1 INTRODUCTION

Locating hidden and buried objects has long been a subject of interest to archaeologists seeking buried cities, tombs of the famous and other historical objects. In contrast, searches for a murder victim buried in a clandestine grave have only relatively recently been subjects of published papers in scientific journals (Imaizumi, 1974; Rodriguez and Bass, 1985; Nobes, 2000). Clandestine graves contain buried human remains not intended to be found, and are the focus of forensic or criminal investigations led by police, increasingly drawing upon the expertise of anthropologists and other professionals (Reichs, 1992). Although a range of location techniques have been found successful under some circumstances (Imaizumi, 1974; Killam, 1990; France et al., 1992; Davenport, 2001), reliable methods for the location of clandestine graves have yet to be identified. Further research needs to be conducted about clandestine gravesites to develop and refine search techniques that are reliable and applicable to the varying circumstances encountered in forensic investigations. Under the present circumstances, unsuccessful searches do not preclude the presence of a body. Neither is there a satisfactory technique to validate the absence of a body within a given area. It is an under-researched area that suffers from a lack of financial investment.
In a murder case, the body (victim) is the primary element of evidence. For a small proportion of cases, the body is not immediately found and may remain unfound for extended periods of time (personal communications with police services in Australia, and national survey of police jurisdictions survey conducted as part of this research). The numbers of bodies found in clandestine graves are not tallied systematically and those bodies not found cannot be knowingly counted in Australia. In 2003 - 2004 there were known 305 victims of homicide recorded in Australia (Australian Institute of Criminology Crime Facts Info, No. 108, 11 October, 2005). Some of these will have been deposited in clandestine graves. In addition, there are approximately 300 of the 30,000 people that are reported missing in Australia each year that are not found (Henderson et al., 2000). Some of these may have been murdered (Pinto and Wilson, 1990). This research focuses specifically on those unfound graves, recognizing that this is a significant problem to the families of the victims, and the justice process.

There are several reasons why locating unknown burial sites is problematic:

- There is a lack of extensive and repeated scientific controlled research conducted over several years. Results from the few scientific studies are qualified by recognising that the results may
only be relevant for that particular environment (Schultz et al., 2002), and therefore further studies should be initiated in other environments due to the unique nature of case studies, to build a more comprehensive body of knowledge;

- There is limited research on the detection of skeletal remains specifically;
- Although human cadavers have been buried for the purposes of studying decay and decomposition there are no studies where human cadavers have been buried for periods longer than two years to study the properties of graves;
- Police experience in locating graves has not been incorporated extensively into the scientific knowledge on this area;
- Not all grave types will be able to be detected by the same techniques, for example, the detection of mass graves and unmarked cemetery or churchyard burials needs to be sufficiently differentiated from the detection of clandestine graves;
- Sub-surface instruments have not been specifically adapted for the purpose of searching for a single shallow burial, in part because there has not been commercial interest in undertaking these developments.

Police services in contemporary western society have been and remain, the primary recovery agents of non-archaeological buried bodies.
Forensic anthropologists are involved at the request of police to assist in the recovery of human remains (Beck, 1982; Bass, 1987; Killam, 1990; Maples and Browning, 1994; Haglund and Sorg, 1997; Ubelaker, 1997; Hoshower, 1998). As the demand for the expertise from forensic anthropology grows (Reichs, 1992), the need for rigorous research on specific forensic problems such as the location of buried human remains has emerged (Haglund and Sorg, 1997; Hoshower, 1998). The published literature reflects this increasing engagement by police of external experts from different fields (including anthropologists, archaeologists, geologists, entomologists and botanists) that have written about the problems they have encountered in addressing this issue, pointing to the many unknown and unresolved matters (Owsley, 1995; Lindemann, 2000; Davenport, 2001; Schultz et al., 2002; Buck, 2003). However, for most consultants locating clandestine graves is an adjunct to other work, and therefore dedicated research and experimentation is minimal, which is in no small part due to the limited commercial interest and therefore few sources of research funding.

The detection of buried human remains in the forensic context has arisen as a problem for science through the following sequence of events:
1) Police, as the responsible agency for criminal investigations have sought external assistance only when searches for a clandestine grave are unsuccessful.

2) The expertise of archaeologists and anthropologists began to be sought by police because of their experience in discovering buried historical sites (including burials) and knowledge of body recovery processes. This engagement has been prompted in part because of the need to be less intrusive in order to preserve information able to be gleaned from the in situ context.

3) Professionals consulted by police began to apply geophysical instruments in order to explore evidence for subsurface indicators when surface indicators were not apparent for graves. This is in part because it was not methodically documented how gravesites appear on the surface after lengthy periods of time.

4) Those professionals involved in cases with the police recognized the need for further information about detecting clandestine graves. Other spheres of knowledge were explored such as changes in vegetation growth, the physical properties of gravesites, changes to subsurface strata, environmental differences and decomposition processes in context.

Locating clandestine gravesites involves the bringing together of knowledge from several disciplines including anthropology (physical,
biological and cultural), biology, geophysics, taphonomy, archaeology and
geology (soil science). This is reflected in the formation of
multidisciplinary professional bodies that have assisted police in the
search process; for example, Necrosearch International (based in
Colorado), the Forensic Search Advisory Group (in the United Kingdom),
the University of Tennessee’s Anthropological Research Facility (or “body
farm”), and the Argentine Forensic Anthropology Team (E.A.A.F., based in
Argentina). Other organisations such as ERA Technology (“ERA” is this
organisation’s full title, and is based in the United Kingdom) provide
expertise in the operation of geophysical equipment in order to assist
police searches for bodies. The Federal Bureau of Investigation (FBI) in
Virginia formed the Technology Assisted Search Team (TAST) in 1995 for
the purpose of technology aided evidence retrieval, including the
detection of shallow buried bodies (Freeland et al., 2003). Many of these
groups assist police on a voluntary basis.

As a scientific problem that remains unsolved, the information to draw
upon comprises very few published case studies of forensic searches for
graves (Imaizumi, 1974; Nobes, 2000). Unsuccessful case studies tend not
to be published although these would contribute positively to the body of
scientific information. As a consequence, there are still significant
information gaps that remain open to research. These include the need
for further information on gravesites over extended periods of time (this
has not been undertaken in Australia); the physical properties of a gravesite; and the interaction between the decomposing body and its environment.

There are very few scientific studies that have focused on the topographical indicators of gravesites over time (of note are those of Rodriguez and Bass, 1985; France et al., 1992 and 1997). Carter and Tibbett (2003) have researched the potential for fungi to be associated with graves. The environment may influence the endurance of indicators over time, but the full nature and extent of this is not known. Overall, there is a lack of baseline data about the nature of graves containing buried human remains within different environments to inform methods of detection.

There are few studies that have involved the burial of human cadavers for the purposes of detecting and locating gravesites. Those studies that have been conducted involving the burial of human cadavers or pigs have been limited to less than two years (Rodriguez and Bass, 1985; Schultz et al., 2002; Freeland et al., 2003) and only one study has focused on controlled pig graves up to five years (France et al., 1997). This is discussed more thoroughly in the literature review.
As with many other areas of forensic research, technology has been seen to offer more efficient ways of undertaking the detection of clandestine graves. Geophysical devices have been used for some time by archaeologists for site detection, based on their value in identifying subsurface anomalies (Fischer, 1980; Ebert, 1984; McManamon, 1984; Scollar et al., 1990; Hunter and Martin, 1996). This has developed into a separate archaeological discipline (Neubauer, 2001) and has included the use of aerial surveillance, ground penetrating radar, magnetometers, and resistance meters. Geologists and geophysicists normally use these instruments for the examination of soil layering and underground features and their wider application extends to the location of pipelines or cables, and ordinance devices.

For buried human remains, the anomalies seen as most likely to be detected by geophysical instruments are those associated with soil disturbance, such as the graveshaft (Unterberger, 1992; Miller, 1996). In the forensic context, geophysical instruments are being applied to depths that are much shallower than those purposes for which they were originally designed. This equipment is generally not refined to the point of distinguishing between tree-roots, rocks or other objects often found within soil layers. Skeletal remains and teeth, as the most permanent remains of a body, have not been the focus of detection in previous studies. Significantly, there is an absence of documentation on the
effectiveness of these instruments at various time intervals post burial, and across different soil types in forensic search situations. Their application has not been researched extensively or rigorously for the purpose of detecting buried human remains (Buck, 2003).

Technological equipment is expensive to hire and although commercial geological firms provide expertise in the operation of the equipment they are not necessarily expert in grave searches. The research on detecting buried bodies using remote sensing geographical instruments in controlled studies have used cadavers buried for under two years (Freeland et al., 2003), and animals (Schultz et al., 2002). The longest known controlled study of clandestine graves to which geophysical instruments have been applied is to pigs buried for five years (France et al., 1997).

Research on the detection of non-clandestine graves has been undertaken using geographical remote sensing instruments such as ground penetrating radar (GPR), electromagnetic induction (EM) (Bevan, 1991; Unterberger, 1992; Davis et al., 2000; Buck, 2003). These studies are concerned with the location of bodies buried in coffins, usually in cemeteries with unmarked sites for the burials for various reasons. Despite the presence of a large object such as a coffin, compared to a single set of bones the geophysical instrument survey results have been
inconclusive (Bevan, 1991; Buck, 2003). The different properties of clandestine graves, mass burials and churchyard or ritualised formal burials present different issues that affect searches. A mass burial contains several or many bodies and the grave will cover a greater area and be of a much greater depth in order to contain the bodies. A clandestine grave in a forensic investigation is expected to contain one individual (or sometimes parts of an individual) buried at a shallow depth (up to a meter but generally less) for logistical reasons (the difficulty in digging a deep grave with only a shovel or hand held implements). Unlike a churchyard, or ritual burial, the body is not buried in a coffin because the intent is to mask the grave. The clandestine graves will feature fewer of the potentially detectable “anomalies” that may be characteristic of other non-clandestine graves.

Data relating to searches and the location of forensic graves in Australia is minimal (Nobes, 2000 cites a case in New Zealand), and there are no published scientific studies demonstrating the application of technology to the detection of buried human remains from a forensic perspective. Thomas (1999) has discussed the application of geophysical remote sensing instruments in Australia in general terms. There are papers relating to the detection of Aboriginal graves in cemeteries (L’Oste-Brown et al., 1996; L’Oste-Brown et al., 2002; New South Wales National Parks and Wildlife Service, 2003).
The steps involved in the creation of a clandestine grave, which begins with the murder of a person are shown in the Table 1 (stage 3). The research described in this thesis has been prompted by problems encountered in stages 6, 7 and 8.

Table 1: Stages in the burial and investigation process

<table>
<thead>
<tr>
<th>Stage</th>
<th>Event</th>
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<tbody>
<tr>
<td>1</td>
<td>Death of victim</td>
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<tr>
<td>2</td>
<td>Conveyance to burial site</td>
</tr>
<tr>
<td>3</td>
<td>Creation of the gravesite and interment of body</td>
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<tr>
<td>4</td>
<td>Decomposition in situ/ environmental changes to the gravesite (ongoing)</td>
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<tr>
<td>5</td>
<td>Information brought to police and subsequent investigation initiated</td>
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<tr>
<td>6</td>
<td>Search conducted by police</td>
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<tr>
<td>7</td>
<td>If gravesite not immediately located, consultants sought for advice and further searches conducted</td>
</tr>
<tr>
<td>8</td>
<td>Site location</td>
</tr>
<tr>
<td>9</td>
<td>Exhumation and recovery</td>
</tr>
</tbody>
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In order to develop and test search techniques an understanding of stages 3 and 4 is necessary, to explain the reasons why some techniques may be successful and others less successful, and to understand what is
being detected in comparison to other objects found beneath the surface. This is discussed in sections 3 and 4 of this thesis and the experimental component addresses the surface and sub-surface indicators found (section 7).

At stage 6, historically, searches for graves have been undertaken by ground search, that is, walking over the likely expanse of area. This method is still the preferred and first option used amongst those searching for clandestine graves. The success of this method becomes less likely as the time interval between the search and the original burial increases. The reasons for this are that police may not know what surface indications to look for in a given environment, changes to the target area due to man-made developments or natural changes that obscure the usefulness of informant descriptions. The ground search is labour intensive, expensive and in many ways impractical for police.

**Aim of the Study**

The following objectives formed the basis of this research:

1) To describe the characteristics of gravesites in South Australia over time for the purpose of developing and refining location techniques;
2) To test methods of detection, including geophysical instruments, on known buried remains;

3) To determine those factors that impact on the success of various detection techniques from a physical and biological perspective;

4) To explore socio-cultural anthropological factors in determining the body disposal site based on available information.

**Hypothesis**

The following hypothesis was developed for testing:

1) That gravesites containing buried human remains have identifiable physical characteristics that are detectable. These characteristics occur at the surface and subsurface levels.

The null hypothesis is that gravesites do not have characteristics that are identifiable and can be reliably linked to gravesites.

Nine gravesites were established in South Australian scrubland and unused land areas to monitor and record observable surface changes, to identify physical characteristics of the gravesites and to test various geophysical instruments. Kangaroos, pigs and human cadavers (and one calibration pit) were buried in shallow graves between 0.43m and 1m
depth and left undisturbed for the duration of the research. The burial
time ranged from six years to one year. Changes to the surface of the
gravesites were monitored, soil samples from the gravesites were
analysed and geophysical instruments (including ground penetrating
radar, electrical resistivity and electromagnetic induction) were used to
survey the gravesites.

This research was limited to land-based burials and excluded water
contexts, which pose different conditions and logistic problems in
detection. Emphasis has been placed on the detection of skeletal remains
as this aspect has received little attention in the literature. The use of
cadaver dogs was also excluded although they have been employed in
searching for buried human remains with varying degrees of success
(Killam, 1990; Swindells, 1994). The reasons for excluding cadaver dogs
included the many variables impacting upon a dog’s detection capacity
such as temperature, length of burial, soil type, weather conditions at the
time of the search, the dog and handler’s experience, and the level of
fatigue of the dog. There was also a lack of available specialized cadaver
dogs in South Australia at the time of the research.

