Geophysical Investigation for the Pukekohe Cemetery Memorial Project, May-June 2025

Summary of Survey, Results and Interpretation

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ScanTec was approached by the Pukekohe Cemetery Memorial Koomiti to assist in the investigation and mapping of above-ground and below-ground features at the Pukekohe Cemetery as part of the Pukekohe Cemetery Memorial Project.

Survey work started in May 2025, and was carried out by Matt Watson (geophysicist) assisted by Alex Watson (survey technician).

The above-ground mapping involved using GNSS equipment for measuring the precise locations of features, such as footpaths, driveways, head-stones, foot-stones, fences, walls, hedges, shrubs, etc. An example of the data is shown below (Figure 1). The resulting maps and images can be used in Geographical Information Systems (GIS) software for many different purposes including planning and design.



(Figure 1) Above ground mapping at Pukekohe Cemetery showing GIS data (left) and 2025 Aerial photograph (right)

The below-ground survey involved scanning the ground with Ground Penetrating Radar (GPR) and producing high resolution images, with particular focus on the urupa (eastern part of the cemetery). This technique is commonly used to investigate unmarked burials within cemeteries and urupa. It involves pulling a small antenna box slowly across the surface, which continuously sends radio-wave pulses into the ground. The pulses are then reflected back from features within the subsurface. A 3-dimensional GPR image of the subsurface was

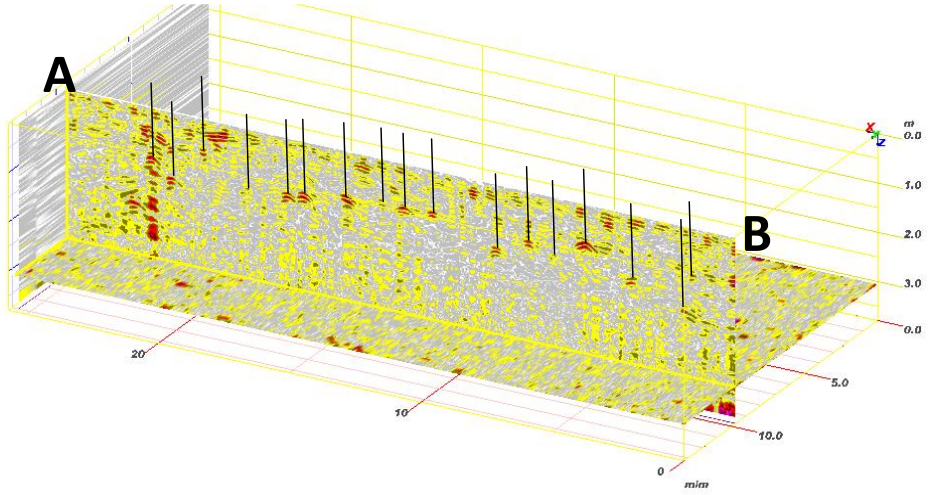
constructed using many parallel lines at 250mm spacing. This is a time-consuming process, with measurements taking over a week to collect. Figure 2 shows the extent of the surveyed 3D GPR areas (blue rectangles).



(Figure 2) 3D-GPR Mapping area at Pukekohe Cemetery (blue rectangles)

