8 DISCUSSION OF RESULTS

“But what be bones that lie in a hole?”
Tolkien, J.R.R. 1999 *The Lord of the Rings*, (original work published 1966)

Killam (1990) states that after two years there may be no sign of a grave. The results of these experiments demonstrate that graves in South Australia have identifiable surface characteristics that are especially evident during interim or summer periods and endure over several years. However, after two years it was found that surface characteristics might be obscured if the graves are located in a sheltered position such as beneath a tree. There was no difference between emergent surface characteristics for animal or human gravesites.

In this study and in this environment there were signs of graves after six years. Examples of surface indicators include the different colour and texture of surface soil (the upcast) and different patterns of vegetation growth over the gravesites and adjacent to the graves where upcast had been placed during the burial process.

Plant growth as a surface indicator, was affected by the capacity of the upcast to retain water, which would be expected given that it is the upcast that is now on the surface of the grave. Successional regrowth on the gravesites followed predictable patterns wherein the hardiest short
rooted plants appeared after rains on the rubbly clay like upcast. During summer, the plant growth died off around the graves. It is suggested this was due to the surface soil’s greater porosity and lack of capacity to hold water, and the drying heat that parched the plants. The implications for a search situation are that distinguishable surface characteristics relating to plant growth on a grave are more detectable in this environment during the summer (or non-winter) periods.

The plants that grew at the gravesites did not differ from those in the surrounding area and this did not change over time. All graves showed reduced capacity to sustain plant diversity in that only a limited variety of plants were able to grow on the grave surface (supporting France et al., 1997); specifically weed types such as salvation janies, soursobs and grasses. No shrubs grew over the graves, or any tree saplings. This finding may be different in areas of different soil types.

The results of this study support the findings of France et al. (1997) that differential plant growth is related to disturbance and not the interment of a body per se. Overall, the results from the observation of plant growth support France et al. (1997) that climate and moisture are important to the plant recovery of the gravesites. In addition, the soil type and situation of the graves, that is, where they are located in relation to other forms of shelter impacted considerably on gravesite “recovery” as
demonstrated by the differences in appearance of the graves over the long term. This is supported by the observation of green grass within the burrowed pig graves that was in distinct contrast to the yellow grasses in the surrounding field during autumn period. There were no other patches of such green growth in the area and it was a clear indicator of the graves. By way of explanation, it is suggested that the burrows in which the green grass was growing had collected more water and afforded more shelter.

Rodriguez and Bass (1985) found that some graves had more rapid vegetation growth and others less and that depth of burial affected plant growth. These phenomena were not observed at any of the nine gravesites in this study. More lush vegetation was not found at any of the gravesites compared to the pre-burial state after twelve months as suggested by Owsley (1995). The animal graves had the same type and extent of plant growth. At Smithfield, although the three graves (including calibration) were created at different times, the observation notes and photographs show the same pattern of plant growth, again in accord with the season. There was no difference in surface plant growth that was related to depth of burial. This study extended for a significantly longer period than the Rodriguez and Bass project, and as detailed in the results section, the vegetation on the graves differed from each other only with regard to overhanging shelter that promoted ground
litter and water retention (that is the two animal graves beneath trees). These differences were not observed until two years after burial.

One feature that was observed and has not been reported elsewhere was a “halo” or barren area around all of the gravesites (including the calibration) in which there was little or no vegetation regrowth. The halo area reflected the placement of upcast during the digging of the graves, where some had been left on the surface, once the grave was refilled. This halo was only observed during the summer period and did not occur on those graves beneath a tree beyond two years after burial. This feature reinforces the observed effects of upcast on vegetation regrowth. The halo appeared where there was little shade; the ground was flat (not allowing for any water catchment) and received the full sun, effectively parching any small shallow rooted plants. At the sites that were sheltered under a tree, the barren halo effect was short-lived. The halo does not appear to be related to the presence of a body, based on this feature being observed at the calibration pit, although the halo was not as marked at that site after three years. Additional calibration pits would be necessary in order to further examine whether the release of chemicals from animal or human remains effected vegetation in this way.

Supporting the evidence that upcast affects plant growth, a feature that has not been reported elsewhere is that green moss did not grow close or
on any of the graves when it was found growing on the surrounding soil surfaces during winter. This was found at both animal and human burial areas, including the two graves under a tree. The absence of moss appears to coincide with the presence of upcast and may be considered a winter indicator of graves as the halo feature is related to the summer and drier periods. In a search situation this would be difficult to use however, because there can be many areas that do not necessarily have moss.

