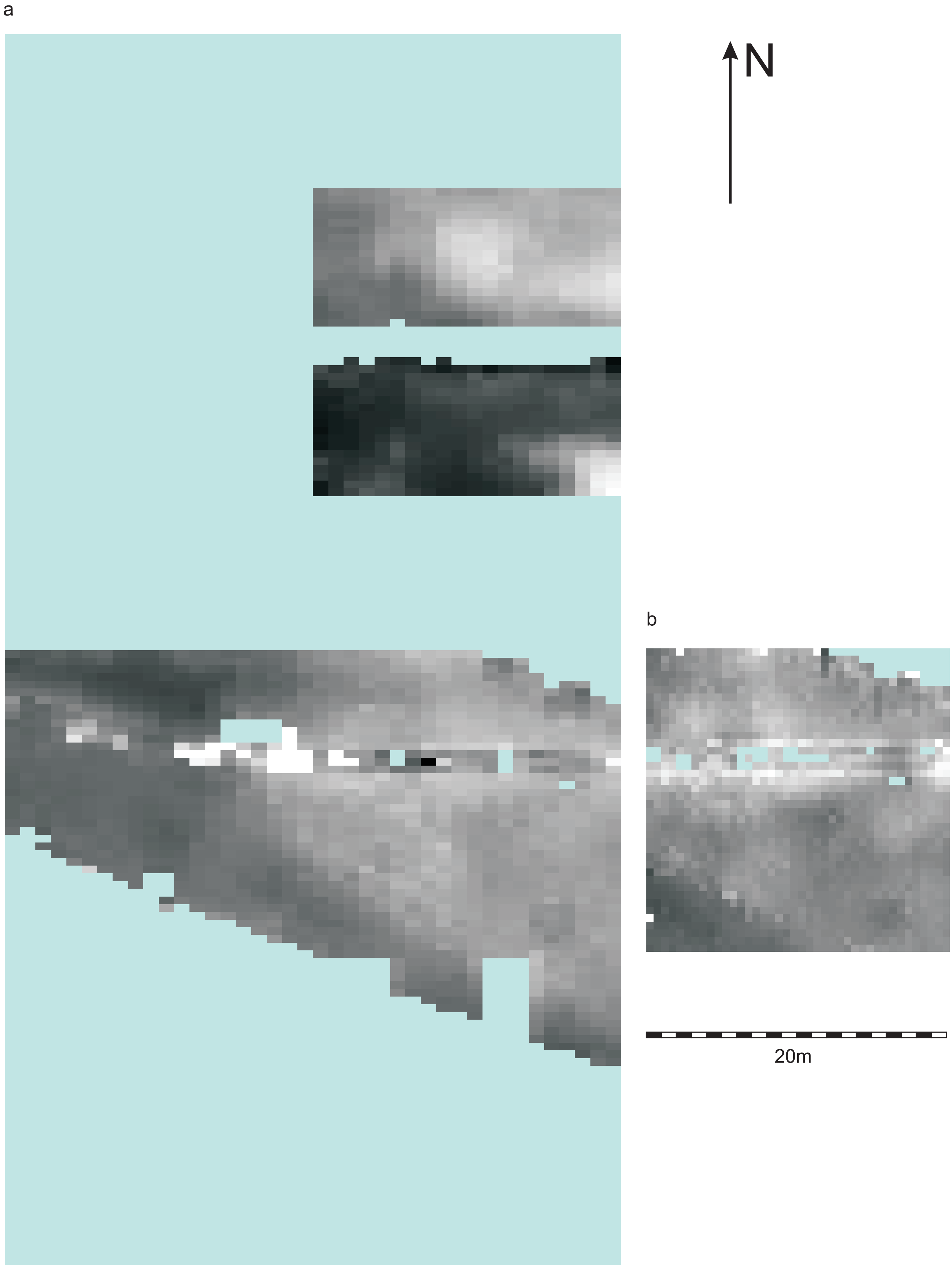


Figure 3