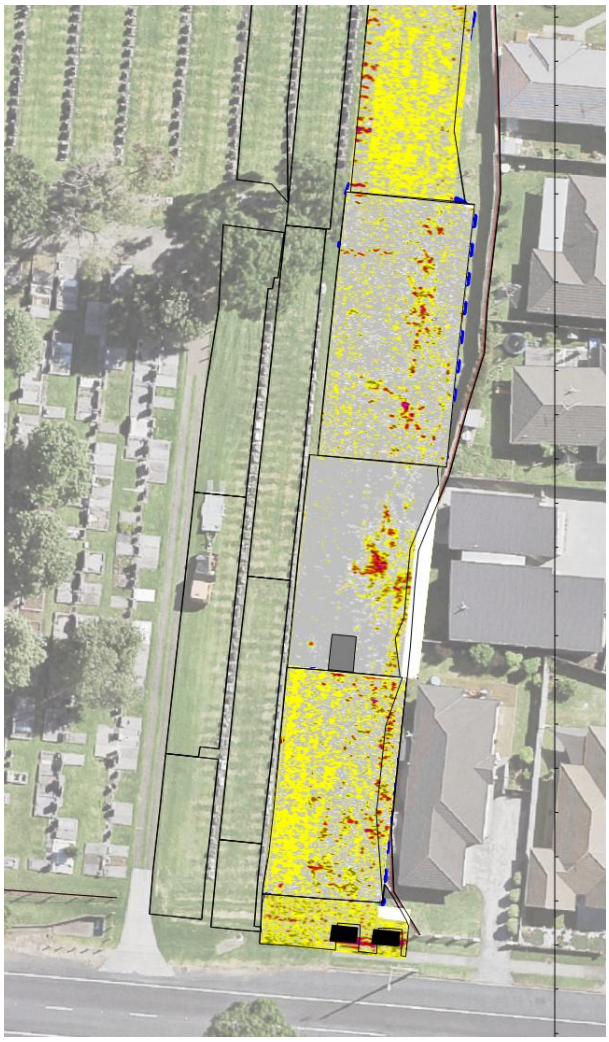
Considerable data processing and analysis is required to enhance the reflections specifically from the burials, to understand the reflections and provide an interpretation of the features that may have caused them.

The image below (Figure 3) is an example of one of thousands of GPR sections collected that form the 3D data blocks. This particular section is through GPR Area B3, within the urupa. Each of the vertical black lines highlights a reflection that is interpreted as a possible burial. The colours represent reflection intensity levels, with red/purple indicating higher returns and the presence of more pronounced features.



(Figure 3) Example of cross-sectional GPR data showing features interpreted as burials (vertical lines)

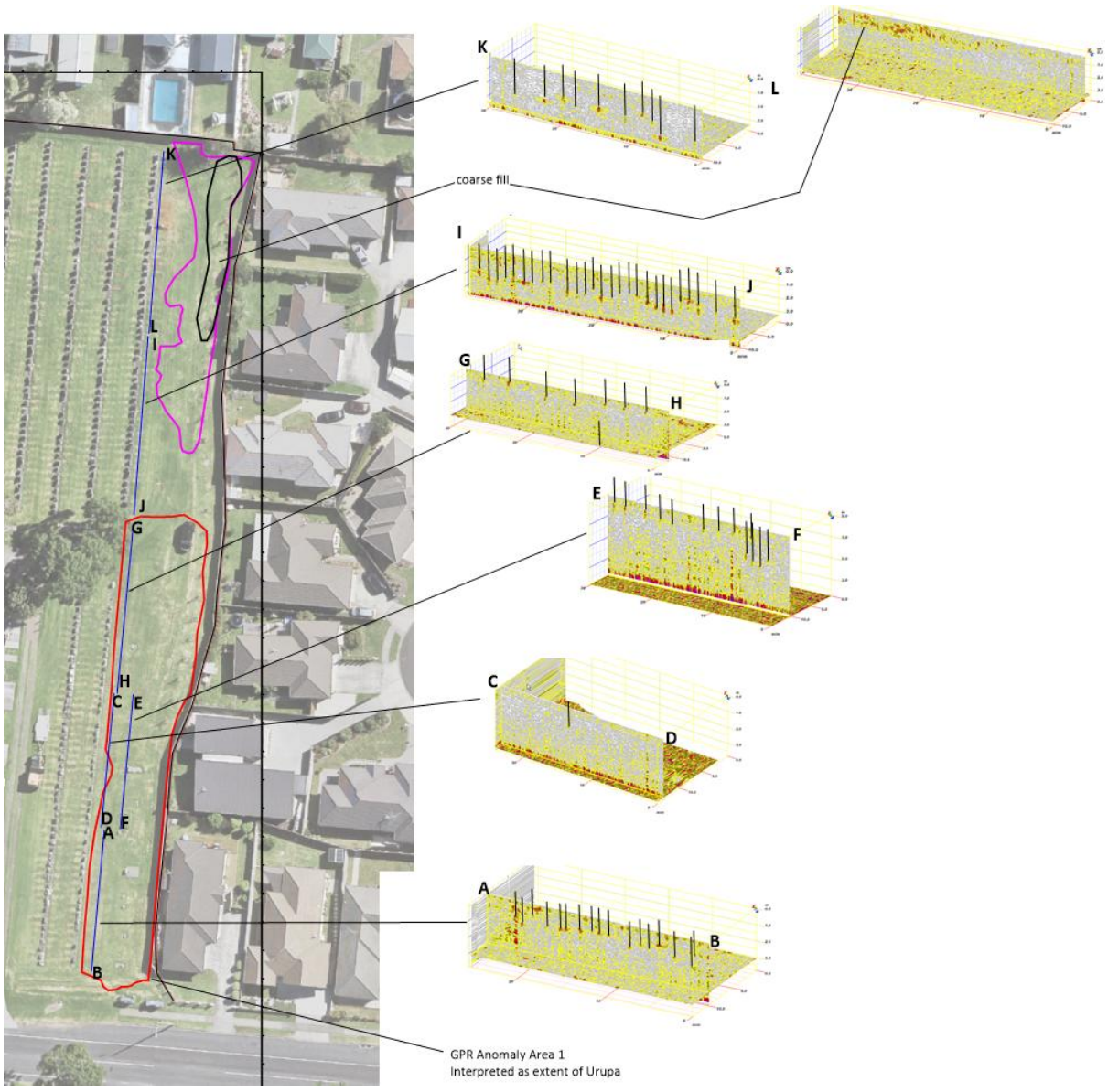
Analysis and interpretation of the GPR data is carried out using a series of plan-view (depth-slices), which are created by slicing the 3D block at 250mm horizontal intervals for analysis (see Figure 4).