The presence and degree of ground litter or debris over the grave surfaces was a noted difference between the graves and was in fact the only difference between the graves. In all other aspects the surface indicators of the gravesites followed the same pattern (with the exception of the protection from scavenging given to the human gravesites). Ground litter obscured the only two sites beneath trees relatively quickly, yet the other sites that were not near a source of natural debris continued to be “bare”. As the debris lies over the top of the graves there is a potential for other visible signs, such as the contrast of the colour of upcast, to be masked from view. There was also less vegetation in which the debris could be collected at those graves in more open situations. The implication is that if a body is buried near the base of a tree there is the likelihood that after two years surface signs will no longer be visible and the ground litter will appear to mask it from the surrounds. Therefore
scraping the surface areas of ground litter near trees may assist in the
detection of gravesites in order to identify traces of upcast.

In the outer metropolitan area where the animal graves were located a
distinctive indicator was related to the intermittent faunal foraging over
six years. The scavenging and the initial presence of insects (particularly
ants) were the sole surface indicators that could be directly attributed to
the presence of a body rather than due to the soil disturbance caused by
digging a grave. The fact that the calibration pit was not scavenged and
did not show any signs of insect activity supports this statement. Faunal
scavenging and the presence of insects (the latter in the short term)
demonstrate key methods for grave detection. This also demonstrates the
potential application of well- trained cadaver or scent dogs to the
detection of clandestine graves in respect of detecting decomposition
related chemicals and by- products. As stated previously, this study
focused on the detection of longer term burials and in particular, skeletal
remains.

This study demonstrated that burrowing is likely to continue over several
years and was not confined to a shorter period when the remains could
be considered freshly buried. All six animal graves were scavenged
shortly after interment. At various stages over the six- year monitoring
period four of these graves continued to be scavenged. Eventually
burrows were constructed within the grave itself and the gravesites became scavenger homes. Based on the continued scavenging, it can be suggested that one surface indicator of buried (human) remains could be an animal burrow as some of the gravesites of the buried animals were transformed into fox burrows and no longer looked like the other gravesites.

Besides the protected human graves, there were exceptions to the ongoing burrowing; the two graves buried at the base of a tree (one pig and one kangaroo) were not repeatedly burrowed, although they were as accessible as the other graves. The reasons for this are speculative, but may be related to an obscuring of smells because of the tree and its root system, and a higher level of natural ground litter over the graves. For a grave buried near a tree, these results suggest that continued scavenging is less likely although there were several graves to choose from as alternatives. This may be different when there is one single grave. These facts may have some bearing on the potential application of “cadaver or scent” dogs and should be considered in the training of these dogs.

Although subject to weathering, the contrast between the upcast and the surrounding undisturbed topsoil on the gravesites continued to be identifiable throughout the monitoring period in contrast to Rodriguez and Bass’s (1985) finding that the contrast of upcast will lessen over
time. It is likely that the degree of distinction between the pre-burial soil horizons will impact upon the degree of contrast between upcast and undisturbed soil and the endurance of this distinction. For example, the soil horizons in the animal grave area were more marked than those at the human grave area, resulting in more contrast between the upcast and the surrounding surface soil in the animal grave area. The Munsell soil tests suggested a change in time to the hue at the animal sites but this only differentiated the gravesite soil from the surrounding soil. The was little differentiation between the results of the human gravesites and the surrounding soil in the Munsell test results, although to the naked eye the colour and texture showed visible differences. This also reflects the less distinctive soil horizons at Smithfield compared to Roseworthy. As an independent field-test then, the Munsell soil test would be less useful than carefully observing changes in soil colour and texture for the detection of buried human remains.

France et al. (1992) reported that the boundaries of their pig graves became “masked” and returned to their “original surface grade”. The results of this study contrast with the France et al. finding in that the boundaries of the graves did not become masked, as shown by the unforaged human and calibration sites.
Upcast tended to appear cracked over the grave surface and immediately near the gravesites and was less settled than the soil surrounding the graves. This cracking and splitting of soil where the disturbed soil meets the undisturbed soil, as stated by Duncan (1983) indicated the presence of upcast and a grave and was found to be reasonably enduring in the South Australian environment although faunal scavenging at the animal graves interfered with this observation. However, it was identified at the calibration and human gravesites, and was especially visible during the drier months.

A common indicator of graves is considered to be a depression and even a secondary depression (Rodriguez and Bass, 1985; Killam, 1990). At the three graves at the Smithfield location, there was a depression at the calibration site and human gravesite 1, but not at human gravesite 2. The second human gravesite was buried for a lesser period and the gravesite was constructed into a bowl shape to examine the impact of water drainage and it is likely this would impact upon the formation of any depressions. However, the fact that both human gravesite 1 and the calibration site featured a primary and secondary depression suggests depressions are a result of soil settling and not solely due to the “body collapsing”. Rodriguez and Bass (1985) proposed that a deeper grave will result in deeper depressions, but this was not found during this study.
The human grave was 0.75m and the calibration was 0.59m and this depth did not affect the degree of resettling.