Further fieldwork included the successful detection of a 150 year old
burial using electrical resistivity surveying. A national survey was
conducted on body location techniques used by Australian police
investigators in a seven year period identifying those methods found most successful in Australia. The three main methods identified were accidental discovery, further information being given to police and police ground search. These results suggest greater potential in Australia to develop more reliable techniques for clandestine grave location. In addition, all Australian newspaper reports of human remains located that had not initially been found between 2000 and 2004 were analysed. The results showed that 84% of these bodies were located in outer metropolitan or remote areas and 53% of the bodies were in bushland or national parks. Where the means of location was stated, the majority were located through accidental discovery.

Visiting key practitioners of body searches in the States and United Kingdom through a travel fellowship allowed the author to establish through personal communications that there is no reliable technique of locating clandestine graves and buried human remains. However, it is an international problem that has involved and continues to involve dedicated professionals who generously donate their time, knowledge and expertise to assist police. Although there have been successful locations there is still the search for the deus ex machina (a device to resolve a situation or untangle a plot) to reliably find a buried body.
The problem of searching for buried skeletal remains within a clandestine grave may be summarized as being a search for a small set of objects (a skeleton) in a small area, subject to surface changes that may mask the actual grave zone. As an under-researched area of forensic science, there are two parts to this problem; locating a grave or potential grave and ascertaining that an apparent gravesite contains buried human remains. There has been relatively little attention to visible changes to the grave surface over extended periods of time. Although the sub-surface stratigraphy may be disturbed, this relatively small disturbance in geographical terms is difficult to read using current technology and any anomalies tend not to be distinctly characteristic of skeletal remains.

This study presents the results of a methodical approach to the detection of gravesites, based on experimental research in South Australia conducted over six years. The following sections contain a literature review of search techniques used to date; a discussion of the interaction between the buried body and the burial environment in relation to the known properties of a grave and the implications for detection; and the results from the experimental studies conducted as part of this research. Included is a brief discussion about the cultural anthropology of the creation of a clandestine grave and the implications for the location of buried human remains. Further research will be necessary to establish the potential for extrapolation of the results to other environments.
2 REVIEW OF THE LITERATURE ON THE DETECTION OF BURIED HUMAN REMAINS

The literature on searches for buried human remains in the forensic field has been generated through the increasing use by police of external consultants, particularly anthropologists, to assist them where police searches have not located murder victims. Literature on detecting buried human remains in a forensic investigation demonstrates firstly, that this is a problem that is not resolved; secondly, each investigation involves unique and varied conditions; and thirdly, there is an incomplete body of cohesive scientific reference material.

The literature has been written by a wide variety of professions, including archaeologists, police officers (Imaizumi, 1974; Boyd, 1979; Hoving, 1986), geophysical experts (Nobes, 2000), and anthropologists (France et al., 1992; Owsley, 1995). Chapters have been included in texts on general body location methods (Krogman and Iscan, 1986; Killam, 1990; Chamberlain, 1994; Hunter et al., 1996; Dirkmaat and Adovasio, 1997; Pickering and Bachman, 1997; Byers, 2002) and police manuals (McLaughlin, 1974; Tuck, 1996). General articles on the subject are found in police journals (Swindells, 1994; Thomas, 1999). Geophysical experts have discussed the potential application of geophysical instruments to searches (Lindemann, 2000; Davenport, 2001). That locating buried human remains does not have a scientific or proven method to draw
upon is exampled by the difficulties encountered by experienced anthropologists and archaeologists (for example, Schwartz, 1993:87 and Wright, 1996:10). The greater proportion of literature on forensic searches either assumes the body has been found or describes the recovery process (McLaughlin, 1974; Skinner and Lazenby, 1993) and this reflects the absence of definitive methods of location.

The search for buried human remains in cemeteries (Bevan, 1991; Unterberger, 1992; Davis et al., 2000; Buck, 2003), a related field of study, has been cited in forensic literature. However, there is insufficient recognition given to the different circumstances encountered in the forensic context that limit the capacity to extrapolate the mixed results from these studies to the forensic context.

The majority of the literature is from the United Kingdom and United States, and some is from New Zealand. Variation in environment and circumstances of searches has led to singular cases being reported in the literature, resulting in a limited body of data from which there has been little capacity to extrapolate conclusions about successful search methods. From Australia, there is very little literature on actual searches for clandestine graves or forensic cases. The extent of the literature is bounded by discussion of the potential application of geophysical instruments, in particular ground penetrating radar, and the difficulties
likely to be encountered in a forensic context within Australia (Thomas, 1999). There are accounts of geophysical remote sensing instruments having been used to detect Aboriginal graves buried in the European manner (L’Oste- Brown et al., 1996; New South Wales National Parks and Wildlife Service, 2003).

There are no established databases collected from actual forensic cases where bodies have been found (even accidentally) describing surface indicators or evidence for changes to vegetation at the sites, relating to length of burial, soil type or environmental characteristics, or the method whereby bodies were actually located for future comparative reference. One of the difficulties is that there is considerable variation over different environments.

There are few scientific studies on detecting buried human skeletal remains. One of the earliest studies published on buried human remains was from Rodriguez and Bass (1985). This was based on evidence obtained from human cadavers buried for one year. France et al. (1992 and 1997) conducted the only study of burials over a longer duration of time (five years), in which pigs were buried and their findings reported on “multidisciplinary methods” of gravesite location. Although France et al.’s (1997) study of buried pigs took place over five years (and it is likely therefore that the remains were skeletal) there is no discussion of
skeletal remains and their specific detection. Subsequent studies of buried animals have focused on the capacity of geophysical instruments to detect decomposing animals or cadavers; Schultz et al. (2002) buried pigs and applied ground penetrating radar (GPR) over a 21 month period and Freeland et al. (2003) tested ground penetrating radar on decomposing shallow buried human cadavers over a five month period after burial (these studies are discussed in more detail later).

Rodriguez and Bass (1985) and France et al. (1992 and 1997) discuss changes to vegetation in controlled gravesite studies involving human cadavers and pigs respectively. These are two of the few studies that focus on the gravesite itself. Rodriguez and Bass conducted controlled burials of unembalmed human cadavers buried in shallow trenches (0.3m - 1.2m deep) from one month up to one year. The surface indicators described relating to graves were not uniformly found over all gravesites. For example, differential plant growth was observed at only two burials, in which shorter growth was recorded on one grave and on the other growth occurred more rapidly. The increased foliage over shallow burials has been attributed to the release of organic materials from the decomposing body, particularly after a year or more (Rodriguez and Bass, 1985:850). France et al.’s (1992) study showed that although it is a common belief that the additional nutrients provided by a body within a grave will affect plant growth, five years after burial both calibration pits
and those containing pigs were not noticeably different (1997:505). The conclusion was that disturbance of the soil was the key variable and not the body as a source of nutrients.

France et al.’s (1992) study showed that it is possible to identify disturbed ground through vegetation changes, but that different vegetation patterns are not necessarily indicators of the presence of a body within a grave. “Pioneer or opportunistic” plants were the first to grow on the gravesites, including plants that were not previously present. The disturbed plots (regardless of the presence of a body) continued to be visually different from the surrounds for five years. Undisturbed plots were found to have a greater diversity of plants compared to disturbed plots irrespective of whether the graves contained a pig. Rodriguez and Bass (1985) do not discuss plant diversity specifically, nor any differentiation in type from the surrounds.

Owsley (1995:735) states vegetation will be absent initially or sparser over a recent burial, and that after twelve months the vegetation may in fact be more “lush” over the grave. This observation is attributed to the aerated, moister soil of the grave. France et al. (1997) cite climatic conditions as important to gravesite recovery and plant establishment, the key element being moisture (1997:504). It is likely that the capacity of surface soil to retain moisture and facilitate plant growth is the key
factor in the growth of vegetation, enhanced by suitable climatic conditions. The type of subsurface soil that is brought to the surface after refilling a grave will affect growth in relation to its capacity to retain moisture. The location of the gravesite will also impact on the regrowth of vegetation over the gravesite in terms of shelter (whether the burial is beneath trees) and water catchment potential (for example, if located in sloping ground). There are no specific studies on the surface recovery of gravesites other than the work by France et al. (1997).

Deeper burials were considered by Rodriguez and Bass to reduce plant growth because of the greater disturbance to the soil (1985:850). There is little evidence for the effect of depth of burial on vegetation growth on grave surfaces and there have been no specific studies on this aspect. It is equally likely that a deeper burial will result in deeper and different soil layers being brought to the surface as upcast that will impact on vegetation growth.

Soil compaction has been described as an indicator of a grave (McLaughlin, 1974; Duncan, 1983; Morse et al., 1983; Rodriguez and Bass, 1985; Killam, 1990; France et al., 1992; Owsley, 1995; Hunter and Martin, 1996). “Compaction” is an incorrect use of the term in geological terms, as compaction generally means the reaction of soil to applied external pressure (such as a tractor). What is meant in terms of clandestine graves
is the resettling of soil laid in the grave, following rain or post-burial climatic conditions. When backfill is repositioned over the body to fill in the grave, the soil horizons and any subsurface stratification are mixed together. This soil has been aerated. Over time rain or the action of gravity will result in the soil particles coming closer together with fewer air spaces. In the study done by France et al. (1992) cited previously, a “masking of excavation boundaries” is reported and the return of compaction found in the grave to the “original surface grade”. It is also stated the fill material “becomes more fine-grained”. It is not clear whether the fill material is more fine-grained because of its sub-surface source, or it became more fine-grained once brought to the surface over time. There are no other comparative studies on this aspect over several years.

Duncan (1983) describes a “splitting” and cracking of the ground where the backfill meets the surface as “compaction” occurs. It may be speculated that this observation is related to the capacity of the upcast to retain moisture in comparison to the surrounding undisturbed surface soil and that the different granular texture of upcast (from the mixed soil horizons) is affected differently by surface climate conditions upon exposure to the pre-existing surface soil. It is not known how long this indicator may endure.
Depressions are referred to in the literature as indicators of graves based on the resettling of backfill (Krogman and Iscan, 1986; Killam, 1990). Rodriguez and Bass (1985) report the noticeable resettling of soil within the burial trenches, varying in the time taken to form depressions, from one week to a few months. They state that deeper burials (1.2m) resulted in the formation of deeper depressions. Secondary depressions (depressions within a depression) were observed at the 0.6m and 0.3m gravesites (shallower gravesites). It is possible that the position of the body within the grave may have an influence on the formation of depressions; however, this is an area that has not been explored in studies or the literature.

Other surface indicators of graves cited in the literature include those associated with the enduring characteristics of the upcast or backfill itself such as colour differentiation from the surface soil (Rodriguez and Bass, 1985), and excess different coloured soil near the grave (Owsley, 1985). Rodriguez and Bass (1985) note the darker colour of the upcast lessened over the study period of six months to one year. No reason is given although it may be speculated that it may be due to weathering, exposure and possibly the scattering of the grains. As a general statement, Killam states that for a burial of more than two years, there may be no visible signs of a grave (1990:237). There is no other documentation in the literature to corroborate this statement. The length
of time necessary for surface indicators to become less discernible or virtually blended with the surrounding environment (if at all) is not known, and indeed may be expected to vary from environment to environment.

Signs of faunal activity have been identified as a surface indication of a potential gravesite, because of the inherent source of food to some animals (Galloway et al., 1989; Haglund, 1997; Murad, 1997; France et al., 1997; Janaway, 1996). Scattered bones may be found at the ground surface at varying distances from the gravesite, or there may be signs of burrowing to reach the buried body. Turner and Wiltshire (1999) buried pigs in the United Kingdom, and found that it was not until after three months that scavengers disturbed the graves. It is not known for how long after the burial foraging may continue. Contributing factors may be climatic conditions, depth of burial, concurrent insect activity (impacting on the rate of skeletonisation) and the access and type of scavengers within the area of burial.

There are no available accounts where a body has been located in a forensic search through aerial surveillance, although it has been recommended as a search technique in the early stages of searching an area (Killam, 1990). Aerial photography has been used for archaeological site discovery from the early part of this century (McManamon, 1984:
In particular, crop marks have proved useful indicators that are visible through aerial photography in archaeological surveys, but Chamberlain (1994) states single graves are too small and relatively inconspicuous for this method to be effective. Aerial photography has several limitations in the detection of unmarked forensic graves. The indicators suggested in the literature include a difference in soil colour (upcast), possibly depressions, differences in vegetation growth and faunal scavenging. Aerial surveillance may not detect such traces from the air, depending on the contrasting variability of the surrounding terrain. Further, in some areas there may be all of these but not due to a buried body. Retrieving any results from aerial surveillance is dependent on the clarity of the photograph and many factors will influence the quality of photographs for this purpose, such as the time of day (causing shadows), weather conditions, general visibility, height of the surveillance, and the type of terrain being photographed. Scrubland and areas containing trees may mask signs of a gravesite even if conditions are otherwise ideal. There are no accounts of this technique being used successfully in Australia for forensic cases.