(Figure 4) Example of plan-view GPR data showing subsurface features at a particular depth level.

The interpretation of burials is made using analysis of both vertical (cross-sectional) and horizontal (depth slice), and looking for characteristic reflection patterns (anomalies) based on shape and signal intensity levels.

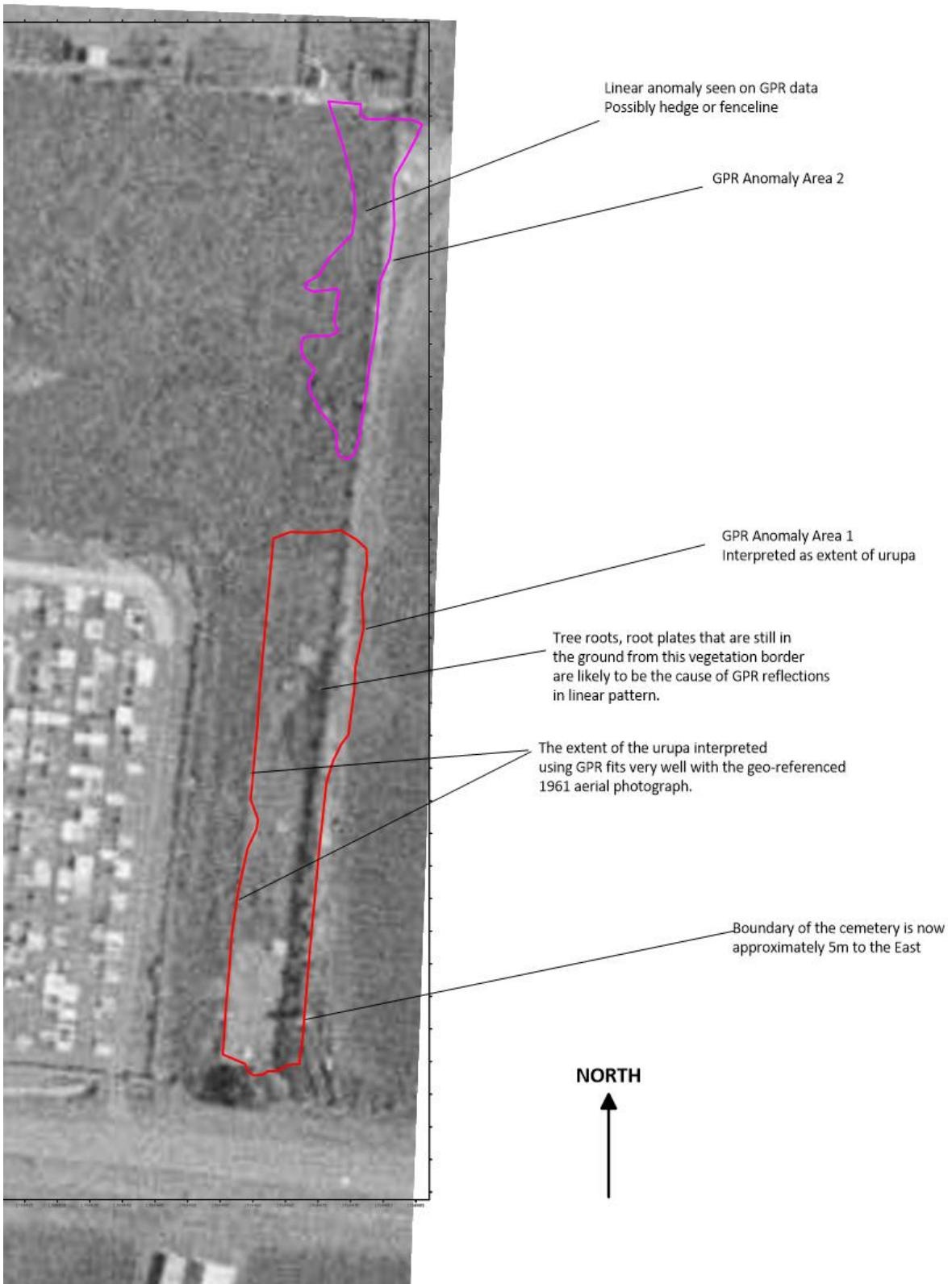
An interpretation of the boundary of the urupa has been made using the GPR data. This is shown below in Figure 5, with the red line outlining the perimeter of the urupa.