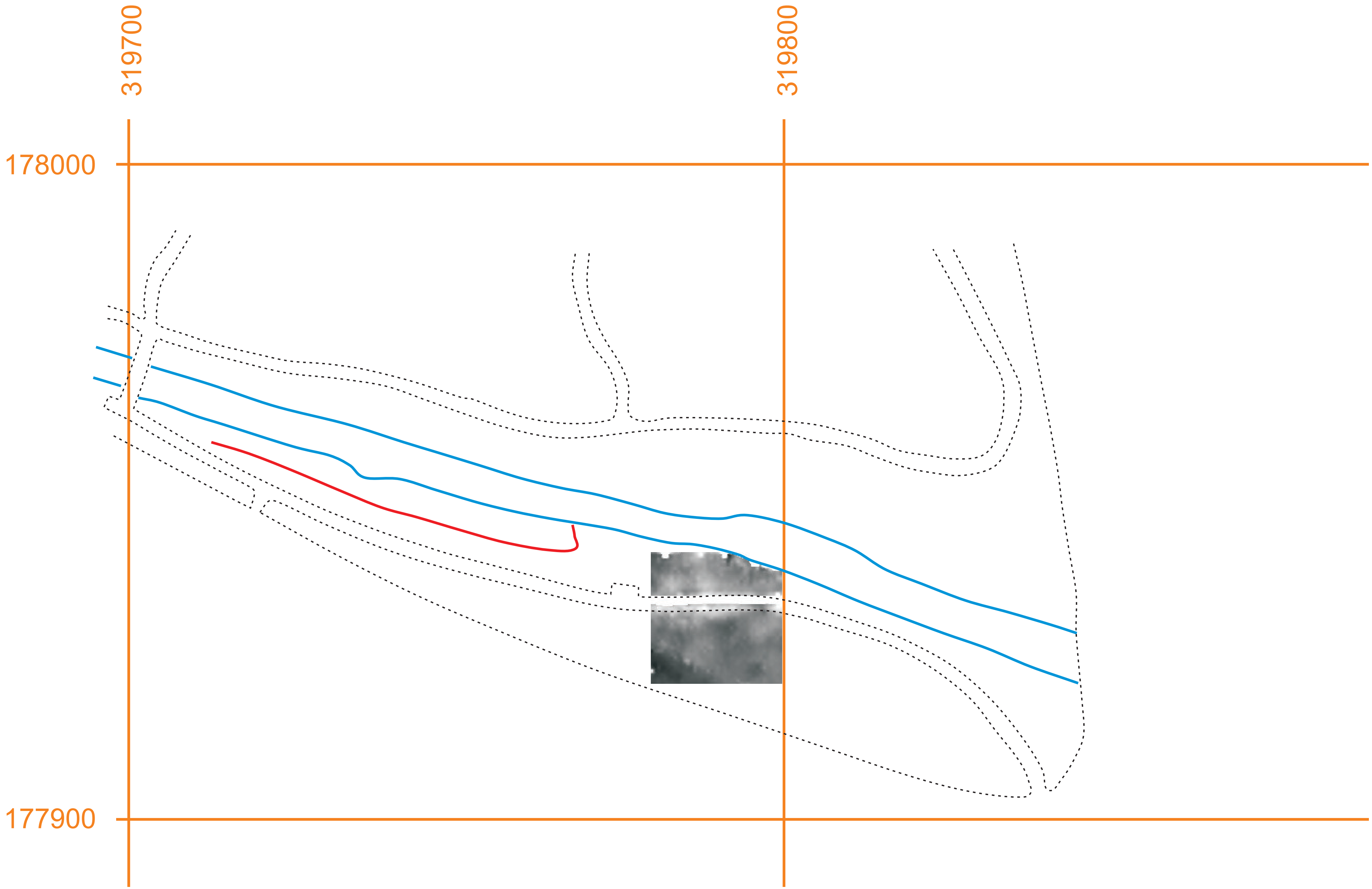


Figure 4