Pre-burial photographs of the area are an advantage for comparative purposes and this is not always possible (Hole and Heizer, 1965: 168). In Australia whole areas are not regularly mapped as they are in other countries. For example Britain is surveyed by air every two years for
Infrared photography, sometimes from aircraft, has been used for the detection of gravesites on the basis of two main principles. Firstly, a body might be expected to generate heat through the decomposition process that may show up on the photographs. Secondly, the temperature of disturbed soil might be expected to differ from its surrounds such that it may show up on the photographs (Duncan, 1983). In principle, as decaying material radiates heat differently to non-decaying material (Davenport, 2001:89) there is potential for thermography to be applied to detecting shallow graves, however, the variations may be from many other sources. Variations in the daytime surface temperature of soils are mainly due to evapotranspiration that is controlled largely by surface resistance. At night, when there is no evapotranspiration, the surface temperature may be attributed to the measure of water in the environment. The flow of heat in the upper soil layers of an area is related to the region’s capacity to retain heat. Okamato et al. (1997:34) applied the thermal image method using an infrared radiometer to verify the position of buried tombs. The results showed an abnormal temperature distribution of the surface over the buried objects, but the target objects were considerably larger than a single set of buried bones.
McLaughlin (1974) states that infrared photography did not detect bodies buried at approximately 1m – 1.5m deep in a state of rapid decomposition but on the other hand detected a grave of 48 hours (although the results are not presented). In contrast a two-week-old grave was undetected (McLaughlin, 1974:19). This demonstrates a high variability of results, particularly at different time intervals after burial. The conditions may have had some impact and may not have been taken into account.

The analysis of chemical traces as a potential indicator of buried human remains has received little attention in the literature. Long term experiments on bone geochemistry or burials have not commonly been undertaken by physical anthropologists (Radosevich, 1993). One significant area of research in terms of the application of trace element analysis to anthropology is diagenesis in relation to post mortem changes to the constituents of bone (Sandford, 1993; Pate et al., 1989). Generally, most anthropologists have limited training in biochemistry and this has meant anthropological trace element analyses largely reflect studies concerning diet and diet reconstruction (Sandford, 1993). Certainly soil type and conditions will impact upon trace elements remaining in the soil at a detectable level in comparison to the surrounds (Henderson, 1987; Chamberlain and Pearson, 2001).
There is evidence to suggest that the potential of trace elements remaining in the soil following a burial should be further explored for the detection of clandestine graves. Phosphorous, in the form of phosphates in soils is associated with human activity (Chamberlain 1994) and has been used in archaeological research. As it remains in the soil for long periods and is not leached from the soil like other elements (such as carbon, nitrogen or calcium), phosphorous has the potential to be used in some way as a detector of buried human remains. Human bodies contain a considerable amount of phosphorous (Chamberlain, 1994) and it has been stated that decomposition of human bodies results in an “enrichment of phosphate levels in the vicinity of the inhumation” (Chamberlain, 1994: 48). Chamberlain (1994) cites the higher levels of phosphorous up to 10cm below burials in Yorkshire although these returned to background levels at greater depths. In this context, consideration must be given to the effect of added fertilizers in some areas, although these are generally applied only to surface layers of soil (Chamberlain, 1994: 48).

McManamon (1984:248) describes the significant history behind phosphate testing for archaeological site discovery, such as tests for various phosphorous compounds that are stable and relatively widespread in archaeological features and anthropic soil horizons. Research from Bethell and Carver (1987) after the unearthing of the
Sutton Hoo ship provides significant data linking chemical traces from the decomposition of bodies with inhumation sites over a long period of time. The Sutton Hoo was unearthed in 1939; 89 ft long clinker-built rowing boat, buried beneath a large raised mound (barrow) in East Anglia. Fourteen graves were excavated between 1984 and 1985 at Sutton Hoo, revealing a dark brown soil silhouette in the shape of human bones, contrasting with the lighter colour of surrounding sand. The chemical traces of a burial all occurred within a short distance (1-2 ft) of the site of that burial. It was concluded that the formation of body silhouettes/pseudomorphs is a phenomenon of acid or sandy soils.

Higher levels of copper, manganese and phosphorous were related to the presence of bone and the silhouette of bone compared to surrounding unstained soil. Boron, magnesium, nickel, and zinc were also reported in the body silhouette. The burial silhouettes are stated as being formed from a combination of a mixture of residues from the burial itself (particularly skeletal phosphorous), and the additional biophile elements attracted from the surrounding soil matrix. Of the biophile elements, manganese was the most significant, causing the darker body “stains”. These processes are not fully understood (Bethell and Carver, 1987:18). Keeley et al. (1977) found higher concentrations of phosphorous, manganese and copper in body silhouettes of archaeological graves in Mucking, Essex compared to the surrounding soil. In this case,
phosphorous levels were high in places where the bones had survived rather than deteriorated.

There has been some published work exploring changes to soil as a result of the decomposition of bodies. Owsley (1995:736) has commented that higher concentrations of potassium, copper, and especially manganese in soils surrounding a decomposing body can be identified through chemical analysis. Other studies about changes to soil as a result of the decomposition of bodies have been undertaken by Rodriguez and Bass (1985), Vass et al. (1992) and Carter and Tibbett (2003). These changes address alterations in soil alkalinity, the release of body substances into the soil such as fatty acids, and surface plant growth attributed to the presence of decompositional by-products respectively.

Rodriguez and Bass (1985) found that soil alkalinity increased just above and just below shallow buried cadavers during a twelve month period. Vass et al. (1992) conducted a study on time since death using soil solution. Seven cadavers were placed on soil surfaces (not buried) during decomposition. They found distinct patterns in the soil solution for volatile fatty acids (extracted between soil particles) during decomposition and for specific anions and cations once skeletonisation had occurred. In their preliminary studies they found that sulphate remained present in large amounts after four years (1992: 1248). Further,
calcium continued to demonstrate a cyclic release from skeletal material that was found in substantial quantities. As Vass et al.’s work relates to bodies above ground it is not known how durable these findings are in a burial situation.

Carter and Tibbett (2003) have posited field mycology as a potential means of locating and recovering buried human remains, specifically stating that particular chemoecological groups of fungi (ammonia fungi and postputrefaction fungi) could serve as surface grave indicators. A relationship between decomposition and the fruiting stages of these fungi is yet to be defined and further research needs to be undertaken. However they make the observation that ammonia and post-putrefaction fungi types fruit when nitrogen is released after burial following decomposition of the cadaver. There is therefore a relationship with the fruiting and amount of nitrogen released from a cadaver.

Testing for alkalinity using a soil probe is the only sub-surface detection instrument that has been specifically modified to detect properties associated with the body itself and it’s interactions with the burial environment. Imaizumi (1974) successfully located a body during a prolonged search in Japan using a modified soil probe. A litmus test for alkalinity was incorporated into the soil probe based on the theory that decomposition of the body would produce a high percentage of alkaline
substances that could be confirmed in the field. This search investigation pre-dated the work of Rodriguez and Bass (1985) and Vass et al. (2002).

The soil probe may also be used to detect variations in the density of the sub-surface (to determine if the area has been disturbed). Owsley (1995) effectively used the soil probe in two forensic cases that resulted in the successful location of buried bodies. A perceived disadvantage of the soil probe is the labour-intensive nature of the search technique and it requires careful penetration into the ground surface. In a crime scene situation, non-invasive methods are more likely to preserve *in situ* evidence. For this reason, geophysical instruments primarily used for applied geophysical or engineering purposes, have begun to feature prominently in the more recent literature about the detection of clandestine graves following their incorporation into archaeological searches.

Geophysical instruments have been used extensively in archaeology since the 1950s (McManamon: 1984; Pendick, 1998:34, Scollar et al., 1990). In the absence of a specialised buried body or bone detection method these have later been applied to the detection and excavation of clandestine graves in reported forensic literature (Spennemann and Franke, 1995). Instruments applied have included the ground penetrating radar (GPR), electrical resistivity, electrical conductivity, electro-magnetic induction
(EM), magnetometers (MAG) and equipment to detect gases emanating from the buried body (Killam, 1990; Chamberlain, 1994; Dirkmaat and Adovasio, 1997; Davenport, 2001). These instruments detect below surface anomalies within the soil layers through passive and active means.

Although a wide range of instruments have been described in terms of their application to detecting human remains (Killam, 1990; Chamberlain 1994; Lindemann, 2000; Davenport, 2001), there are few controlled studies or forensic case studies. Police manuals and chapters discussing the location of human remains cite the application of geophysical instruments to searches (Killam, 1990; Dirkmaat and Adovasio, 1997; Byers, 2002) although there are little substantiating data and few case studies of successful detections. The reliability of these instruments has not yet been established for detecting buried human skeletal remains (Buck, 2003:5). Killam’s widely quoted book “The Detection of Human Remains” (1990) discusses the use of such instruments. However, the content is not based on controlled studies, but rather field experience. Some methods, he states, did not have results available in the field. These included gravity surveying, passive microwave, side-looking airborne radar, infrared scanner imagery, visible colour aerial photography, and colour infrared aerial photography. Other methods had some results
available in the field such as seismic refraction, and resistivity surveying. He does not present specific details.

Although geophysical remote sensing instruments have been applied in other associated commercial situations such as for locating pipelines or cables, or ordinance devices (that are all relatively small objects), detecting buried human remains has yielded less predictable results. As yet, search equipment is not purpose-designed for crime scene or forensic work (Thomas, 1999:64). There are few studies or cases with definitive or conclusive consistent results. At present, we cannot state for sure if the body is not in the area after using remote sensing geophysical equipment. The presence of anomalies by geophysical instruments may be detected but that does not necessarily indicate a body (Bevan, 1991; Nobes, 2000; Davenport, 2001). Considerable research in varying conditions is still required (Schultz et al., 2002).

There is little published literature that expresses scepticism about the capacity of geophysical instruments to detect buried human remains. Chamberlain (1994) is one who asserts that “conventional geophysical survey methods” such as magnetometry and resistivity are not useful for locating single burials. This is particularly the case in urban areas where “secondary disturbances” may result in complicated signals distorting the survey reading. Chamberlain states that where the ground penetrating
radar has proved successful in detecting individual burials, it is the identification of anomalies between the grave fill and surrounding soil that is detected (1994: 47). Schultz et al. (2002) and Freeland et al. (2003) on the other hand, provide evidence for the ground penetrating radar detecting the bodies of buried pigs. Instruments in theory should be useful over a long period of time if they are able to detect disturbed soil because disturbed soil will continue to have different properties to its surrounds (Unterberger, 1992; Miller, 1996). These contrasts create the potential for the ground penetrating radar to be useful for the purpose of detecting gravesites because they are enduring characteristics (Star et al., 1997).

There are only a few published controlled studies involving either the burial of pigs (France et al., 1992 and 1997; Schultz et al., 2002) or human cadavers (Freeland et al., 2003) for the purpose of systematically testing the veracity of geophysical instruments. Of these studies, ground penetrating radar is the most commonly applied instrument. France et al.’s study (1992 and 1997) is the only controlled experiment to have tested more than one type of instrument. In detecting the graves of shallow buried pigs France et al. reported the most useful instruments to be the magnetometer, electro- magnetic profiling and ground penetrating radar (1997:505). No details are given of the tests in these published accounts, such as percentage of gravesites detected, including the
calibration sites. The instruments were considered useful because of their capacity to detect sub-surface anomalies rather than the body itself or any unique physical properties of the grave with the exception of soil disturbance. They state the magnetometer (MAG) surveys detect areas of excavation, which is attributed to a reorientation of magnetic soil particles after backfilling the graves (1997:505). Electromagnetic surveys were considered more useful than MAG surveys, because of the influence on ground conductivity from the increased porosity of the backfill materials. The conclusion from this study was that ground penetrating radar was the most useful instrument for this purpose due to its capacity to detect soil changes and excavation patterns. However, the bases for these conclusions are not detailed in the publication. Further, it is not stated how many of the gravesites were actually detected.

Schultz et al. (2002) showed that soil type was an influencing factor in burial detection by ground penetrating radar. Schultz et al. (2002) discussed the discernment of skeletal pig remains compared to decomposing pigs by ground penetrating radar. They conducted ground penetrating radar surveys over 24 pig burials for 21 months in Florida at two burial depths; approximately 0.5m and 1m. It was found that in clay, grave anomalies were more difficult to detect over time, despite there being little decomposition. The pig cadaver survey results were faint but the grave shaft was discerned. Contrastingly, those pigs buried in sandy
soil were detected throughout the 21 month period. Anomaly characteristics pertaining to the grave in sand are stated as comprising the disturbed soil, the outline of the interface between disturbed soil and undisturbed soil and the body. In sand, these characteristics were the same if the pig was skeletonised or not. Comparison with control graves (not containing a pig) demonstrated that over time, the reflection from the disturbed soil decreased until it was finally no longer detected in sand. In contrast, a skeletonised pig buried for 19 months showed reflections from both the grave wall and skeleton. Unfortunately figures showing the ground penetrating radar responses for the control graves are not presented in the published article.

It is not stated what implements were used to bury the animals in the Schultz et al. study, such as a backhoe or shovels, and this has been shown to impact on the discernment of the graveshaft through sub-surface survey data (Unterberger, 1992). Schultz et al. recognize the relatively short period of burial time, supporting further research using ground penetrating radar for burials of longer duration and in different environments. However, this study is significant because it demonstrates that in some situations the skeletal remains may be detected by a ground penetrating radar and that after a time period, graveshafts may not be detected due to the re-settling of soil.
Freeland et al. (2003) used two ground penetrating radar instruments to survey control shallow graves containing unembalmed fleshe human cadavers, buried at a depth of 0.6m at the University of Tennessee's Anthropological Research Facility. The decomposing cadavers were buried alongside artefacts such as construction debris, metal, wood stones in soil comprising red clay in the subsoil and silt loam in surface. A folded plastic tarp covered the lower half of the body and a 0.1m thick concrete slab covered gravesite. It is stated that the decomposing body mass within the torso was identified by the ground penetrating radar, and also the grave walls and folded tarp covering the lower body. However, of the six test “plots” the rate of successful detection of “hot spots” are not stated in this paper, nor is the duration of burial.