The body in gravesite 1 was buried in a flexed position; there are no experimental studies that discuss the effect of burial position on surface soil depressions. As there were only two human bodies in this study no conclusions may be drawn in regard to surface appearance as a result of position of the interred body. The animal graves cannot be used for comparison because of the burrowing. However, given that a body is relatively large and a grave is not likely to be less than a metre square, a depression is a visible landscape feature associated with a large hole and it was apparent after two years. This feature was enduring and did not dissipate.

This study showed that any mounds of soil remaining after interment that might be used as surface indicators of graves (Killam, 1990) do not endure as indicators in this environment. There were only two slight mounds of soil out of the nine graves after burial and these two mounds disappeared after the first winter rains, having been washed flat. Mounds are unlikely to be lasting indicators of a gravesite beyond a few months or first rains in South Australia. During the burial process it was found there was little soil left that would lend itself to a mound as all the soil dug out could be redeposited back in to the grave. It would be surprising
if criminals left mounds at gravesites, but it is not known from “ethnographic” research or data from instances of the early detection of clandestine graves whether this is the case. Some persons may dig graves and leave a mound to mask a possible tell-tale depression forming later.

Evidence from the chemical analyses of soil samples from the gravesites suggests near surface indicators in the form of distinctive soil elements. These tests were not conducted as a field location method but were intended to be used to develop field based detection techniques based on gravesite characteristics. Human gravesites 1 and 2 showed higher levels of calcium, iron, nickel, zinc, magnesium, and potassium at 0.2m depth than either the calibration or random samples. The human gravesites had different burial durations (2 years 10 months and 7 months respectively) and therefore this commonality of results is significant. As it was not possible to obtain human bodies earlier in the research it would be of interest to conduct further soil tests after a longer burial duration. There may also be detection of elements residing naturally in the upcast because human gravesites 1 and 2 and the calibration pit showed similar levels of copper, sodium, aluminium and chromium that were higher than the random samples.

After six years all three kangaroo sites soil samples showed overall higher levels of calcium, magnesium, sodium, sulphur and titanium than
the random samples. Calcium and magnesium are two key elements that show sustained and higher levels compared to random samples at all stages of the burial period over a total six year burial period. The pig graves were different in that after five years all three pig sites showed higher levels of sodium and sulphur compared to the random samples. Only sites 1 and 2 (not site 3) showed sustained and significant increases in the levels of calcium after five years. As site 3 was located beneath a tree it may be that the tree leached nutrients.

The total nitrogen in the pig samples is significantly higher than the kangaroo samples. This may be due to the difference in the length of time after burial or the fact that the pigs were buried at shallower levels and after animal scavenging, the samples would have been taken closer to the bodies. Alternatively it may be related to the different animal types.

These results offer support to the contention there are higher concentrations of particular elements such as potassium, copper, and manganese within the grave area or surrounding soil (Owsley, 1995) and of Vass et al. (1992) who found higher levels of sodium, chloride, ammonium, potassium, calcium, magnesium and sulphate. Of relevance here is that Vass et al. (1992) found calcium demonstrated a cyclic release from skeletal material that was found in substantial quantities. There
were no significantly higher levels of phosphates found in the soil tests. It is notable that these soil samples were taken at a shallow level above the body. It is hoped that any elements able to be distinguished above a buried body could be used in the development of a field based detection method.

Killam (1990) states that the alterations to the soil from digging will be detectable indefinitely. This statement reflects a key premise for the application of sub-surface sensing geophysical instruments, designed to detect sub-surface anomalies. France et al. (1997) reported the most useful instruments to be the magnetometer, electromagnetic (EM) profiler and ground penetrating radar (GPR). Ground penetrating radar has been reported as successful in detecting graves and the remains themselves for burials less than two years (Miller, 2002 and Schultz et al., 2002). In this study several instruments were used to survey the gravesites; not all resulted in indications of anomalies coincident with the graves and there was variation in results from the same instrument type in surveys at different intervals, for example the resistivity tests.

Ground penetrating radar identified anomalies at the animal graves and human gravesite 1. At human gravesite 1 some anomalies were apparent on the survey results after 23 months of burial and the results showed a contrast to those of the calibration grave, suggesting the possibility of
having detected anomalous remains. Further surveys in twelve months would be recommended to explore this possibility.

At each of the animal grave surveys soil disturbance coincident with the animal gravesites was detected, the last being when the kangaroos had been buried for 22 months and the pigs at six months post burial. The results suggest detection of the disturbance and it is not clear whether the remains themselves or clothing items were also detected. Miller (2002) found that after eight months the margins of graves could not be detected using GPR. The margins of the graves were not clearly detected in these surveys. Schultz et al. (2002) found that in clay GPR anomalies are more difficult to detect over the 21 months during which their pig burials were surveyed. Although not buried in clay, at 22 months post burial the kangaroo graves were not as apparent as the pig graves (at six months), although anomalies were visible in the survey results. It is also not certain whether the objects that appeared in the animal survey results were the animal remains, rocks or the clothing items.