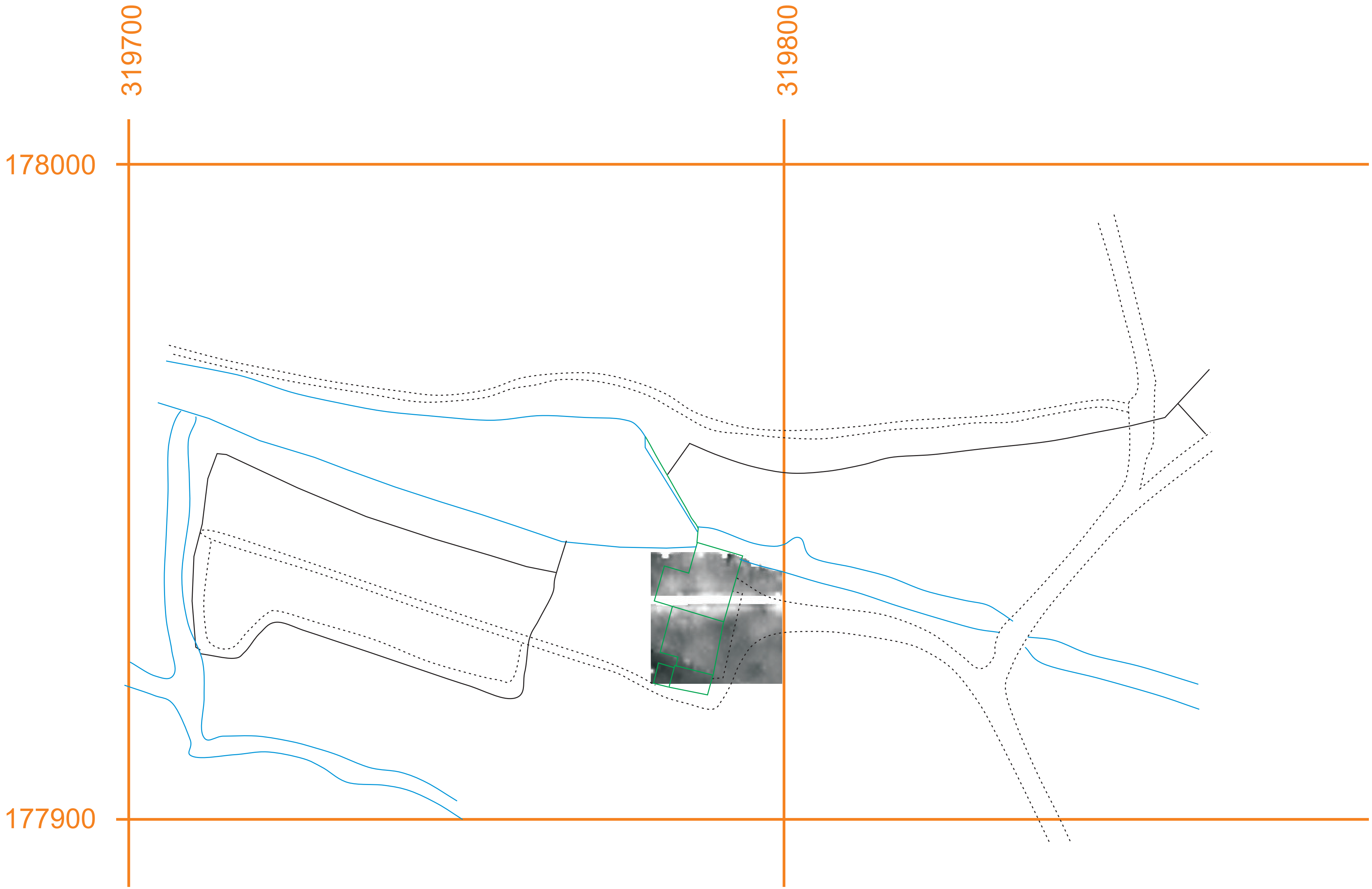


Figure 5