Miller (2002) for her Masters thesis (unpublished at the time of writing) buried eight decomposing or near skeletal remains beneath concrete slabs in a series of six plots ranging in depth from 0.3m to 1.8m. The graves were surveyed over a period of nine months at monthly intervals using ground penetrating radar. The purpose of the study was to demonstrate the ground penetrating radar's capabilities in detecting the metamorphosis of the bodies within the gravesites. Confounding variables were introduced within the graves such as buckets and metal objects. Miller found that eight months after burial the margins of the
burial trenches could be detected. Harsh conditions of either heat or cold were not conducive to obtaining good survey data.

Mellett (1992) used ground penetrating radar to locate the body of a missing person in a forensic case. The remains were found on the calibration survey at a depth of 0.5m. Although metal objects resulted in a reflection, the humerus reflection was also shown. He poses the theory that bone continues to leach calcium into the surrounding soil after interment. The calcium salts are posited as making the bone and the immediate surrounding area more electrically conductive, rendering it visible to radar pulses.

Davenport (2001) describes a case in which ground penetrating radar was used, where anomalies under a concrete slab were given priority for excavation, revealing human remains. It is therefore inconclusive that if, under the conditions cited in the control study were to be found in a case situation, the instruments would reliably detect buried human remains.

Nobes (2000) applied both ground penetrating radar and electromagnetic (EM) surveying to search for a body buried (without a coffin) for almost 12 years in a plantation forest in New Zealand. The body was successfully located through an isolated EM anomaly that was found to be coincident with the body rather than with the ground penetrating radar. This case
situation was characterised by a number of difficulties encountered; the body had allegedly been buried initially in a shallow grave and later transferred to a deeper grave, approximately 1.2 meters deep; there was no opportunity to conduct necessary geophysical surveys before commencing searches; tree harvesting and tree stump removal had taken place in the area; the area itself (a forest plantation site) produced a significant number of anomalous sites (boulders and tree roots) featuring in both the EM and ground penetrating radar survey results; and the sandy ground had the potential to obscure any grave-like excavations. This exemplifies a situation where there were a number of other anomalies identified through the use of technological equipment, in a difficult case environment.

Hammon et al. (2000) examined the application of ground penetrating radar for the location of buried human remains and also its limitations for this purpose through a computer modelling procedure. Their approach was to simulate ground penetrating radar responses to different body cross-sections in a range of soil types, varying moisture levels and depths of burial. This study is concerned with bodies as opposed to skeletal remains and Hammon et al. acknowledge that the data would not be relevant to skeletal remains. However, the main limiting factor on image quality was found to be attenuation both within the body (biological tissues) and the surrounding soil. Further, as the
bones collapse through decomposition and final skeletonisation, they state the data presented in this study would not be relevant (2000:185).

There has been minimal testing of technology based methods other than ground penetrating radar for detecting shallow buried bodies and in particular, skeletal remains. Although McLaughlin (1974) states Vapor-Tect equipment (for the detection of methane, hydrogen phosphide, carbon dioxide, ammonia, hydrogen, hydrogen sulphide gases) was used to verify the presence of a body buried for ten years (1974:25), this has not been reported in other cases.

There is literature on the use of geophysical remote sensing instruments to search for graves in cemeteries or mass graves. The characteristics of such sites are significantly different from clandestine graves. Firstly, a set of skeletonised remains buried within the earth has a much smaller and disparate surface area than a coffin. The depth of burial is more likely to be known for a cemetery burial (approximately 2m) and usually involves a predictable direction or orientation of the grave relating to ritual. If a backhoe is used for burial, this will produce a clear demarcation between disturbed and undisturbed earth compared to a shovel, as would be more likely to be used in a forensic case (Unterberger, 1992). Ground penetrating radar has been successfully used to detect European style
Aboriginal graves in Australian cemeteries (L'Oste-Brown et al., 1996; Long and von Strokirch, 2003).

Bevan (1991) conducted nine geophysical surveys over historical burial sites and cemeteries in the United States, using the ground penetrating radar and electromagnetic induction. The results had mixed success, with the ground penetrating radar providing results that suggested graves where there were none and not detecting known graves. Graves where bones had been re-buried were not detected by ground penetrating radar. This is of interest given that one of the advantages of ground penetrating radar is its capacity to detect soil disturbances (France et al., 1997). However, even the identifying pattern found for coffins at one cemetery was caused by a natural change in the soil strata at another cemetery.

Bevan (1991) also used a Geonics EM38 electromagnetic induction meter at a 19th century Shaker cemetery in Kettering, Ohio. Close to thirty anomalies (defined as low or negative values of apparent conductivity compared to surrounding high values), were found and six of these anomalies were selected for shallow excavations. Five graves were identified at a depth of less than 1m. At Lamington Black cemetery, New Jersey, Bevan states that there was a correlation between known gravesites and conductivity highs. He suggests that the conductivity
highs may be caused by soil contrasts in the grave shafts and not necessarily by metal, such as that of coffin handles.

Nobes (1999) applied an electromagnetic survey (EM), magnetometer-gradiometer and ground penetrating radar in combination to survey Maori graves in a cemetery. Although he could not excavate and confirm his survey results, he found various anomalous responses. He noted that the foot ends tended to have small or negligible responses whereas the head end response was quite clear.

Davis et al. (2000) used ground penetrating radar in 1998 to locate the graves of seven men who died in 1918 and were buried in a cemetery in Norway. Seven coffins near the existing seven grave markers were successfully identified following use of the ground penetrating radar. They found that the ground penetrating radar is able to detect voids in uncollapsed coffins, but where the coffins had collapsed, there was little contrast in the electrical properties of the materials. They concluded that soils that are electrically conductive such as clay, attenuate the ground penetrating radar signal, thereby severely limiting any possibility of detecting collapsed coffins and bones. Both low frequency and high frequency antennae did not prove successful in grave detection.
Buck (2003) conducted geophysical surveys of several cemeteries and concluded that there should be a critical evaluation of field conditions and further refinement of technical methods and skills. The bodies were buried approximately 2 m deep in metal coffins, and surveys were conducted using ground penetrating radar and a caesium magnetometer. In sandy clay loam covering volcanic sediment, the tests gave negative results and did not detect known gravesites. At Fort Hood, Texas, ground penetrating radar and electrical resistivity was used on a small family cemetery (the soil type was coarse sandy gravel). The ground penetrating radar survey contained some ambiguous anomalies but not enough to reach confident conclusions. Although one hyperbolic reflection from a ground penetrating radar survey corresponded to a grave, the other anomalous reflections corresponded to areas both with and without graves. Of note was a clear ground penetrating radar anomaly that corresponded to the relatively subtle feature of an older (ca. 1884) grave, but not the more obvious feature of the newest (ca. 1923) grave. At another cemetery of silty loam soil type, although no potential anomalies were detected by the ground penetrating radar, excavation revealed grave features. The caesium magnetometer also tested on a trench, backfilled only a few days before (2.5m deep, 1.5m wide in silty clay loam). Neither the ground penetrating radar nor magnetometer detected the trench.
Such studies demonstrate that even where bodies are buried in coffins and therefore provide larger surface areas and reflector surfaces for detection by ground penetrating radar, geophysical remote sensing survey results are ambiguous or do not provide information sufficient to lead to the reliable detection of gravesites. In situations where there is no coffin and the burials are shallower, there is no collection of information that supports the consistent, predictable detection of skeletal human remains through technological means. In comparison to a body buried in a coffin, a set of skeletal remains presents a smaller surface area than a coffin to detect, with little likelihood of air voids within the ground.

For geophysical instruments in general to be successful in a given application, it is dependent on the presence of indicators and appropriate conditions specific to the task (Scanvic, 1997). The quality of information able to be provided by the geophysical instruments is generally influenced by field conditions, especially the soil type and the water content of the soil. It would be expected that there might also be considerable seasonal variation of results even over known gravesites in a control situation, although there are no studies that demonstrate the results of geophysical surveys over the same gravesites in different seasons. All geophysical instruments have specific limitations that must be understood before application to a forensic search for buried human remains. The limitations relate to the environment and include soil type
in which the instrument will be most effective, soil conductivity (which is affected by water and dissolved ion content) and artefacts that may affect the detection of contrast in the subsurface such as clothing or coverings to the body (that will impact on moisture retention in particular).

The geophysical instruments are heavily dependent on whether anomalies will stand out against the background of an area surveyed. Replaced soil has a higher level of air than the compacted undisturbed earth, and this serves to lower the average electrical permittivity of the ground over the grave. An example is the affect of electrical properties on the ground penetrating radar (GPR) response. If the ground is electrically conductive, then the ground penetrating radar signal will be severely attenuated, and the antenna frequency will be critical to the detection of radar reflections (Nobes, 2000:717). Further, air within disturbed soil increases the velocity of the surface wave, although the presence of water will decrease this velocity. Bones are difficult to detect because of their size and their electrical properties are similar to dry soil (Nobes, 2000).

Geophysical remote sensing instruments are more effective if background “clutter” is able be suppressed to provide more discernible results (Nobes, 2000). Part of the detection problem lies not in the detection of a signal or anomaly, but in the interpretation of what it is indicating. A signal may come from many other things besides bones or a
body; the “anomalies” detected may be objects that can be naturally occurring, such as tree roots, rocks, changes in texture to the soil. What has not been documented is the range of signals from buried bones that could be reasonably expected under different circumstances (Nobes, 2000).

A buried body, in principle, should present a source of contrast because of the initial action of changing the soil structure of the pre-burial environment; the enduring properties associated with the body itself; and the potential changes to the soil that could be expected to result from the interaction with the burial environment. Anomalous results will depend on the response from a buried object being great enough to exceed the sensitivity of the survey instrument, and the natural background variability (Nobes, 2000:717). However, despite the logic behind the application of these instruments, “…there is no remote sensing method that will consistently find a body or physical evidence” (Davenport, 2001:87).

There has been little research on the effectiveness of the combined use of geophysical instruments, for example in what order and how to apply combined methods in different soil types, particularly to rule out there being a body within a given area. Various reference books suggest the use of multiple survey techniques, such as using electrical resistivity and
ground penetrating radar (Killam, 1990) or combinations of instruments (Nobes, 2000). Such measures allow for a greater understanding of the soil conditions. In archaeological searches, Neubauer (2001) advocates an approach of integrated prospection, in order to overcome the limitation of individual geophysical techniques, as they are based on different physical properties. Nobes (2000:718) recommends the use of more than one survey method but acknowledges that cost is prohibitory. For example, he suggests using the EM31 survey first as a volumetric reconnaissance, and then to follow up with a ground penetrating radar survey. The logic is that the EM survey is able to identify potential target sites, and the most useful ground penetrating radar antenna may be then be determined from this information.

A further important factor is the portability of different instruments over various terrain types. Trained and experienced people must operate geophysical remote sensing instruments, with the ability to correctly calibrate the instruments to the environment and adjust the equipment to yield what may be small contrasts in the sub-surface.

The use of technology has a cost dimension. The cost factor is in the hire of the equipment (which could be up to a week, dependent on the size of the area, and possibility of needing to repeat readings), expertise in using the equipment, the processing of data and interpretation of the data.
Geophysical instruments of the nature described above are available through private consulting firms on a cost per day basis and should be applied with expertise, particularly with regard to the interpretation of the survey results. Some universities have some instruments, although price of purchase is restrictive to many universities.

Instruments cited in the literature are discussed separately below with reference to the literature findings for their potential effectiveness and the principal basis upon which they have been applied.

**Ground Penetrating Radar**

The ground penetrating radar has been most commonly applied and discussed in terms of its application to both forensic searches and cemetery searches for buried bodies, as was noted in the previous section (Bevan, 1991; Nobes, 2000; Davenport, 2001; Buck, 2003). Ground penetrating radar (GPR) is an “active” geophysical prospecting device because it transmits man-made or induced signals into the ground and measures the signals returned to the receiver (Killam, 1990). In principle, the ground penetrating radar antenna measures the “echo” returned from discontinuities within the soil after the electromagnetic energy pulse is transmitted. The precise “echo” characteristic of human skeletal remains has not been identified for the ground penetrating radar.
As with most remote sensing geophysical instruments, there are conditions under which the ground penetrating radar is more likely to detect sub-surface anomalies than others. Forensic searches ideally suited to use of the ground penetrating radar are those over sandy and silty soils where the water content is low (Killam, 1990). Electromagnetic properties of the soil will impact upon the depth the ground penetrating radar is able to probe (Kanable, 2000). Where soils contain high levels of salt water (and is therefore electrically conductive), the ground penetrating radar will not be effective because the radar energy is “conducted away” before it is reflected in the ground. High levels of conductivity are commonly found immediately below the root zone of plants where there is a moderate degree of salinity, and this impacts upon the ground penetrating radar’s capacity to detect objects or voids below this zone (Stott, 1996). Stott (1996) found that the ground penetrating radar was not useful in a highly saline, sandy light-clay soil because of the high levels of conductivity to detect subterranean animal tunnels.

Areas that have already been excavated and disturbed will obviously limit the ground penetrating radar’s capacity to detect the presence of disturbed soil surrounding buried skeletal remains. Natural sub-surface geological changes, resulting in varying soil types or large rocks, or else
tree roots can present as scattered signals (Davis et al., 2000). The most suitable ground for a ground penetrating radar is relatively flat with little vegetation. Sheet metal or reinforcing mesh (with a grid size less than 4 inches) will impede the ground penetrating radar (Killam, 1990).

**Electromagnetic Induction Meters (EM)**

Electromagnetic (EM) induction meters induce an electromagnetic current into the ground, providing a means of measuring the electrical conductivity of sub-surface features (Davenport, 2001:92). Soil does not have a preferred polarization, but objects do and this creates identification possibilities. Disturbed ground may have a different conductivity to undisturbed ground (Davenport, 2001:92). However, these instruments can be affected by electromagnetic interference in areas with high resistivity, sand being an example.