In summary, significant identifiers of gravesites and in particular, buried remains were not shown in the GPR survey results, although certainly anomalies were revealed in the subsurface structure that could be equated with the known gravesites. In a situation in which it was not known that the gravesites were there the results could not be used to
conclude that there were buried human or animal remains beneath. However, it could be considered a disturbance had taken place. There were also difficulties in positioning the GPR to survey all gravesites, such as those animal sites near logs or bushes which highlights typical problems faced in a search situation and the possibility of overlooking some areas if reliant on an instrument based survey.

Anomalies in conductivity levels were found in the results of the electromagnetic conductivity surveys however, the types of anomalies were not always consistent. For the first conductivity survey taken of one kangaroo grave (at 22 months) and one pig grave (at 6 months post burial), the kangaroo grave demonstrated a higher conductivity reading coincident with the grave. The conductivity results for the pig survey were less significant although a slight increase in conductivity was apparent. This result may have been due to the season of survey (summer) when there may have been very little moisture retention in the soil. Other contributing factors may have been the depth of burial (the pig was more shallow), the larger original mass of the kangaroo, clothing in the kangaroo grave retaining moisture, or the position of burial, as the pig was near a bush (which may have leached moisture from the soil) or the fact that the pig had been scavenged severely.
In the second conductivity survey the kangaroo graves demonstrated higher conductivity than the pig sites. At this time, the kangaroos had been buried for almost 5 years (4 years 9 months) and the pigs for 3.5 years. The reasons for this difference between the two sets of graves could be related to the shallower burials of the pigs or the more pronounced burrowing over the already shallow pig graves compared to the kangaroo sites. This type of survey resulted in no significant conductivity results for pig sites 1 and 2, although the readings were slightly higher at pig site 3 compared to the other two pig graves and the random soil samples from the area. The burrowing over the animal gravesites has most likely contributed to both difficulties of obtaining accurate readings and to the indefinite results.

At the centre of kangaroo graves 1 and 2, both the vertical and horizontal readings were significantly higher than the means of the vertical and horizontal sample readings. However, both these graves also contained a small metal belt buckle that would have impacted upon the conductivity readings. Kangaroo site 3 did not show any significant readings, having lower readings than the other two kangaroo sites. This grave did not contain metal. The reasons for this difference between the graves may be that the tree leached much of the moisture, the plastic bag covering the kangaroo at burial may have meant that moisture was trapped beneath the bag, and only the conductivity of the dry surface upcast was read, or
alternatively, the effect of the upcast may mean that no graves in this area would have significantly higher conductivity readings were it not for the small amount of metal in kangaroo graves 1 and 2.

The human grave conductivity levels directly over the body were significantly higher than the calibration pit. At this time the first human grave had been buried for almost 2 years (1 year 10 months) and the calibration grave had been established for 11 months. The metal cage was still in place during the survey and this has clearly influenced the readings as they increase as the reading points near the metal. However, the results show a difference between the human grave and the calibration site, although the difference could be attributable to the nearby metal only.

The results of the electrical resistivity survey conducted over kangaroo sites 1 and 2 demonstrated lower resistivity levels than the surrounds, consistent with the conductivity results. However, at the human gravesites (two years and one year after burial respectively), higher resistivity readings were found over the two human gravesites compared to the surrounding areas and these were considered to reflect the high evaporation rates where there is no vegetation and there is less moisture retention. If this is so, then electrical resistivity and possibly electromagnetic conductivity respond to the characteristics of upcast as a
component of the soil over which it is being applied. It would be expected that the calibration pit would also show higher resistivity because of the sparse vegetation cover, however, the calibration pit showed slightly lower resistivity compared to the orientation survey. The seasonal conditions in which an instrument-based survey is conducted may well impact upon the results and likelihood of detecting anomalies. Different results may have been obtained if the soil in the area was dampened first.

In contrast, a 150 year old grave was detected using electrical resistivity demonstrating the significant differences between those graves that contain a coffin and those that do not, the denser clay soil that retained water at the 150 year old burial and perhaps the effect of the depth of the graveshaft on detectable subsurface differences.

Some instruments applied were not found to be useful in detecting buried remains, such as I-SITE laser imaging, infrared imaging and aerial surveillance. The first two instruments needed to be focused directly over isolated target areas and therefore present a higher risk of missing buried human remains in a search situation. Aerial surveillance was not effective in a terrain that was not cleared of surface shadows and vegetation.
In terms of the construction of the experimental design to meet the aims of this research, the calibration pit was important to provide a baseline against which to compare surface and sub-surface information obtained from the graves containing remains. In retrospect it would have been beneficial to have calibration sites at the animal gravesite area to assess surface changes and also because it was not expected these sites would be foraged so extensively, and that this would impact upon the capacity to undertake geophysical surveys.