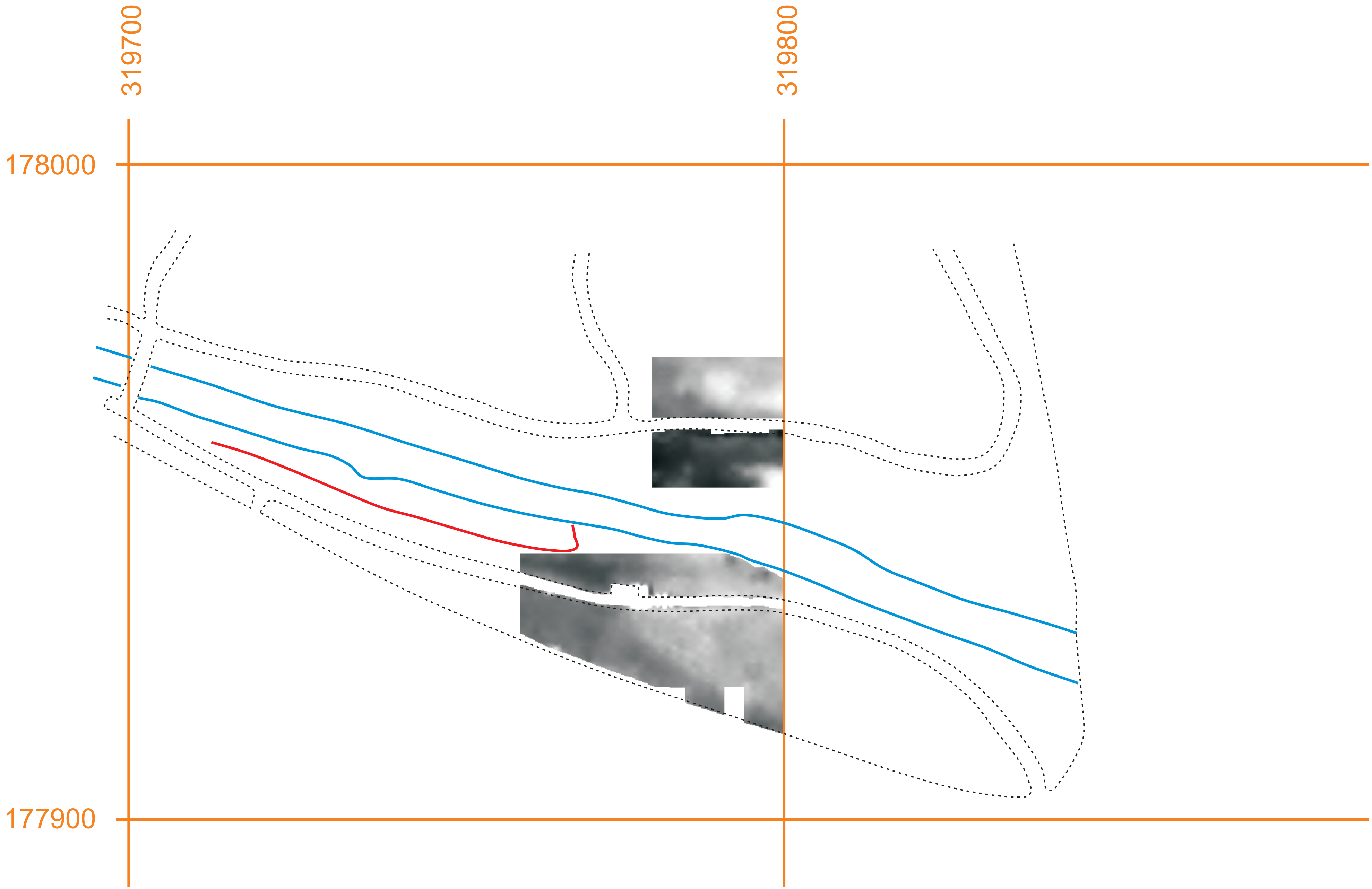


Figure 6

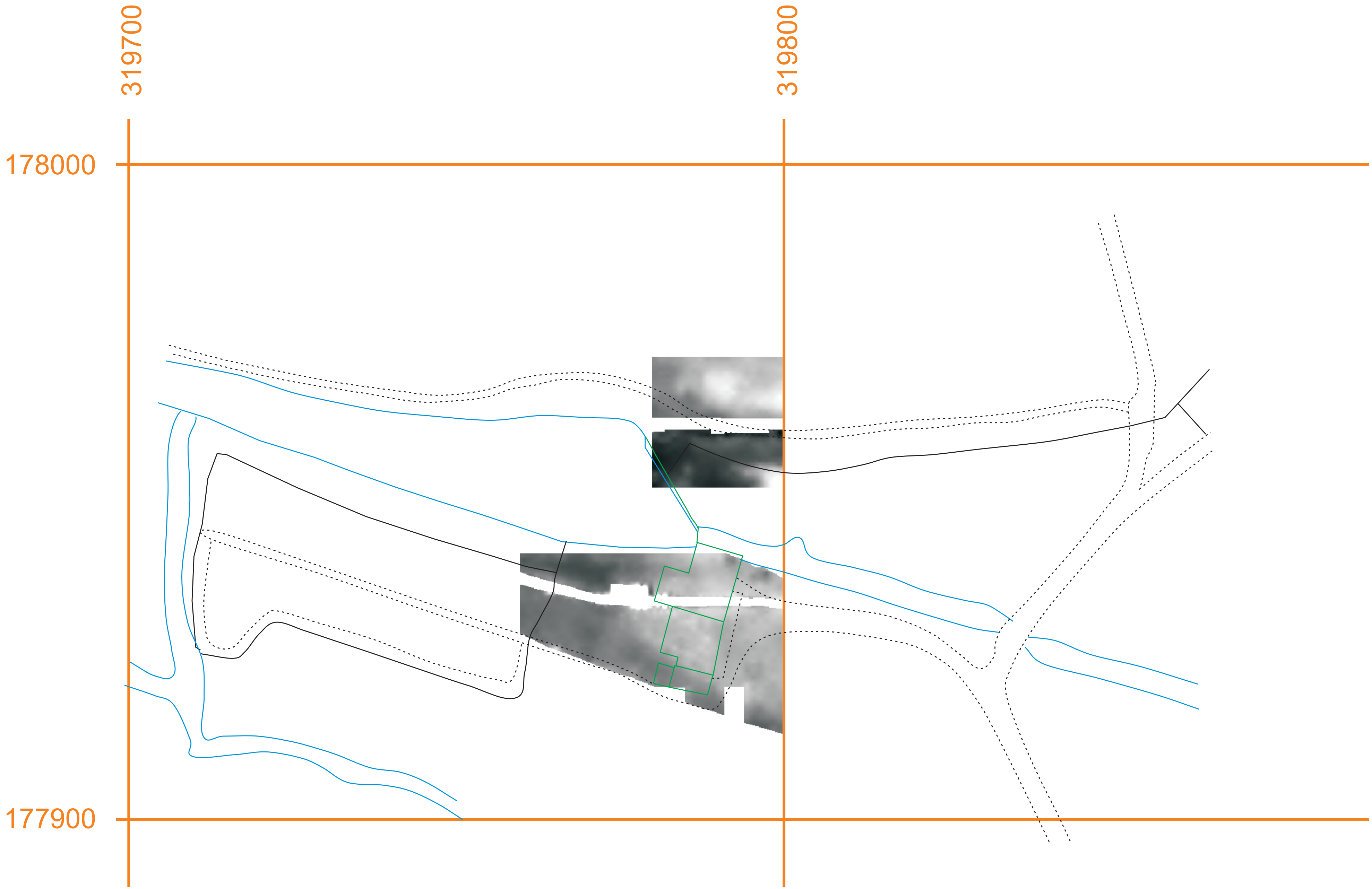