Anomalies in conductivity could be due to many factors and cannot be isolated to a grave or human skeletal remains, such as clay content, water and metal. The electrical conductivity of soil increases as the water, clay or metal content increases and as the concentration of dissolved ions increases in water (Fischer, 1980; Nobes, 2000). Fischer, (1980) concludes from archaeological excavations that higher water content levels act to increase the potential to detect small objects. However, this technique
would be of limited value if the search area contains metal objects, such as a metal fence.

If a body is clothed, there will be greater contrast between the electrical conductivity of the soil in an area and a grave (Nobes, 2000). Clothing that allows the retention of moisture will result in a higher electrical conductivity reading (Nobes, 2000).

**Resistivity Surveying**

This technique involves placing electrodes in the ground at regular intervals and sending an electric current through one of them. The resistance to an electric current by soil and other anomalies is measured as the ratio of voltage across the electrodes to the current flowing through them. Anomalously high or low resistivity scores form the basis for detecting features and anthropic soil horizons (McManamon, 1984:246). The system requires the use of at least four electrodes, an electrical source, and a measuring device (Hole and Heizer, 1965: 171).

Resistivity surveying is dependent on the porosity of the soil and chemical content of the water within the pore spaces (Hole and Heizer, 1965; Killam, 1990), soil type, degree of saturation, concentration of ions, and temperature of pore water (Yoon and Park, 2001:148). Salts from the
soil and biological humics determine the ionic concentration of soil, which affect conductivity (Killam, 1990). In terms of a gravesite, a higher current flow than the surrounds could be expected because of increased concentrations of ionised water (Owsley, 1995:736). However, it is cumbersome to use and is more time-consuming than other geophysical remote sensing methods. It is more effectively used in less extreme months because of its reliance on soil moisture levels (David and Linford, 2000:29).

There are many factors that will clearly impact upon the survey results using this instrument and there are no documented successful forensic gravesite detections using resistivity. Powell (2004) identified a 150 year old burial within a coffin using electrical resistivity in South Australia.

**Magnetic Surveying**

Magnetometry has been used for archaeological purposes since the late 1950s (McManamon, 1984:245). For example, the remains of the largest wooden temple in the United Kingdom were discovered by detecting small variations in the soil’s magnetic field (David and Linford, 2000:27).

There are several different types of magnetometers. The proton magnetometer measures the intensity of the gravitational field of the
earth directly below. The results across an area show variations in the strength of the magnetic field. In effect, protons are acting in the manner of bar magnets, aligning themselves with the magnetic field. The magnetic intensity shows in the rate of gyration (Hole and Heizer, 1965:169).

A major limitation is the significant sources of magnetic background to be found in most modern developed areas. Also there are natural magnetic properties of some soils and surface geological anomalies that act to mask the magnetic contrast of otherwise detectable target features. This means substantial amounts of information about the natural magnetic background are required (McManamon 1984: 246). One advantage is that magnetic surveys do not exhibit any seasonal variation (David and Linford, 2000:30).

**Magnetic Gradiometer**

A magnetic gradiometer detects and measures the change in the magnetic field degrades between two sensors over the distance between these sensors (Thomas, 1999). The fact that it is lightweight is an advantage in the field. However, background magnetic fields can mask indicators from small targets such as a grave.
There are no published accounts of its application to forensic searches for buried bodies.

**Acoustic imaging**

Acoustic imaging has not been documented as having been applied in forensic investigations to locate buried human remains, although research by Frazier *et al.* (2000) have developed an acoustic system for high resolution imaging of objects buried in soil, specifically cultural artefacts. They focused on detecting land mines as these have greater reflectivity due to “larger impedance mismatch with soil” (2000:147). The results showed the feasibility of acoustically imaging small objects buried in dry homogeneous soil and they were able to detect objects with small cross-sectional areas and significant length, such as buried bottles and a metal bar.

**Summary**

From the literature, it is evident that a reliable method of detection for clandestine graves and skeletal remains has not been identified, although there is supporting evidence for both a range of surface indicators that may be associated with gravesites and the value of some geophysical instruments in certain circumstances. In particular, there are a limited
number of controlled studies and too few studies involving cadavers from which to draw definitive methods of detection in a wide variety of circumstances.

The evidence available for identifying surface indicators of buried human remains is based on a limited number of controlled studies. This evidence suggests that vegetation differences may indicate a gravesite or disturbance, but not necessarily a buried body. In addition, the literature states that soil depressions may be expected at a gravesite, upcast will be visible, an interface between upcast and undisturbed ground, insect activity and digging from faunal scavenging are all surface indications of a clandestine grave. Controlled studies need to be expanded to include various climate and soil conditions. Except for faunal scavenging, these indicators are also evidence of soil disturbance and are not associated particularly with the burial of a body, animal or human. It is not known how many months or years such indications may endure, as there has only been one study of five years of buried pigs (France et al., 1997).

There are other issues that remain unresolved such as whether surface indicators may be expected in all environments and more information about the physical properties of gravesites is needed. The gravesite surface and changes to it have only been peripherally examined in the context of the literature.
The detection of chemical changes to the soil as a result of the burial and decomposition of a body has not been studied extensively, although alkalinity changes have been used to detect a buried body using a soil probe (Imaizumi, 1974) and Vass et al. (1992) have studied decompositional byproducts. From a detection perspective, over a large search area this type of approach would require considerable time and would need to be conducted at a small grid level. However, further exploration of the chemistry of the gravesite could lead to information that could be applied to field based detection methods.

Sub-surface detection is possible through the use of remote sensing geophysical instruments. In the literature, a large range of geophysical instruments is cited as being available for the detection of clandestine graves but there is little critical analysis. While they have not been designed or refined for the purpose of detecting buried human remains, there is evidence of successful detection although it is limited and confined to a small range of instruments in this category. Essentially, these instruments detect anomalies or contrasts in a given environment and are strongly influenced by the environmental conditions. Anomalies detected may also be caused by various other sub-surface elements. The successful application of such instruments is heavily dependent on understanding their limitations and the conditions under which the results will be maximized.
Further studies are needed about the reliability of different geophysical instruments in detecting shallow buried human remains in forensic cases. The evidence for their application where there are larger and deeper burials involving coffins is ambiguous and inconsistent. Partly this is because of the limited body of literature involving actual forensic search cases and perhaps because police do not always involve anthropologists or other experts in this field. To overcome the variation associated with any one method, some practitioners have advocated multiple methods be used in searches to increase the potential for successful detection (France et al., 1997; Nobes, 2000) but there is a need for further research on this proposal. There is also an expense factor that can be prohibitive to the use of geophysical instruments in more cases and studies. At this stage, there is no capacity for reliably predicting the ability of any one instrument to detect buried human skeletal remains even when the conditions are in theory ideal for its use.

The literature demonstrates the need for ongoing research into the detection of buried human remains and the increasing activity in this field. Human beings continue to be murdered and hidden in shallow graves. Not all are found and there are dedicated professionals who undertake forensic searches voluntarily. This is prohibitive of the
necessary research into detection methods that may lead to more successful techniques to assist police investigations.
3 THE NATURE OF A GRAVE

“What is he that builds stronger than either the mason, the shipwright, or the carpenter?...say a “grave-maker”: the house that he makes lasts till doomsday.” (William Shakespeare, Hamlet, Act V, scene I)

A grave is a hole dug downwards into the ground from the surface, forming a vertical shaft into which a body is interred, and the soil replaced. Graves (either ritual burials or clandestine graves) are not constructed on an angle as in a burrow. Graves are manmade and do not occur as natural phenomena. In physical terms, a burial is an interference with a given environment; an inhumation of an external object into a pre-existing environment (either natural or developed), thereby disrupting and altering that current ecosystem in content and form. This section describes the appearance of a grave in terms of the dynamics involved in its creation and discusses what is known about the extent, nature of and duration of the disruption to the immediate ecosystem as background to the issue of detecting clandestine graves.

Creating a grave and burying a body has the following predictable effects on the immediate surrounds:

- Alteration of the surface area (for example, displacement and disturbance of vegetation, surface litter or debris);
- Soil upheaval and its subsequent settling (disruption of stratigraphic layering within the hole dug, mixing of the soil horizons, soil consolidation and the formation of depressions);
- The deposition of a food source for foragers and insects; and
- The possibility of artefacts left at or within the gravesite (personal effects or belongings; tools or weapons).

A gravesite, although not an original part of the landscape and ecosystem in which it is set, becomes subject to the same environmental conditions as its surrounds. Post-burial, the processes of the ecosystem are acting on changed circumstances. Does the disturbed area (gravesite) become more or less affected by weathering processes? What do indicators of a grave comprise? Is there a catch up period when these obvious differences are obfuscated, at least to the naked eye? What is known about the appearance of clandestine graves after time has passed? There is little documentation of what graves may look like at different intervals post-burial. Although Killam (1990:237) states for a burial of more than two years, there may be no visible signs of a grave, this has not been established in controlled studies.

Visual changes to the surface environment resulting from a clandestine grave would be expected to be present in the form of “anomalies” to the surrounds (Hunter and Martin, 1996:40); such as differences in soil
(colour, texture, degree of compression), differences in plant growth, signs of animals foraging (Killam 1990: 31), and depressions or mounds of earth (Geberth, 1983). Such differences have been documented in only a minimum number of research studies and are largely presented as statements of expectations in general texts or edited books on forensic subjects (Krogman and Iscan, 1986; Killam, 1990; Hunter et al., 1996; Dirkmaat and Adovasio, 1997; Pickering and Bachman, 1997; Byers, 2002). Notable studies are those of Rodriguez and Bass (1985) who linked observations made at gravesites with clues for the purposes of detection and France et al. (1997) that concerned pig gravesites over five years (refer to the literature review in section 2). With so few studies there is not enough information to generalise findings to a variety of environments and over long time periods.

**Initial description of the clandestine grave**

As the grave hole is dug, soil from below the surface is lifted out, aerated and mixed with the different horizons (upcast), altering the stratification of the subsurface soil permanently (Dirkmaat and Adovasio, 1997; Pickering and Bachman, 1997). Surface plant material is uprooted where the hole is begun and upcast soil deposited on top of the adjacent surrounds damaging any neighbouring plant growth. After the body is placed within the grave, the pile of soil removed from the ground is
returned to the hole, to cover the body and refill the grave. Killam (1990:7) states that these changes to the soil layers continue to be detectable.

*Figure 1: Soil structure compared to undisturbed surrounds.*

<table>
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<tr>
<th>Soil horizon 1</th>
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<tr>
<td>Soil horizon 2</td>
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<td>Soil horizon 3</td>
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*The line at the top of the figure represents the broken continuity of surface features. Note the soil horizons will vary in depth across different areas. Diagram by author.*

Upcast has been termed that soil dug out of the ground and backfill as earth returned into the grave (Hunter and Martin, 1996:86). In this thesis, the term “upcast” will be used as there is no need to distinguish between the two terms; upcast is that soil brought up from the gravesite and returned to the same area. Sub-surface soil is usually of a different colour (lighter or darker) and texture (for example, it may contain rubble) to that on the uppermost surface (Rodriguez and Bass, 1985; Owsley, 1995:735). This is commonsense and the only likely exceptions are soil types with no soil horizons at the shallow depths associated with most forensic burials, such as sand and desert environments or in sites of landfill.
Digging a grave removes not only the surface growth but also what may be classified as natural “debris or litter”. This debris comprises a layer of dry leaves, pods, gumnuts, dead flowers, twigs and branches that have dropped from trees or other plants, or been wind blown across the soil surface and have settled on the ground surface. The debris settles and compacts over time, unless blown away. If removed it cannot be replaced in the same way. Upcast is clearly visible without this surface layer of debris. The recovery time for the natural replacement of surface debris or ground litter is not documented in any studies.

The size of the grave will depend on the instruments used to dig the grave (shovels, picks, crow-bars or backhoe), the strength of the person or persons digging, time available, and most importantly, the soil type and terrain. The area of upheaval will be related to the size of the grave; the larger or deeper the grave, the greater is the area that is changed (Hunter, 1997:88). Even a small grave will produce a larger disturbed surface area than the actual diameter of the grave. For reasons of expediency, and the difficulties associated with digging a grave, victims of murder tend to be buried in relatively shallow graves. Further, to position a body in a prostrate formal position, a longer grave is required (a body in a curled or foetal position requires less surface area). There is no collected data about the position of the body when found in clandestine graves against which this statement may be substantiated.
If a body is buried after the onset of *rigor mortis*, this may impact the degree of difficulty experienced in transporting the body (such as placing it within a vehicle) and the shape and size of the burial pit. For example, if the body is in a state of *rigor mortis* at the time of burial, it is more likely to be buried in an extended position, meaning the burial pit would be the length of the body as compared to if the body was buried in a curled or flexed position.

When a body is placed within the hole, the volume of space for the upcast soil to be returned to the hole is reduced. Owsley (1995:735) states that one indicator may be the presence of a mound of earth not returned to the grave. It may be assumed that in a murder case it would be unwise to leave a mound above the grave (even to compensate for any expected soil consolidation) for the simple reason that the intent is to disguise its existence. Alternatively, any excess upcast spread around the area will cause further damage to the surrounding vegetation (Duncan, 1983:7). Actual cases in the literature have not reported mounds as indicators for clandestine graves, although it is possible mounds over the graves resettle.
Post-burial grave appearance

After the body has been interred and the grave refilled, traces of subsurface soil (upcast) will remain around the gravesite, unless the upcast is laid on plastic or a groundsheet. A gravesite, then, can be detected visually, when first created, by colour and textural changes that are predicated on being anomalous and different from its immediate surrounds. Rodriguez and Bass (1985) suggest further this visual indicator will not remain constant but will “lessen over time” as a result of weathering (in their study of bodies buried from six months to one year). France et al. (1997) in the only longitudinal study of pig gravesites found that, at less than five years after burial “excavation boundaries tend to become masked, fill material becomes generally more fine-grained, and the compaction of the fill material to the original surface grade is facilitated” (1997:504) but that these changes did not occur during a dry season. Climate and in particular, moisture, was found to be a significant influence on the duration of the physical characteristics of graves. Spenneman and Franke (1995:6) note an exception to this expectation. During exhumations in the Marshall Islands of graves (approximately 1.6m deep) created between 1946 and 1958, they found that the soil in the interior of the grave was unconsolidated and uncompressed. This emphasises the potential variation across
environments and the need for comparable studies in different countries and areas.