It would have been an advantage to be able to obtain human cadavers earlier in the study to allow for a greater burial time. This proved difficult because of the care taken to ensure that families of deceased persons gave direct and purposeful permission for the bodies to be used in this study and there were only two people who died in the study period that had undergone this discussion and prepared the appropriate documentation.

Further geophysical surveys had been intended during different seasonal conditions and after a greater burial duration. This proved one of the most difficult aspects of the research. Considerable time and effort was put into applying for grants to fund this expensive work but there were limited avenues of grant funding that related to this area of research. This factor alone underlines the poorly funded nature of this area and
the lack of research into locating buried human remains. It also means that the research and practical casework undertaken by others, much of it voluntarily, deserves recognition because of the dedication and persistence in the face of adversity. The University of Adelaide provided equipment and expertise to conduct some surveys but this was only when the limited equipment was not in use, and the equipment itself was not as up to date as it could have been. Much of the survey work was due to a small company who themselves had to hire equipment but provided the survey work without payment. Again this depended on the availability of the company and the equipment. In South Australia there were very limited sources of geophysical instruments for this purpose that were not priced at high daily rates for which funding could not be obtained. Some interstate companies kindly offered to provide equipment on the condition that freight and expertise costs were met but these costs could not be covered from any source. There is a certain amount of pressure to complete doctoral research and no further time could be spent trying to secure the large amount of funding for extensive geophysical surveys over nine gravesites on a repeat basis. However, there is scope to continue this research on the gravesites already established in the future.

Using the geophysical instruments highlighted the logistical problems associated with using this type of equipment in a field situation. Firstly, it is time-consuming; cumbersome to manoeuvre in the field and there is a
risk of overlooking burial sites if there are fallen logs or branches or vegetation obstructing a path. This was apparent in the case of the animal graves that were positioned to test out the practicalities of this type of fieldwork. It is essential for an orientation survey to be conducted, although of course there is always variation within a field. For example an anomalous reading was found using electrical magnetic induction at Smithfield that could be overlooked because it was known not to be at the location of the grave. In a case situation this could not necessarily be concluded. Due to the relatively small area of a grave it is important to operate geophysical surveys on a small grid basis, preferably obtaining readings at 0.5m or even less. This adds to the amount of time taken to obtain data, and the amount of data to be processed expertly with the appropriate software. It also adds to the likelihood that burial areas will be missed because of time constraints, and the total expense and arduousness of the task.

One way to overcome these problems would be to isolate key gravesite locations based on surface signs. It is suggested that this limits the value of using geophysical instruments because if this is achieved, careful confined and shallow excavation will quickly reveal disturbed soil and the practicality of proceeding in many situations.
Conclusions

The results obtained from these experimental gravesites substantiate the hypothesis that gravesites containing buried human remains have identifiable physical characteristics that are detectable. There were visible surface characteristics, characteristics suggested at the chemical level, but at the subsurface level any potentially identifiable characteristics were less defined in the survey results from the instruments used in this study. However, there is the potential for variation in the capacity of grave soil to conduct electrical current compared to the background area that could be further explored, especially in a period when the soil is not as dry.

The evidence suggests that not all detectable surface signs are related directly to a body contained in the grave; the signs occur because a hole has been dug and refilled. Faunal activity was the one surface indicator that was directly related to there being organic remains within the ground. On the basis of these results it can be concluded that signs of faunal scavenging can identify gravesites and that animal burrows should be examined closely as they could have been former gravesites. In South Australia the bones are not likely to have been moved far from the burial site.
Traces of upcast, surface cracking, depressions and secondary depressions may serve as indicators of buried human remains. These are not a phenomenon only of buried remains but indicate a hole has been dug. Identifiable subsurface signs attributed to the presence of buried remains (animal or human) included higher levels of certain trace elements (in particular calcium and magnesium) in soil immediately above the remains buried that endured over several years.

It was found that there is a greater likelihood of identifying potential gravesites in an interim or summer period because any “halo” effect (an absence of vegetation coincident with upcast) over those graves not beneath a tree for longer than two years will be apparent. If a gravesite is of two or more year's duration, there is a strong possibility it will be covered in ground litter and difficult to detect if it is in a sheltered position such as beneath a tree. During a winter search period the absence of moss near graves when it is growing elsewhere may serve as a potential surface indicator. Largely searches are recommended to take place in an interim or summer period as the surface indicators will be more easily identifiable.

Electrical resistivity identified unexpectedly high resistivity levels coincident with the first human gravesite. Electromagnetic induction showed some anomalous readings coincident with the gravesites but
there was little uniformity across gravesites and qualifications were necessary to the data. Grave artefacts made from metal may have impacted the electrical and magnetic based surveys and the wire mesh at the human graves is likely to have influenced readings taken at the human graves during the electromagnetic induction surveys. These instruments demonstrated that there may be subsurface indicators of gravesites and/or buried remains, although they may not be clearly distinguished from background “noise”.