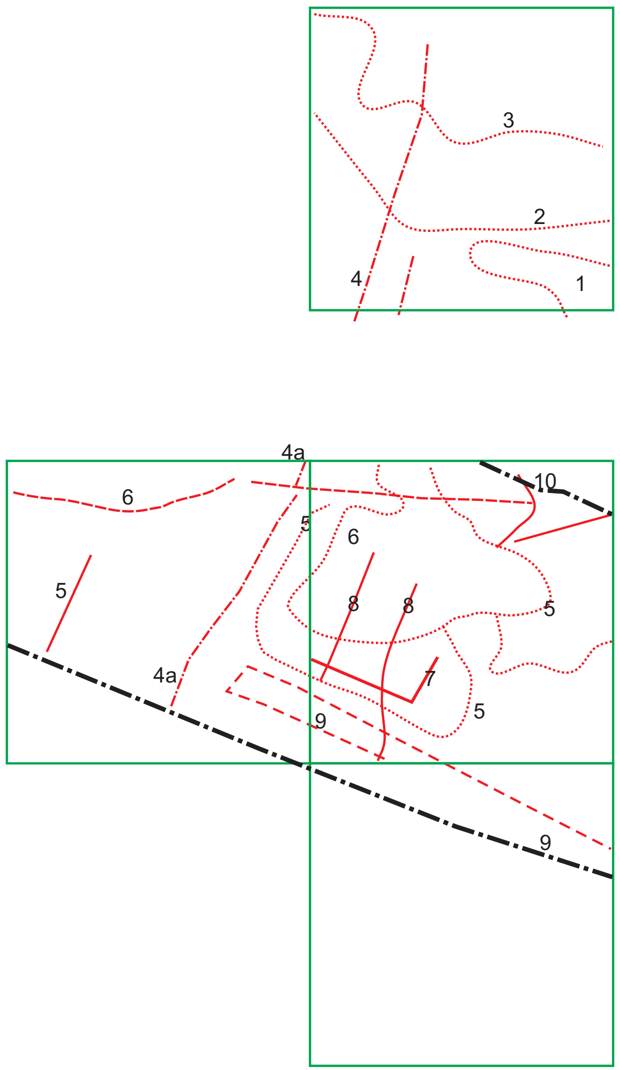