This exception notwithstanding, in most situations after soil has been upturned and replaced into the grave, it will begin to “settle”. Soil upheaval can be detected by contrasts in soil settling within an area, pointing to a possible gravesite (Imaizumi, 1974; Duncan, 1983; Schwartz, 1993:14; Owsley, 1995). Unearthed and less compacted soils may be recognised by their grain, degree of cracking when moisture content is low in the area, and degree of “give” when pressure is applied. Cracking or splitting of the surface has been found at the junction of the upcast and undisturbed ground, or where the grave edges meet surrounding soil (Duncan, 1983:9). This again will depend on weather conditions and there is no post-burial time factor associated with this surface appearance.

Depressions or “dipping” due to either the natural soil consolidation over the grave, and/or bodily decomposition have been cited as surface descriptors of gravesites (Duncan, 1983; Rodriguez and Bass, 1985; Killam, 1990; Owsley, 1995:735; Hunter and Martin, 1996; Janaway, 1996). Duncan (1983:9) states that different soils have different rates of compaction, resulting in a variation of the depth of depressions over different soils. He states a secondary depression “will normally be found
only over a grave of about 24-30 inches [approximately 0.7m] in depth". It is posited that the shallower the grave the more pronounced the secondary depression and that a depression will form more quickly following rain or the input of moisture. In contrast, Hunter and Martin (1996:88) state that greater depressions will be found in deeper burials compared to shallow burials because a deeper grave will become more compacted. There has been little controlled research into depressions and their formation over gravesites.

It is likely that the positioning of the body within the grave will affect the resultant signs of consolidation and the subsequent formation of depressions, although no specific studies have determined depression patterns in clandestine burials. It has been stated that if a body is laid prostrate and horizontal two depressions will be expected. Firstly, a depression will form as the ground begins to slope inwards towards the centre of the grave (Killam, 1990: 35) and a secondary depression may occur over the abdomen area as this collapses, in a shallow grave (Morse et al., 1983), but not necessarily in a deeper grave. This assumes the body is laid in a position likely to produce secondary depressions. There are no references to the pattern of depressions if a body is flexed. The nature of sub-surface bloating in a clandestine grave is unknown. Duncan (1983) states the main unknown as being the degree of skeletal collapse of the buried victim, however, it may be argued that the collapse of the skeleton
will have less impact on the soil space within a grave than the decomposition of the surrounding tissue. This is suggested because the soil will seep into the areas previously occupied by tissue as it decomposes, which will not be sudden. The skeletal components will occupy the same volume in the soil as before decomposition – it will be tissue decay that results in the formation of depressions.

Once the grave is refilled initially there will be no vegetation over the upcast unless placed there deliberately. The application of plant ecology and botany to forensic investigations is a relatively new area and has been discussed by Duncan (1983), Rodriguez and Bass (1985), Bock and Norris (1997), and France et al., (1997:366). Bock and Norris state “…disturbances in vegetation can be identified even two or more decades after the event…” (1997:366) which suggests the lasting nature of such changes providing the changes are understood in terms of their significance. However, archaeologists have used changes in vegetation to assist in the location of historical sites, including gravesites. For example, in 1949 Woolley identified graves in Carcemish, North Syria, by examining patterns of weed growth in a field that had been ploughed to a depth of 0.75m. He correctly identified graveshafs by following the patterns of deep-growing weeds, deducing that at some time past the gravel and soil had been broken up by digging, thereby allowing the weed roots to penetrate deeper than would normally be possible. This is a
deduction made from an area that had been disturbed. Woolley was able
to find areas that were disturbed to a greater depth from plants whose
roots grew deep in some areas over others. This is an example of using
anomalies within an area to identify graveshafts. There is a need for more
information about vegetation patterns over forensic (or more recent)
graves, and associated identifying anomalies.

Ecologists and botanists use the term “plant succession” or successional
dynamics to refer to the way in which plants will propagate and grow
within an area following a disturbance of vegetation and/or soil (Rees et
al., 2001). Climatic conditions will govern rapidity of new vegetation
growth over gravesite. As time passes, the composition of the species
changes (Bock and Norris, 1997). This will continue until a stable plant
community is established. Further, Bock and Norris (1997) state that
succession in vegetation may be able to be predicted for different
regions, when it is known which plant types are early or late successional
for a given area.

Local climatic conditions are important for the regrowth rate of
vegetation in a disturbed area. Early successional plants tend to display
high fecundity, long dispersal, rapid growth in high resourced areas, and
slower growth in lower resourced areas. Conversely, traits ascribed to late
successional are: relatively low fecundity, short dispersal, slow growth,
and general ability to survive in low resource areas (Rees et al., 2001:650). Regardless of plant type, immediately following a burial any plants will be smaller and younger than nearby plants. It is not known if there are certain environment types in which vegetation over a gravesite will eventually resemble a pre-burial state.

The level of pH in soil affects vegetation. In alkaline soils with a high pH plant growth tends to be healthier because of the higher levels of nutrients available, whereas in acid soils plant growth is not as healthy, indicated by poor colour and less vigorous growth (Killam, 1990). If a decomposing body affects the pH level in soil then plant growth would be expected to be influenced accordingly.

From the previous literature review (section 2) vegetation differentiation over a gravesite was described as:

- Absent or less dense over a recent gravesite (Bock and Norris, 1997; Owsley, 1995:735);
- More “lush” over the grave after one year than in the surrounding area because of the less compact, moister soil (Owsley, 1995:735) and after the first burial growing season (Bock and Norris, 1997) and because of the release of organic materials from the decomposing body (Rodriguez and Bass, 1985);
• Showing a difference in the size and height of plants (Duncan, 1983:7);
• A noticeably different mix of plants on disturbed compared to undisturbed areas (France et al. 1997);
• Parched vegetation in dry circumstances, where soil on gravesites does not retain moisture as well as the surrounding soil (Hunter and Martin, 1996:88).

France et al. (1992 and 1997) described vegetation changes to pig graves after five years in Colorado. Eighteen gravesites were established, of which sixteen contained buried pigs and two were calibration pits (empty gravesites). The depth of burial is not stated. In terms of vegetation patterns, the results showed that:

• Undisturbed plots were found to have a greater diversity of plants compared to disturbed plots irrespective of whether the graves contained a pig;
• “Pioneer or opportunistic” plants were the first to grow on the gravesites, including plants that were not previously present;
• No plots attained the pre-burial plant species mix;
• The percent cover for each grave was similar but the species mix at each site was different;
• Disturbed plot vegetation changed according to stages of plant succession (specific changes not given);
The critical factor to gravesite recovery and the establishment of plants was moisture.

France et al. (1997:505) observe that although it is a common belief that the additional nutrients provided by a body within a grave will affect plant growth, the observations made after five years of both calibration pits and those containing pigs were not noticeably different. Calibration pits and graves show similar revegetation patterns. From this study, we may extrapolate that identifying disturbed ground through vegetation changes can indicate a grave, but that vegetation changes are not necessarily indicators for the presence of a body. However, they state that the disturbed area, regardless of the presence of pig will look different to the surrounding areas (1992:1552). No data is given that relates to soil depressions.

The post burial appearance of a grave will be affected by any subsequent disturbance such as that by fauna. The body deposited is a food source for various types of fauna both large and small. Signs of digging, indicated by small burrows or tracks, insect activity (eggs, larvae), or droppings may present as evidence of a gravesite (Rodriguez and Bass, 1985; Owsley, 1995:735; Hunter and Martin, 1996; France et al., 1997; Haglund, 1997). Predators will vary within each country and therefore the distinguishing traces will vary. For example, there are turkey vultures in
Colorado, coyotes, raccoons and foxes in Tennessee, foxes and rats in the United Kingdom, wild dogs, dingoes and wild pigs in parts of Australia and foxes in South Australia to cite a few.

The actions of creating a grave and its affect on the environment have been described, including the likely appearance of the grave from the surface. Obvious resultant surface indicators of graves have been stated in the literature (including soil and vegetation differentiation and an expectation of soil depressions forming). It is stated that detectable topographical anomalies may be expected to be of varying durations; both shorter and longer term (Hunter, 1997:88). However, further specific information about these surface indicators, such as when they emerge (post-burial time) and how long they endure is not currently available. It is also not known if clandestine graves resume a pre-burial appearance. Of critical importance are climatic conditions, as this will affect the components of a gravesite at the surface, that is soil and vegetation, and clearly there will be considerable variation in different environments for this reason. The study by France et al. (1997) is the most detailed to date in terms of grave appearance after several years.

The descriptors given in this section are all related to the changes imposed on the environment through the act of digging a hole, except those actions of predators. From this information there is little to suggest
a direct relationship between the presence of a body and the surface signs described with the possible exception of the depressions. The majority of signs, particularly from France et al.’s study would be present in any disturbed area regardless of a body being buried. The next section discusses the inter-relationship between the body and the grave environment.
4 THE BURIED BODY IN SITU

“Nature does not know extinction; all it knows is transformation.”
Wernher von Braun, American Weekly, 10 February 1963

Within the grave the body will decompose and interact with its environment, creating an active ecosystem. An exchange of chemicals takes place at the interface between the body and its environment. This section describes the decomposition process of the body, the environmental factors that will affect this process, and the components of the body that may be expected to remain for subsequent detection. It also addresses what is known about how decomposition impacts upon the appearance of the grave surface and the subsurface.

The Decomposition Process

Decomposition is about transformation; in this study, the transformation of a human body after death within a burial situation and the associated forces acting upon it to bring about this transformation. Examining death, decomposition and burial falls within the field of taphonomy (Garland, 1987:121). The taphonomic behaviour of the body is influenced by many factors, such as the cause of death or state of the body at death, the time interval between death and burial, the treatment of the body
prior to burial, and the characteristics of the burial environment (Garland and Janaway, 1989: 16).

In its living state, the human body comprises water, dissolved salts, protein, carbohydrates and lipids or oils and fats and the bones and teeth constitute the mineralised tissues (these latter comprise 7% of the body) (Chamberlain and Pearson, 2001:12). Almost all (99%) of the mass of the human body is made up of six elements: oxygen, carbon, hydrogen, nitrogen, calcium and phosphorous.

The decomposition of a human body commences within minutes of death (approximately 4 minutes is given by Vass et al., 2002) and is described by the following processes:

1) Autolysis. Immediately after death autolysis commences; initiating the destruction of soft tissues during which the skin swells and blisters (Janaway, 1996:64). Bodily enzymes promote automatic digestion, breaking down proteins and fats, and the body feeds on itself. Eventually the body will start to decay (putrefaction) or become preserved (mummified) in response to environmental conditions (and this may include the production of adipocere).

2) Putrefaction. Putrefaction involves enzyme activity and bacteria feeding on the soft tissues of the body. During putrefaction
bacteria may come from two sources; the body itself, especially the respiratory and alimentary tracts (from when it was alive) and the external environment (Chamberlain and Pearson, 2001:13). Aerobic micro-organisms utilising oxygen, together with the formation of gases create the environment in which the body will reduce (Janaway, 1987:133). The gases that are formed and released during decomposition are hydrogen phosphide, hydrogen sulphide, ammonia, carbon dioxide.

3) Transformation of the body components to simpler chemical forms. The soft bodily tissues (protein, carbohydrate and fat components of the body) are reduced to a fluid. One of these products is short chain fatty acids (McGregor et al., 1996:67; Janaway, 1996). Insects are attracted to the resulting smell and their subsequent larvae continue to feed on the body's tissues. Fungi will feed on cadavers and will even dissolve bones and teeth.

4) Skeletonisation. Eventually, the body will be reduced to skeletal remains with little or no bodily tissues, except where mummification occurs. Certain soil conditions will lead to the deterioration of skeletal remains.

The body itself, when buried directly in soil, may have a mucous sheath around it, formed from liquefied decomposition products and the fine silt fraction from the soil (Janaway, 1987:132).
Figure 2 below summarises the decomposition process in diagrammatic form.

*Figure 2: The grave and the decomposition of the body.*

**Extrinsic factors**
- Physical: environmental and sub-surface conditions (for example, moisture, temperature, etc)
- Biological: Scavengers (insects, mammals, birds, bacteria)
- Chemical: adsorption of elements from the soil into the remains, including skeletal remains (diagenesis)

**Decomposition of the body**

**Intrinsic factors**
- Physical: Skin swelling, skin tissues reducing to fluids etc
- Biological: Micro-organisms
- Chemical: Enzyme activity; Reduction of complex organic matter to

**Transformation of the environment**
Release of materials into environment (heat, chemicals, byproducts from these processes) including infiltration into the soil
Factors Affecting Decomposition of the Body in Situ

Each clandestine grave will vary in terms of soil type, depth of burial, location (country, area, undisturbed ground or developed area), situation within the location (beneath a log, near trees, in an open area) and mode of burial (use of protective wrapping around the body or clothing). These variations will impact upon the rate of decomposition of the body. Other factors affecting decomposition include the season of burial; presence or absence of bodily wounds; amount of cover to the burial area, moisture content, temperature, oxygen availability, insect activity and duration of interment (Dirkmaat and Adovasio, 1997:51). Some burial conditions will promote decomposition and others will inhibit decomposition, the most significant being those that affect the access of moisture, temperature, air, insects and bacteria to the body. The variables important to the geochemical conditions within a burial site include: soil pH, organic matter content, soil solution fluoride and carbonate concentration, mineralogy, and texture, temperature variations, abundance and distribution of precipitation, local groundwater movement, microbial activity (Pate et al., 1989). Overall temperature and moisture levels will be influenced by geographical place (soil composition and chemistry, site slope, surface and subsurface water movement).
Decomposition will be affected by depth of burial. Depth of burial influences the amount of oxygen available which effects decay of soft tissues (Henderson 1987:48). Deeper burials more effectively inhibit the processes of decay on the body (Mant, 1987; Chamberlain and Pearson, 2001:14). In a shallow grave, the decay of the body is promoted because of the greater interchange between the body and the surface. This in turn allows easier access for insects to the body (Thomas, 1995:36), aeration of the soil by earthworms and greater fluctuations of temperature (Henderson, 1987:52). Mann et al. (1990:106) have stated that shallow buried bodies (0.3 or 0.6m) may skeletonise in less than twelve months compared to the several years it may take for bodies buried in deeper graves (0.9 or 1.2 m). Soil type will also influence rate of decomposition in addition to depth of burial.