The ground penetrating radar did not provide information that allowed for the differentiation of skeletal or bodily remains from other potential anomalous sources. It was not established that the current range of available instruments that detect subsurface anomalies necessarily detect skeletal remains. Limited information obtained from the instruments applied is attributed to the fact that the instrumentation currently available is not designed specifically for this purpose compared to their routine uses, including the relatively shallow depths to which they were being applied in this experiment. The resource intensive nature of using geophysical instruments and the subtle nature of the results do not lend themselves to regular and routine use in search situations.

The research undertaken in this study did not identify any key differences in results between the animal graves and human graves that
had any direct impact upon the results (noting the protection given to the human graves). Grave artefacts, such as clothing, shoes or plastic bags did not appear to have any relationship to the surface indicators, although the artefacts (such as the metal in belt buckles) may have impacted the sub-surface indicators obtained through the electrical and magnetic based surveys and also may have featured in the ground penetrating radar results.

There have been no documented characteristics describing an Australian grave to assist in the detection of unlocated graves to date, and this research documents the appearance of gravesites over an extended period of time, that can be applied to environment types resembling those described in this research. Further research is required to detail sub-surface characteristics based on the capacity of geophysical instruments beyond evidence of soil disturbance provided by the ground penetrating radar. The chemical analysis of soil from the gravesites in comparison to the surrounding soil shows potential for identifying characteristics that may be applied to detection techniques.

**Future Research**

There are few other research projects of this length involving animal graves and no others published that have also involved animal and
human graves in Australia for the purpose of detecting clandestine graves. The question of how to reliably detect clandestine graves is not yet resolved. This work provides a beginning point for further research into the detection of clandestine graves and provides the basis for the directions of that research.

The controlled gravesites in this experiment were buried in one main soil type that is a calcareous alkaline based soil. Soil type has an impact on the rate of decomposition, the exchange of elements between the body, soil and groundwater, and propensity for subsurface sensing devices to detect anomalies coincident with or directly related to the presence of buried human remains. Therefore research replicating this study in other environments, including different soil types would provide information about the consistency of surface indicators in particular and provide more information about the utility of geophysical instruments.

There should be further studies of soil chemistry from both burial and non-burial environments (Sandford, 1993). More examination of the element content of gravesites would be of value, again in different soil types to validate and extend the research initiated here. This could be taken further to research the application of a simple field based technique to detect higher levels of key elements at shallow or medium depths. One example might be agents that change colour in reaction to
various elements. Radosevich (1993) advocates interdisciplinary scientific research into the chemical properties of bone because “most physical anthropologists have not recognised the large number of geological assumptions and assertions they have made…” (p270). This knowledge could be applied to the detection of bone beneath the surface.

The results of this study show there is scope for further research into the application of subsurface technology to the location of buried human remains. This is an interface of spheres of knowledge that requires definition, description and collaboration and offers the potential for refinement and application based design. It would be useful to develop an instrument that is premised on those properties of the grave that are most consistently identifiable in different soil types. The results of the soil analyses could be used in this regard and could lead to the development of a different type of instrument rather than the application of instruments developed for a different purpose.

Having a facility with a larger number of buried human remains and calibration graves that were relatively permanent would assist in refining techniques for the location of buried human remains. In this way a knowledge base could be established and different techniques could be tried under varying conditions over a longer human burial time than could be achieved in this study. By way of example, besides the
Anthropological Research Facility in Tennessee there is the Controlled Archaeological Test Site (CATS) located northwest of the University of Illinois campus. This site seeks to examine the efficacy of geophysical instruments from an archaeological perspective in detecting artefacts buried a meter or so beneath the earth and in particular, to examine the type of “signature” readings that result. Pigs have been included among the buried artefacts. However, there are no such establishments in Australia apart from the area used for this study.

Locating buried human remains is the subject of a relatively small number of published scientific research articles. Currently in Australia, due to the lack of research data on successful location techniques, each search is a case of trial and error. Collecting and creating a database containing information about successful and unsuccessful searches would make use of known experiences (including appearance of the grave on discovery, length of burial, state of decomposition, techniques used in the process and data obtained) and would constitute baseline data.

It is important to educate police about the expertise and value of using consultants in the field, early in the investigation to minimise unfruitful searches (and resources). Any results may be used to develop better techniques in the future. Search situations are not easy to construct for experimental situations (due to the difficulties associated with burying
human remains) and case related data are significant if properly recorded.

Creating a source of funding, possibly from a combination of sources (such as police services, universities and private geophysical companies) is necessary for research to proceed. This was one of the major impediments experienced in this study. Surprisingly, the detection of clandestine graves was not perceived as a frequent, substantial or resolvable problem. The limited sourced statistics, survey results and anecdotal evidence collected for this research suggests otherwise. Although police services are responsible for murder investigations and searches for clandestine graves they do not sponsor or conduct scientific research of this nature in Australia, unlike the Federal Bureau of Investigations in the States. However, they are the direct beneficiaries of any advances in detection techniques. Police support of research of this nature would be valuable. The disappearance of Peter Falconio in the Northern Territory of Australia and the fact that his body has not been found demonstrates an inability to locate a clandestine grave, in this much publicised case.