Figure 7

a



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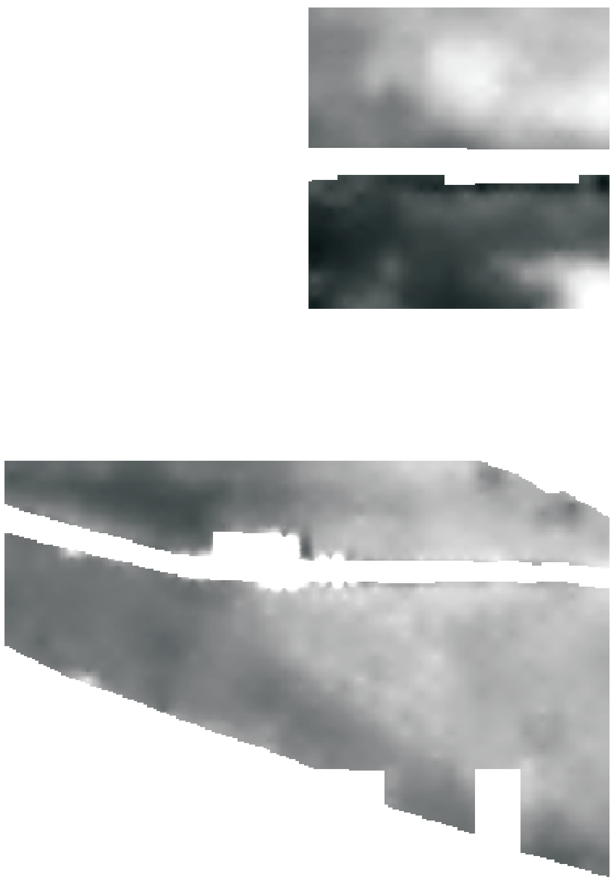