Immediately after burial, the soil is more aerated than surrounding areas (Janaway, 1987:145). Porous, permeable and light soils accelerate decomposition because it promotes a relatively free exchange of oxygen and water from the atmosphere and reductive gases (such as carbon dioxide, hydrogen sulphide, ammonia and methane) from the body (Rentoul and Smith, 1973; Janaway, 1996). Conversely, dense, clay-like soils may actively retard decomposition (Rentoul and Smith, 1973). Krogman and Iscan (1986) state that bodies decompose more slowly in lime-soil and faster in moist clay, clay-loess, dry wood humus and in
acidic marsh areas. Within humic soils there are high concentrations of bacteria and other organisms that feed on decaying flesh (Pate et al., 1989: 313). It is known that tanning agents in peat bogs preserve collagen molecules (Chamberlain and Pearson, 2001). In contrast, Mant (1987) considers the influence of soils on the rate of decomposition to be over-emphasised because he found little effect from a wide variety of soils from which he exhumed bodies, when all else was equal, at a 1.8m (or 5-6 feet). Mann et al. (1990:106) states that it is unknown what effect soil pH has on the decomposition of the body.

Entomologists have studied insect activity both above and below the surface, as part of the process of decomposition of the interred body (Lord and Goff, 1994). The destruction of the body’s soft tissues is mainly due to necrophilous (dead flesh-eating) insects and bacteria (Mann et al., 1990:106), and therefore conditions that inhibit or promote insect activity will have a considerable effect on the extent of decomposition of a human body (Dirkmaat and Adovasio, 1997:51; Chamberlain and Pearson, 2001:16). Temperature in particular, influences the amount of bacteria and insect activity and the rate of chemical reactions; the optimal temperature for bacteria contributing to decomposition being 37C (Henderson, 1987:47, Chamberlain and Pearson, 2001:14). Accordingly, the process of decay is increased with heat or humidity, and decreased in the cold (Rodriguez and Bass, 1985; Mant, 1987; and Komar,
1998) and resulting insect and bacteria activity affects the rate of decomposition. Further, shallow graves have greater increases in temperature as the body is decomposing compared to bodies buried more deeply and this enhances insect and bacterial activity (Owsley, 1995:736). However, the body as an environment for bacteria will cool over time, affecting the temperature appropriate for the growth of endogenous bacteria (Chamberlain and Pearson, 2001:14).

In cold conditions chemical reactions are slowed, thereby reducing bacterial activity and the hydrolysis of fats and proteins (Chamberlain and Pearson, 2001). Mant (1987:66) noted that anaerobic putrefactive organism activity was reduced at temperatures below 21°C. In such circumstances, soft tissues are more likely to be preserved. Colder weather also has the effect of reducing scavenging activity in areas where scavenging animals hibernate (Henderson, 1987:47). In other areas it may enhance the likelihood of scavenging because of the lack of other food sources (such as was found in the research for this study). Turner and Wiltshire (1999) found in a study of buried pigs in the United Kingdom that scavenging facilitated decomposition because this allowed access to the carcass by insects. The soil conditions at the site (acidic, stagnogley soil, waterlogged and low in oxygen) and low temperatures had preserved the carcasses for the three months before the scavenging.
Moisture and water content affect the rate of decomposition through the support of aerobic bacteria and the promotion of leaching. Reduced oxygen and concentrations of nutrients or water prevent bacterial growth, and this delays putrefaction because aerobic bacteria cannot survive (Chamberlain and Pearson, 2001:14). However there is variation, for example, where a body is completely immersed in water, it may be preserved or completely skeletonised. Waterlogged burials enhance the preservation of proteins in cartilage, skin, hair and nails (Chamberlain and Pearson, 2001).

In dry conditions soft tissues are more likely to be preserved because tissues dehydrate rapidly, reducing bacterial activity. Hydrolysis is reduced or eliminated. In hot conditions, water in the body evaporates quickly, drying out the skin and there is no time for bacteria and insects to feed on the flesh (Henderson, 1987). When a body has become dehydrated prior to burial, then decomposition will also be impeded (Chamberlain and Pearson, 2001:14). In addition, salts in dry soils may reduce microbial activity in buried bodies (Chamberlain and Pearson, 2001). Extreme conditions, however, may lead to mummification and inhibit the rate of decay because the action of microbes and insects is inhibited (Henderson, 1987:47; Thomas 1995:35).
Endogenous enzymes and micro-organisms convert neutral fats to adipocere (Janaway, 1996). The formation of adipocere (composed of hydroxy fatty acids) is dependent upon moisture, as fat becomes concentrated with moisture, although warm, dry conditions facilitate the formation of adipocere (Janaway, 1996:70). Mant (1987) noted the rapid formation of adipocere on those bodies that were fully clothed within damp soil, which serves to preserve bones (McGregor et al., 1996).

External coverings to the body will impact upon decomposition within a grave. The body will take longer to decay if wrapped in plastic compared to exposed body parts (Mann et al., 1990:106) as this inhibits access by insects and exogenous bacteria. Mant (1987:68) found that bodies buried without a coffin and with clothes (even very few clothes) decomposed more slowly than those in a coffin, even where there was a significant degree of airspace. He also observed an absence of putrefactive liquefaction of the soft tissues in bodies buried on soil without coffins unless they were buried in some decomposition accelerator (vide infra). However, environmental conditions will lead to variation in the extent of the preservation of bodies buried in coffins (Healing et al., 1995:R63). It is likely these conditions as well as soil type contribute to variation found in different studies.
The soil and decomposition

It is possible that through bodily decay the composition of the soil is changed (Bevan, 1991:1310). The soil receives the products of decomposition (liquefied proteins and fats) because they are highly soluble in water and percolate through the soil (Chamberlain and Pearson, 2001:13). Decomposition will affect the colour and content of the surface soil as bodily fluids and chemicals seep into the soil, providing the body is not either in a container or in plastic, such as a garbage bag. Groundwater may wash down liquefied body products that become fixed onto mineral complexes, able to be detected as chemical residues “after thousands of years” posit Garland and Janaway (1989:27).

Subsurface conditions influence the chemical transformations of the buried body. For example, when there is a sequence of wet and dry conditions (either seasonally or sporadically), organic materials tend to oxidize or decompose, whereas organic compounds may be vertically mobilized, rearranged, or even displaced. Consequently, pH, calcium carbonate, organic matter and phosphate values “will eventually be changed, distorted, or otherwise rendered meaningless” (Butzer, 1982:116). Organic matter, potassium and nitrogen are incrementally destroyed or flushed out of the horizon. Phosphates however, may
change from soluble to fixed forms or may descend to lower soil horizons (Butzer, 1982:115).

Phosphorus is a component of nervous tissue, bones and cell protoplasm. It is insoluble in water, but soluble in carbon disulphide (Pfeiffer et al., 1998:368). Increased levels of soil phosphorous have been found in the soils immediately surrounding a buried body, up to 10cm below the body in Yorkshire (Chamberlain, 1994:48). At burial grounds in Kellington and Bolsover, Yorkshire, soil phosphorous levels were measured at controlled intervals above and below the legs of buried skeletons. The amount of phosphorous was elevated at up to 10cm below the burial, but rapidly returned to background levels at greater depths (Chamberlain, 1994:48).

It has been stated that decomposition will result in an increase in the alkalinity in the soil close to the body (Imaizumi, 1974) and that soil pH indicates the presence of decompositional by-products (Vass et al., 1992:1239). In contrast, Owsley (1995:736), Garland and Janaway (1989:25) and Pate, Hutton and Norrish, (1989:313) state there will be reduced soil pH. However, Garland and Janaway (1989:25) add that with the initial increase in acidity of the soil, there is an increase in buffering capacity, and more ionic charge groups of all kinds are produced, that has the affect of cancelling any real change in pH.
Vass *et al.* (1992) conducted a study on time since death using soil solution. They found distinct patterns in the soil solution for volatile fatty acids during decomposition and for specific anions and cations once skeletonisation had occurred. Electrolytes leach out from the soft tissues first, saturating the soil. After being in soil solution the electrolytes will become largely adsorbed to the solid matrix of soil particles or incorporated into microbial biomass over time (Vass *et al.* 1992:1247). Of the 16 ions investigated in this study, seven proved useful due to their stability in the environment: sodium, chloride, ammonium, potassium, calcium, magnesium and sulphate (1992:1244). Vass *et al.* (1992: 1248) found in preliminary studies that sulphate remained present in large amounts after four years. Further, calcium continued to demonstrate a cyclic release from skeletal material that was found in substantial quantities. During decomposition, propionic, butyric and valeric acids (not the only ones formed) are formed and deposited in soil solution in specific ratios (Vass *et al.* 1992:1245). Pfeiffer *et al.* (1998:368) identified the saturated fatty acids found in highest proportion as palmic acid (16:0) and stearic acid (18:0).

**Skeletal Remains**

When decomposition is complete, all that remains of the body are the skeletal remains in the burial environment. Even the most durable
components of the body, bones and teeth (Bass, 1987:236), continue to be subject to environmental processes within the burial context (Boddington et al., 1987). Some of these processes can result in the destruction of the skeletal remains. As has been stated previously, the burial environment itself involves complex interactions between many variables (Henderson, 1987:43). These variables include soil type (in particular, levels of acidity and alkalinity), moisture levels and humidity. Changes to bone after death are mainly caused by chemical erosion. Factors impacting on the extent and type of erosion are the levels of acidity in the soil, the state of the body at burial (including bone density and age), moisture levels within the burial environment, and the way in which the body is buried (Krogman and Iscan, 1986; Ubelaker and Scammell, 1992:111). However, relatively little is known about processes that affect interred bone and the impact these have on the histological structure and preservation of skeletal remains (Garland, 1987; Cox and Bell, 1999).

Bone may be dense (compact) or cancellous (trabecular or spongy) in texture. Compact bone is primarily found at the cortices of mature bone and cancellous bone lies in the interior of bones. Bone is made up of cells embedded in a calcified matrix. The matrix comprises organic materials that are principally collagen fibres and inorganic salts containing calcium and phosphate (Gray et al., 1995). The organic phase of bone consists of collagen (Waldron, 1987:149) and comprises the elements carbon,
nitrogen, hydrogen, oxygen (Pate and Hutton, 1988: 730; Chamberlain, 1994:22). The inorganic phase constitutes 70% of the weight, the organic phase 24% of the weight, and the matrix water component of bone comprises 6% of the weight (Waldron, 1987: 149). Approximately 5% is made up of glycoproteins (non-collagenous protein and carbohydrate) (Gray et al., 1995: 461). The inorganic phase is composed predominantly of crystals known as hydroxyapatite. The principal chemical elements of the inorganic or mineral phase are calcium, phosphorous and oxygen (Pate and Hutton, 1988: 730).

The fundamental principals of post-mortem processes and their effect on bone are difficult to define because of the many factors involved (Sandford, 1993). There may be an exchange of elements between bone and the soil within the burial environment. Diagenesis has been the term given to the post-burial chemical alteration of bone, including the loss of and increases to biogenic concentrations and examines the adsorption by skeletal remains of elements within the soil and is affected by many factors (Pate and Hutton, 1988; Pate et al., 1989; Edward and Benfer, 1993; Radosevich, 1993; Sandford, 1993).

The exchange of elements between bone and soil will be dependent on the composition of the soil (the pH level), the duration of burial and the level of acidity in the groundwater (Burton et al., 2003). Trace elements
are more mobile in acidic environments (Waldron, 1987:152). Bone is less well-preserved in acid conditions because acids in the soil may lead to the dissolution of the inorganic matrix of bone (Henderson, 1987). Acid conditions may also lead to an alteration in the elemental composition of the bones (Waldron, 1987). Diagenesis can be burial and site specific because of the considerable variation in soil chemistry (Sandford, 1993; Pate, 1997). Radosevich (1993:316) goes further, stating the bones can be differentially geochemically altered at different levels within a burial and within a bone.

After the decomposition of the soft tissues of the body, the skeletal remains begin to exfoliate (McGregor et al., 1996:67). Bone decomposition occurs when organic and inorganic components of bone become separated from each other, and are destroyed. Physical and chemical factors within the burial environment remove the separated components of bone. Garland (1987:121) terms this process “weathering”.

In a burial situation, protein in the organic phase of bone converts through hydrolysis to peptides, which then reduce to their constituent amino acids. Simultaneously in the inorganic phase the crystalline matrix is rearranged. Through this action, the bone is weakened because the protein-mineral bond is weakened; ions are substituted, infiltrated and absorbed, and proteins and minerals are removed. The type of soil and
level of moisture (for example, from groundwater) will affect the rate of hydrolysis prompting these changes to bone (Garland, 1987:121; Henderson, 1987:44). Collagen and its protein fibres react with water in the soil over time, promoted by warmer temperatures (Chamberlain and Pearson, 2001:16). Moisture affects bone through the action of leaching, once the soft protective body tissues have been removed (Goffer, 1980:46; Schwartz, 1993:25). Cations and anions (notably calcium and phosphate ions) are deposited into the soil through bone erosion (McGregor et al., 1996:67). The leaching of minerals weakens bone promoting its destruction through surrounding acidic soils and water (Schwartz, 1993:25). This process can “alter the composition of soils on which bones reside” (Vass et al., 1992:1237).