In summary, there is an established need to continue this type of research, if only because there are buried human remains that have not been found. The burial of human beings in clandestine graves is unlikely
to cease and therefore it is an ongoing problem for which families of murder victims need a resolution. Such a resolution could be obtained through continued research.
9  A FRAMEWORK FOR DETECTING CLANDESTINE GRAVES

Based on what we now know about clandestine graves including the results of this research, a structured framework for conducting searches is described below. It builds on search stages proposed by Killam (1990), Dirkmaat and Adovasio (1997) and the work of Necrosearch (personal communication September, 2001). There are two phases in this framework; a preparation phase (phase 1) and the search phase itself (phase 2). Phase 1 involves collecting information that will impact upon the effectiveness of phase 2. The second phase describes the steps for conducting the actual field search. In this framework subsurface searching is treated as a final search tool because of the expense incurred, time involved in collecting search data and because of its unreliability at this stage of research.

Phase 1: Collation of search related data

The following steps and considerations should be included in the first phase of any investigative search for a grave:

1. Discuss with the investigator (most often the police) the available information that can be disclosed to assist in identifying a broad locale for the deposition of the body in question. The data will include
any witness accounts, verbal disclosures, and background information on suspects. The key piece of information will be estimated time since death.

2. Assess the limitations of knowledge, the reliability of known data and identify possible sources of error (such as mistakes in the direction of travel, ambiguous landmarks and confusion in estimating distance when areas are earmarked based on verbal accounts). This will assist in identifying alternative search areas as field data are obtained rather than recommencing the search process again. It is important to ask if search areas have been targeted already and the reasons for this.

3. Estimate the length of time since interment. This assists in assessing degree of decomposition and likely surface indicators of a gravesite.

4. Obtain a topographical map of the suspected search area. Cadastral boundaries are useful to identify private and public land. Outline the broadest possible area for searching based on what is known to date. Outline the most likely area within this to prioritise in the actual search. This can be modified as further information is incorporated into the search file. There may be more than one likely search area and maps of these should also be obtained.

5. If available, obtain aerial photographs of area (preferably including pre and post-burial). These will provide topographical information to complement the maps, such as buildings in the area.
6. From the maps and any other topographical data obtained, note the nature of the landscape (rocky, tree covered, degree vegetation, soil type, undulation, uniformity) and the layout of trees, shrubs, logs and features that would be either natural obstacles to digging or would provide useful camouflages. Consider any changes that may have occurred since estimated interment that may influence the selection of areas to search in depth or mask a burial site such as excavation, cropping, or building.

7. Determine road access and the distance the body would be likely to have been either transported by vehicle or carried in the target areas. This may narrow the search area.

8. Obtain any available data on the soil type or range of soil types and underlying surface. For example if there is solid bedrock beneath the surface it may indicate the potential likelihood of a shallow burial or an unlikely place for a burial. A geologist or relevant government department is a useful source of this information.

9. Estimate depth of burial, given soil type and horizons, including stratigraphy.

10. Attempt to establish season of burial (which may have some bearing on ground hardness at the time of burial).

11. Consider local climatic conditions, especially recent weather conditions as this will influence degree of vegetation regrowth over the burial site.
12. Identify the fauna within the area, for likely indications of scavenging and rodent activity.

Phase 2: Field search and the identification of likely surface anomalies

1. Select an optimal season for search that will maximize surface visibility (choice in this matter will depend on degree of urgency and the circumstances of the case). This study has shown that in South Australia, an interim season (spring or autumn) or summer maximises ground visibility due to minimal vegetation.

2. Prior to commencing the search 2-3 holes should be dug into the ground (approximately 0.5m - 1m) within the search area to identify the likely colour and texture of upcast soil. The holes will give an indication of the variability of the stratigraphy within the search zone and it may be useful to dig others, depending on the size of the search area. If years have passed since the burial there may have been some fading of the upcast due to surface exposure.

3. Undertake a sample ground survey of the search zone(s) of a smaller area. Examine the vegetation patterns closely and surface texture. The purpose of this is to accustom the searcher to recognise what is usual in the area and to be able to identify during
the search proper what may be anomalous. Binoculars can be used as magnifiers of the surface.

4. Potential gravesites will be of a relatively small size. A grave is a small, defined area within a landscape, and is unlikely to be located from a distance. As such, indicators of a grave will all be found within the immediate grave environment; within a 1·3m radius from the grave itself. It is important to describe what is likely to be a surface anomaly in the area for those persons assisting in a search.