c

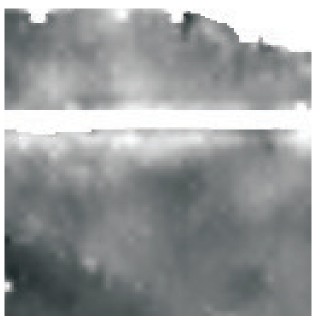


Figure 8

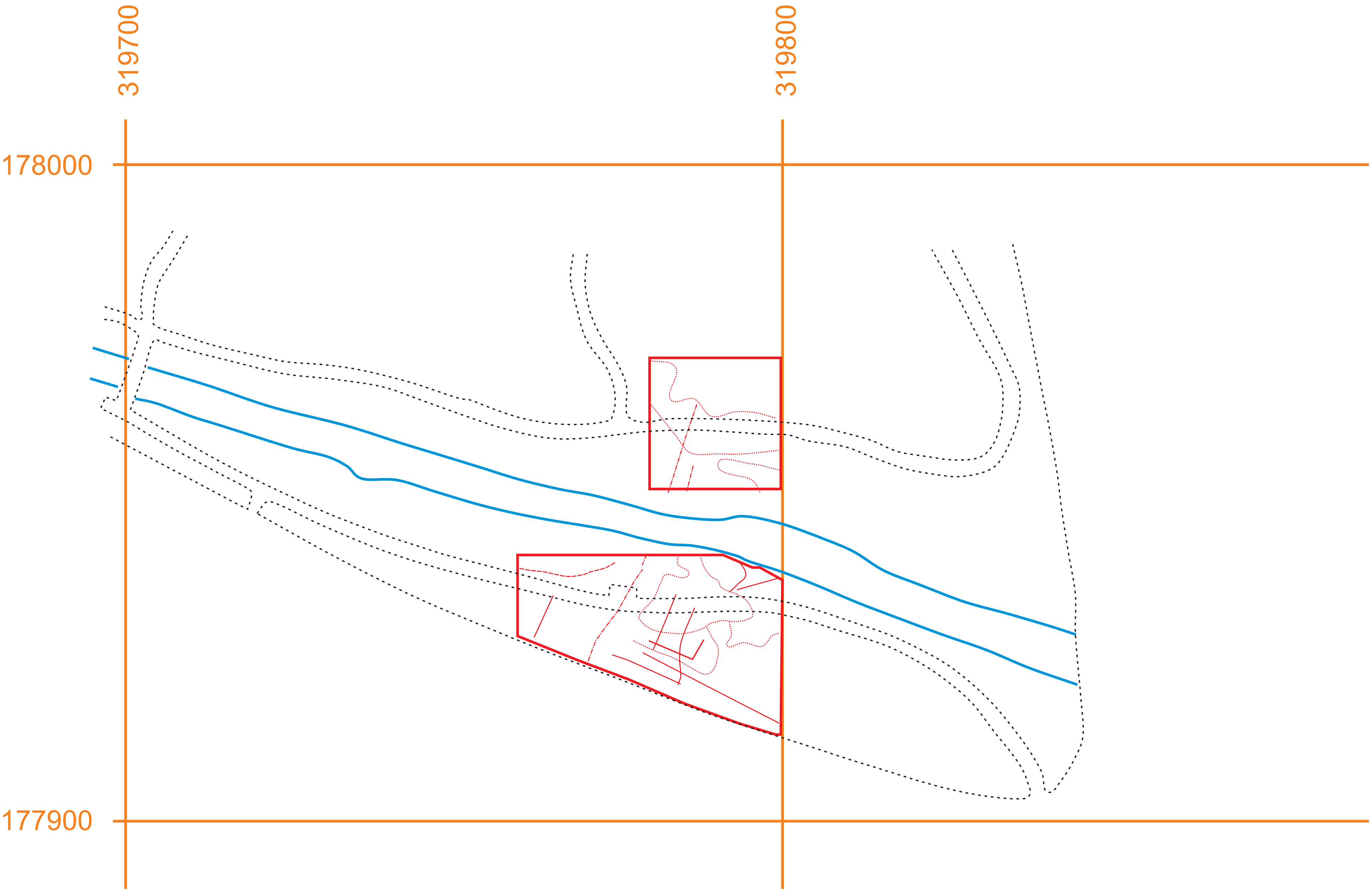


Figure 9

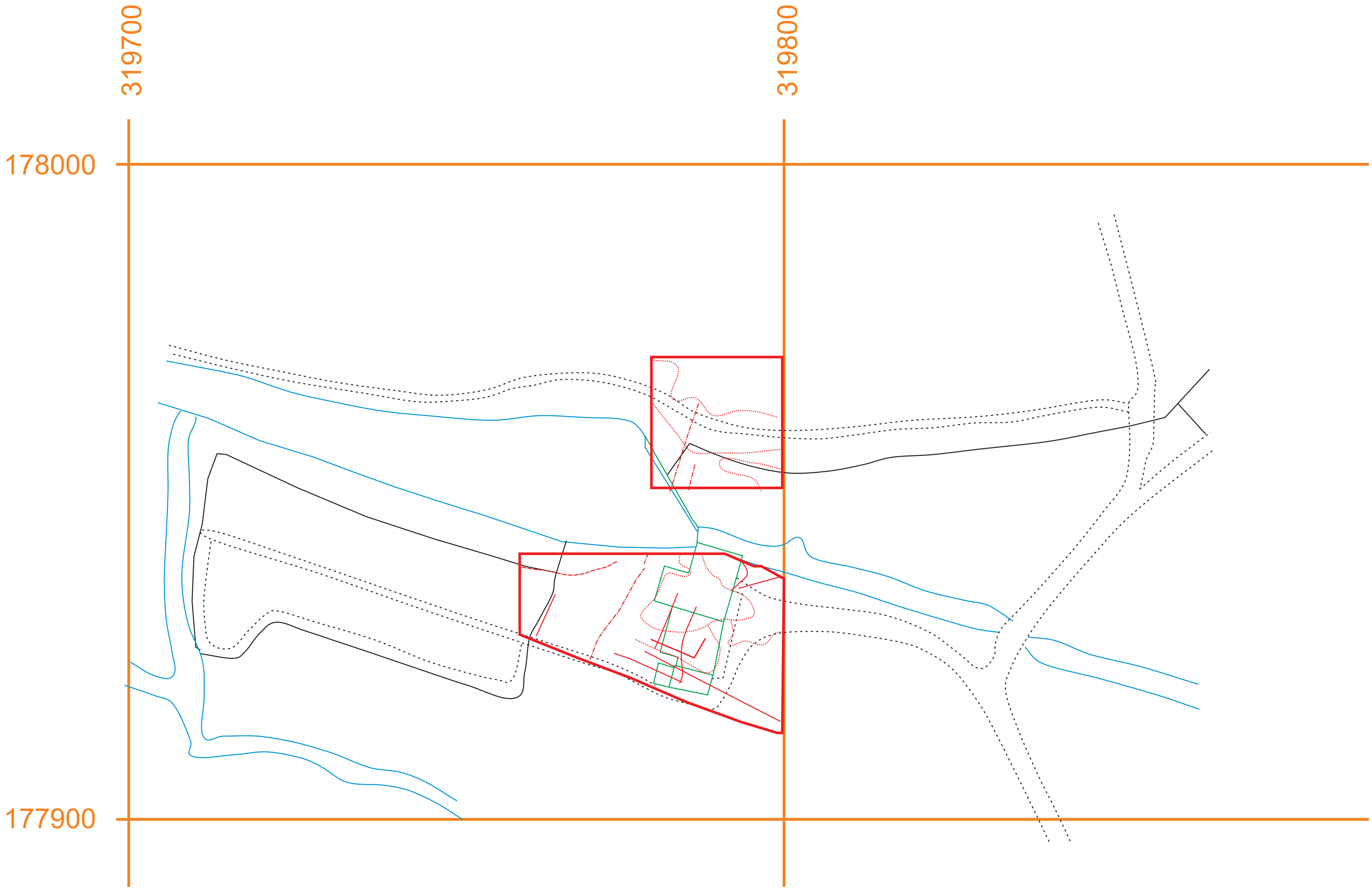