(Figure 5) Analysis of the GPR showing the extent of the urupa (red line). Examples of the GPR data in cross-sectional format are shown on the right hand side, with vertical black lines indicating burials.

Analysis of the position of the boundaries in relation to former cemetery boundaries was carried out by geo-referencing aerial photographs. In particular the 1961 aerial photograph

was used to help interpret the GPR data (Figure 6). The eastern boundary of the cemetery in 1961 was approximately 3m to 5m further to the west than it is currently. (ie. The cemetery has expanded 3-5m towards the west).



(Figure 6) Analysis of the GPR showing the extent of the urupa (red line) in relation to the 1961 aerial photograph.

In the western part of the urupa (near the fence line) there are strong reflections in the data that are interpreted as being due to the vegetation and earth-works along this former boundary line (1961). Differentiating between these and the possible burial reflection anomalies is problematic.

The eastern extent of the urupa (from GPR interpretation) is conservatively positioned at the eastern extent of these (combined) anomalies, which is approximately 1-2m away from the current fence line.

The western extent of the urupa (from GPR interpretation) correlates well with the boundary indicated on the 1961 photo (grass colour).

The southern extent is a few metres to the north of the electric transformers, and also appears to correlate well with the 1961 aerial photograph. Note that the remnants of the gate posts to the urupa can be seen on the northern side of the transformers.

GPR Anomaly Area 2 (Figure 6), outlined in purple to the north of the urupa, is interpreted as introduced fill or earthworks. Some indication of this can be seen visually on an aerial photograph from 1972.

GPR anomalies interpreted as burials within the urupa are generally shallower than those observed in marked areas of the cemetery. This may be either due to burial at a shallower depth and/or subsequent loss of soil at the surface (ie. the current ground level is lower than at the time of burial).

Observations and measurements during the survey of the ground level within the urupa indicate that the urupa is the topographical low point of the cemetery.

Drainage and the potential for flooding and soil erosion of the urupa needs to be considered and understood. A possible explanation for the apparent shallow burial depth may be due to erosional processes taking place at surface level (ie. loss of soil cover).

Please let me know if you have any questions related to this technical report or require further information or clarification. A more detailed technical report for this survey is available *“Technical Report: 3D Ground Penetrating Radar (GPR) investigation at Pukekohe Cemetery, July 2025, M.Watson, ScanTec Ltd”.*

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