The following surface signs will earmark potential sites and will be based on the surface and subsurface geology and topography of the target area:

- Change in the colour of the soil, indicating upcast;
- Change in the texture of the surface soil (softness, cracking);
- Lack of surface debris (ground litter) if this is otherwise characteristic of the area;
- Signs of scavenging, such as burrows (and possibly bones lying on the surface);
- Animal burrows that may have been made over a gravesite and are now faunal habitats;
- Sparser vegetation over the upcast area or more fast growing weeds growing in one area (identify likely succession plants);
• A noticeable halo of little or no vegetation and cracked ground if it is a summer period;
• Traversing tracks (flattened grass, vehicle tracks);
• Shallow dips to the surface, including those that have vegetation growing within the dips (these may be depressions due to the body or evidence of burrowing);
• Absence of moss if it occurs within the area (depending on season of search).

5. The search itself should be approached methodically to ensure all areas are surveyed. The method used will depend on how many foot searchers may be available to assist (who should be briefed as to likely indicators) and the nature of the terrain. Examples of foot surveys are; marking out laneways for each walker and snaking forwards (in “s” movements) within each single laneway; emu walking forwards in a line; marking out large square grids and allocating a responsible person for each grid; spacing people over an area and walking in ever widening concentric circles from the starting point; having two rows of people at opposite ends of a square area walking towards each other in an emu walk (this helps to minimize signs being missed because the same area is surveyed twice) and continuing past each other to effectively traverse the
same area twice but with different eyes. During the search nothing should be picked up if possible from the ground.

6. Mark by non-invasive means identified possible sites (either because of visual signs or because of convenience for burial, or any other reason, as they can always be eliminated when re-examined later). This can be done by ribbons tied to trees or shrubs or by tent pegs with colour flags. Water proof plastic markers are best as they can be left there if the search is not completed in one day.

7. Re-examine each of the marked sites. A soil probe or trowel (to ascertain if upcast is on the near surface) could be carefully used at each of the sites to assist in this process.

8. Preliminary excavation may be conducted. This could be done on a second site visit or during the first visit. The purpose of the preliminary excavation is to reduce the number of search sites. It may be done by surface scraping the topsoil to ascertain subsurface soil disturbance, using a trowel in a manner to ensure there is no damage to any bones. A comparison hole nearby can be dug to provide an indication of adjacent soil horizons and clearly show any differences indicative of prior disturbance.

9. Once the number of potential gravesites has been decreased, further examination may proceed by either careful excavation to a deeper level or by applying sub-surface detection methods. Careful excavation will quickly confirm the presence of upcast or prior
disturbance. A ground probe could be included during this phase. The decision as to whether to use sub-surface geophysical instruments will be influenced by resources available to the investigators and the practicality of disturbing the area through excavations.

**Sub-surface detection methods**

If subsurface or remote sensing instruments are incorporated into the search strategy an instrument or instruments will need to be selected. The ground search stage should have revealed areas that may be prioritised. Where the area is such that surface signs are clearly identified, such as very sandy areas with little vegetation, sub-surface instruments may be a practical alternative.

The steps involved in incorporating sub-surface geophysical instruments into the search are described as follows:

1. Identify the instrument most likely to yield useful results under the circumstances (including terrain type, including sub-surface root systems and previous buried debris, climatic conditions, soil type, approximated depth of burial and sources of interference to the
instrument). The nature of the terrain will provide some parameters for the type of instrument best able to be applied.

2. Clear the area as far as possible of surface vegetation and any metal objects.

3. Conduct an instrument orientation survey.

4. Conduct the surveys and examine any anomalous areas.

5. Excavation should then follow.

**Excavating the gravesite**

Whichever method is used to detect a clandestine grave, the final phase will be excavation and recovery. Excavation will always be the means whereby the remains will be recovered, and may also be the means whereby the sub-surface instrument results are confirmed or found to be indicative of something else.

The most appropriate method of excavation is archaeologically based because the aim in a criminal investigation is to preserve and audit evidence that may be critical to the judicial process. It is not necessary to detail the process of body excavation in this thesis; it is sufficient to state that excavation should be carefully structured to allow documentation of the location and position of all objects found within and nearby the grave. The key steps may be summarized for these purposes as follows:
1. Mark off the area with tape and plot a grid system that will allow the transfer of all finds to be clearly marked on a paper map.

2. Excavate thin layers from the surface to identify the shape and size of the grave. This will be seen by the colour changes of the soil indicating the line of shovelling or demarcation between disturbed and undisturbed soil.

3. Tools that will not endanger the preservation of skeletal material should be used and professionals in the anthropological and archaeological fields will employ these.

4. As much of the surrounding soil of any bodies located as possible should be bagged for sieving later.

5. All bones should be placed in suitable packing and containers to prevent damage from transportation, labelling these with place of grid location and depth.

6. All steps should be photographed and each bone should be photographed in situ with accompanying scale indicators.