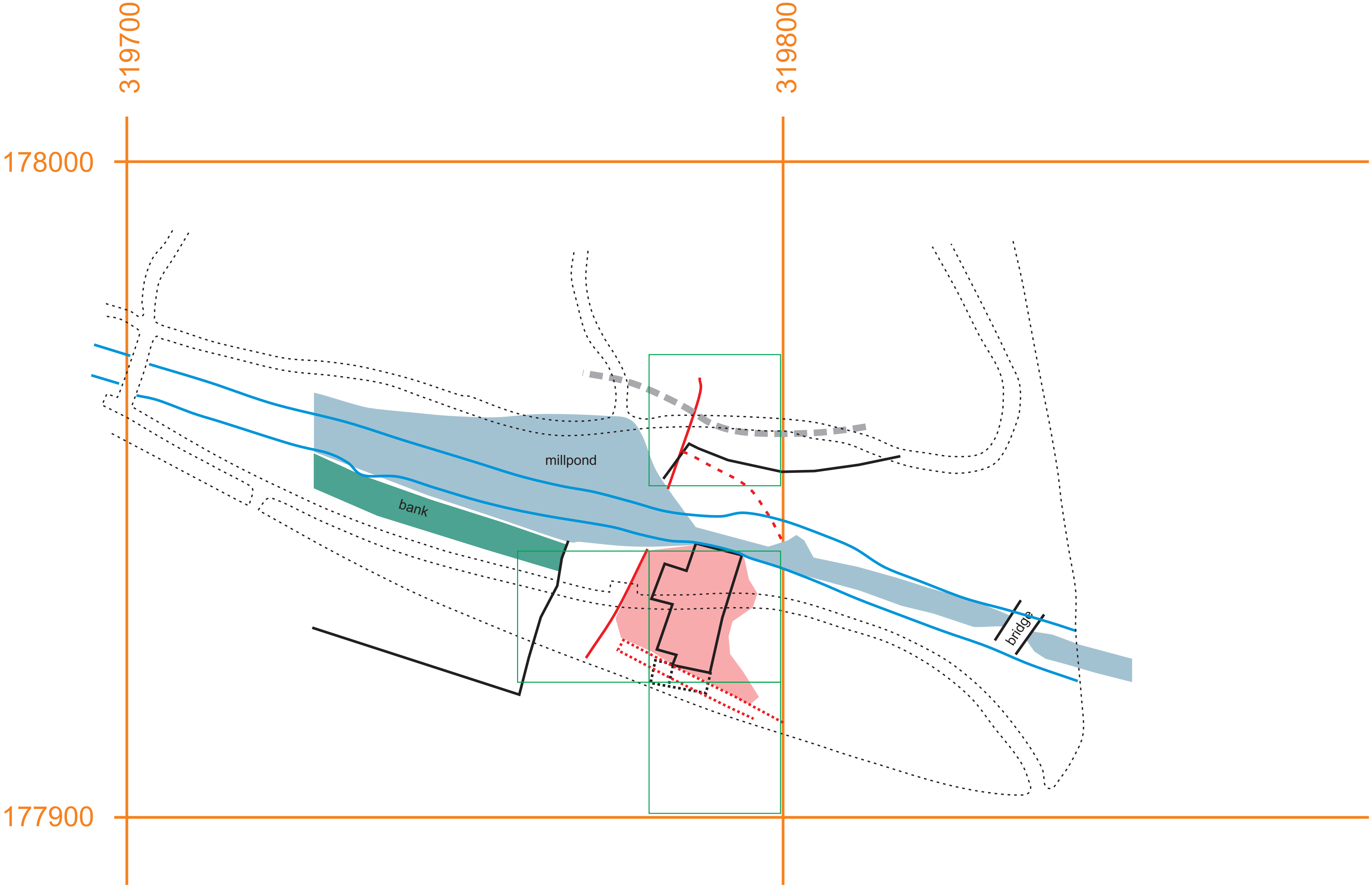


Figure 10



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