Differences in soil type will affect the preservation of bone (Brothwell, 1965:9; Krogman and Iscan, 1986). Burial in a humid environment leaves the bones more susceptible to the physical and chemical actions of the environment compared to those buried in a dry environment (Garland, 1987:121). Bones will decay in soils where there is low pH and repeated cycles of hydration and dehydration (Spriggs, 1989:39). Bone is better preserved in soils with a neutral or slightly alkaline pH, and is worse in acid conditions (Keeley et al., 1977; Chamberlain, 1994). Acidic conditions promote the dissolution of the inorganic matrix of bone and it is not necessary that strong acidic conditions be present for this to occur.
(Brothwell, 1965:46; Janaway, 1996: 68). Pickering and Bachman (1997: 47) cite a grave in Japan (Island of Yap) dating from the end of World War II. Although the different colour of soil revealed the place of interment, the skeleton had all but disintegrated after 35 years because of the highly acidic soil.

Conversely, dry, alkaline, calcium carbonate based soils will act to preserve bones (Chamberlain, 1994:53). Soils with a high pH (or calcareous) may preserve bones, such as was the case in the sands at Mauer in Germany, where the fossil jaw of the Heidelberg Man was discovered (Brothwell, 1965:10). Cox and Bell (1999) state that where the environment is more extreme, such as very alkaline or very acidic, bone will be less likely to survive. As most often environments are not so extreme one way or another this leads to difficulties in predicting bone preservation (Cox and Bell, 1999). The difficulty of predicting bone preservation is shown by an example of variation to what would be expected when during an exhumation the bones of a woman buried for 165 years were discovered in the graveshaft (3.5ft depth). In well-drained sandy loam soil, the pH reading was 4.9- 5.1 suggesting moderately acidic conditions which is generally not considered ideal for the preservation of organic remains (Wu and Bellantoni, 2003). It points to the likely interaction of other factors in the burial environment.
Summary

A body interred in soil is within a complex environment of which it will in turn, itself become a part through a process of transformation. Soft tissues undergo the process of decay involving autolysis (involving the progressive breakdown of proteins, carbohydrates and fats) and putrefaction. The breakdown of fats will result in the production of several acids (such as palmitic, oleic and stearic acids). Adipocere or aldehydes and ketones may be present depending on the oxygen levels within the soil context. Proteins will become broken down into polypeptides and amino acids and gases will be released. The products of soft tissue degradation become fixed into mineral complexes. Water soluble products such as carbonates will be transported though the soil. Once the soft tissues covering the skeleton are decayed, bone is exposed to processes of degradation; acidic soils will act to dissolve the inorganic matrix of the hydroxyapatite and this produces a material that is susceptible to leaching. Alkaline soils on the other hand, may be expected to better preserve the skeletal remains.

The conditions of the environment will impact on rate and extent of decomposition in any given post-burial time period. The most significant of these are moisture, temperature, depth of burial, soil type, insect and bacteria activity. In some burial situations the soft tissues may be
partially or more completely preserved, in others all that will remain will be the skeleton. In other burial situations the skeleton may also degrade.

For the purposes of this study the evidence suggests that a shallow grave will lead to more rapid decomposition of the body. However, it will be the skeleton that is likely to be most durable and will form the most solid components of the body that may remain to be detected within the soil, depending on burial conditions and the length of time before grave detection.

Through the process of decomposition either partially or completely, the immediate surrounds of the burial context will be different from before the interment of the body. The extent of this difference is not fully known and neither is what may be detected as a sign of a buried body. Factors that may distinguish the soil within the grave (upcast) are differences in electrical and magnetic stratification compared to the surrounding soil (Bevan, 1991; Owsley, 1995), differences in temperature, and pH (Rodriguez and Bass, 1985). Higher levels of ionised water in disturbed soil may produce slightly increased current flow (Owsley, 1995:736). The deposition of elements within the soil is an area that needs further research in terms of its nature and duration in order to use this information for clandestine grave detection. Such differences may be
directly related to the creation of a grave and/or the presence of a body and its resultant decomposition.
5 METHODS USED BY AUSTRALIAN POLICE SERVICES TO LOCATE BURIED BODIES

Police in Australia, as in many other countries, are responsible for conducting searches for missing persons, some of whom may be either presumed or known to be dead. As such, police are the primary source of information about the techniques used in searching for human remains. For this reason, a survey of all Australian police jurisdictions was conducted as part of this research to identify the number of cases involving dead bodies not immediately located upon commencement of investigation, and the most commonly used search techniques. Two surveys were conducted for two separate time spans; 1995-2000 and 2000-2002. Five of the seven relevant states and territories responded to the first survey and two states responded to the second survey. The responses show there were the three methods whereby bodies were most often found in these searches; through ground search, from information brought to police and location by passers-by (or accidental discoveries). There appears to have been little successful application of scientific instruments to the locations of clandestine graves in criminal investigations during the periods surveyed, although that does not mean various other methods were not used in the course of the investigations besides those reported as being successful. The results of these surveys, in combination with the lack of Australian literature, suggests there is
scope for further research in Australia to examine potential ways of improving the recovery rate of unlocated human skeletal remains.

Method

A questionnaire was developed to obtain information about murder cases where the body was not able to be immediately located, and for whom searches had been conducted (Appendix 1). This method was used because it was the only means of obtaining information to describe current practice within Australia of locating buried human remains. There are no central sources of information (such as the Australian Institute of Criminology’s National Homicide’s Monitoring Program) that records how bodies are found in forensic cases and there is no comprehensive set of published literature on Australian forensic cases involving searches for buried human remains.

The questionnaire was designed to provide the following specific items of information:

- The number of body searches during the defined time periods conducted by police;
- Descriptions of the burial circumstances of those bodies that were found through searches (whether shallow or deep graves were dug
and the burial site in relation to developed areas, such as roads or suburbs, for example);  
- The range of search techniques used by police to locate graves and those that proved successful; and  
- Documentation of the extent to which technology and type of technology had been used for this purpose.

The first survey (for 1995-2000) was posted to the forensics, physical evidence or crime investigation sections (terminology varied in each state), within all Australian police jurisdictions. A covering letter explained the purpose of the research and a letter of endorsement from the South Australian Police was enclosed (Appendix 1). There are 6 states and 2 territories in Australia. One of the territories (Australian Capital Territory) is the base of the Federal Police and it is not usual for this section to be engaged in body searches. This territory was excluded from the survey on their advice.

The second follow-up survey covered the period 2000 to 2002. It used the same format and questions and its purpose was to update the survey data and ascertain if search practices had changed during the period of my research. The same postal procedure was followed as for the first survey. Those states that did not respond were sent the survey again to allow for administrative oversights. Follow up telephone calls were made.
to ascertain the reasons for not being able to complete the survey. The response data was then collated onto an Excel spreadsheet and tabulated.

**Results**

The response rate for the first survey was 71% and 29% for the second survey. Five jurisdictions responded to the first survey. Two of these same jurisdictions only responded to the second survey out of the total seven police jurisdictions. Two jurisdictions did not provide any information to both surveys.

The reasons provided by police services for not responding were related to the difficulties associated with retrieving this type of information. As the items on the survey could not be extracted from police databases (as they are not systematically recorded), completing the questionnaire necessitated manual file searches. Relevant files could not be isolated for this purpose. Further, it was stated, staff could not in all jurisdictions be assigned to this task.

It is likely the data that were provided in both surveys are under-reported because not all case files were centralised but were maintained in various branch offices. For example, Queensland is divided into
regional areas and the Queensland Police did not consider it feasible for each region to go through their records.


The questionnaire advised each police jurisdiction that the results were not being used to evaluate or compare individual jurisdictions and for this reason jurisdictions have been numbered (for example State 1, State 2) rather than naming the respondent States or Territory.

The responses to each of the questions in the survey are documented below.

1. The number of murder victims not found initially because their place of burial was not known.

<table>
<thead>
<tr>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>23</td>
</tr>
</tbody>
</table>

The five responding police jurisdictions reported a total of 23 murder victims for whom searches were required because the place of burial was not immediately located for the period 1995- 2000.

One State provided additional information that they could add a further 10 bodies to their total number of murder victims not found, but these were classified technically as missing persons until a body was found. As
other States presumably face the same issue, it is likely that the number of unfound bodies may in fact be higher across all jurisdictions.

2. **Length of time taken to recover murder victims where place of burial initially unknown.**

<table>
<thead>
<tr>
<th>Time</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 3 months</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Within 6 months</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 12 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 2 years</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Within 3 years</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Within 5 years</td>
<td></td>
<td></td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

This response has a total of 21 bodies of the 23 bodies found (as per question 1), as State 1 did not record the time it took to find the 2 bodies that were the subject of searches. The greater proportion of these 21 murder victims (10, or 48%) were found within 6 months. Nine (or 43%) were located within 3 months.

Within 2 years after searching began 2 bodies were located; within 3 years, a further 2 bodies were found and within 5 years, 5 bodies were located.

3. **The number of unrecovered bodies pre-dating 1995.**

<table>
<thead>
<tr>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>19*</td>
<td></td>
<td>1</td>
<td>5</td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

*Not classified as homicides*
Question 3 presents the number of bodies that had not yet been recovered that were subjects of investigations predating 1995. These cases comprise 25 bodies that in 2000 had not yet been located, that had been victims of murder before 1995. These data suggest a sizable total number of unlocated bodies that do not include unlocated bodies since that time.


<table>
<thead>
<tr>
<th>Method</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passers-by (accidentally)</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Police ground search</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal information</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Ground penetrating radar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadaver dogs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerial surveillance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Looking Infrared (FLIR)</td>
<td>1*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1*</td>
</tr>
</tbody>
</table>

*Through unplanned excavation works*

The numbers in Question 4 do not equate with the total number of bodies requiring searches cited in response to Question 1 (total 23 bodies). State 1 has included other bodies located during 1995-2000 and State 5 has only accounted for 6 of the 11 reported in Question 1. States 3 and 4 appear to have used a combination of techniques. Police
misinterpreted this question by including all bodies found during this period rather than those that required searches for clandestine graves.

The principal methods of location evidenced in this response are shown to be other people finding the bodies, further information obtained that assisted with location, and police ground search. From the responses to Question 4, it is evident that geophysical remote sensing equipment and other technological means (such as aerial surveillance and forward looking infrared surveys), and cadaver dogs have not been used to successfully locate clandestine graves. There is not enough information to know whether such methods were used at all, albeit unsuccessfully, in these searches.

5. Description of body location for those burials recovered in a remote area (outer metropolitan).

<table>
<thead>
<tr>
<th>Description</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to the road</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Carefully disguised</td>
<td>1 (mine shaft)</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Under trees/logs/bushes</td>
<td>10</td>
<td>4</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Shallow burial</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

The numbers of bodies in Questions 5 and 6 combined outnumber the total number of bodies for whom searches were conducted during this period (refer Question 1). Two explanations are possible; some States have reported bodies located during this period rather than those for
whom searches were conducted or have under-reported the number of bodies requiring searches in the first question.

A total of 10 bodies were found in the metropolitan area (Question 6 below), 4 of which were either in a shallow grave or under ground cover, such as bushes. A further 4 bodies were found close to a road, and may also have been in shallow graves.

For those bodies that were located in the outer metropolitan or more remote areas in Australia, 16 of the 24 reported in this question were found under trees or other foliage, and 5 bodies were in shallow graves. These figures do not include those that have not yet been located, and may still remain in shallow graves.

6. Description of body location for those burials recovered in a suburban or metropolitan area.

<table>
<thead>
<tr>
<th>Description</th>
<th>State 1</th>
<th>State 2</th>
<th>State 3</th>
<th>State 4</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to the road</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Carefully disguised</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under trees/logs/bushes</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Shallow burial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Results of Survey 2 (2000-2002)

There were only two responding jurisdictions to the follow-up survey and were States 3 and 5 from the respondents above. Jurisdictions that did not respond gave the reason that it was too labor intensive to retrieve the information by scanning files at that time.

1. The number of murder victims not found initially because their place of burial was not known.

<table>
<thead>
<tr>
<th>Time</th>
<th>State 3</th>
<th>State 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 3 months</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Within 6 months</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Within 12 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 2 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 3 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 5 years</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The figures in the above response relate only to those bodies that were recovered during 2000-2002 and exclude bodies that at that time were not located.

2. Length of time taken to recover murder victims where place of burial initially unknown.

Nine of the eleven located bodies not immediately found were recovered within 6 months of searching (82%), and the two that are reported to have been located within 5 years indicates that these searches were initiated before 2000.
3. The number of unrecovered bodies pre-dating 2000.

<table>
<thead>
<tr>
<th></th>
<th>State 3</th>
<th>State 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

The above responses show that there were 4 bodies that had not been found at the time of responding whose cases were initiated before 2000.

4. Method of recovery and detection 2000-2002

<table>
<thead>
<tr>
<th>Method</th>
<th>State 3</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passers-by (accidentally)</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Police ground search</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Verbal information</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ground penetrating radar</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cadaver dogs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerial surveillance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Looking Infrared (FLIR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

State 3 reports that ground penetrating radar (GPR) was successfully used to locate 2 bodies during 2000-2002. Police ground search resulted in 3 body locations, and 5 were accidentally found (passers-by). The majority of the 11 bodies were therefore accidentally found.

5. Description of body location for those burials recovered in a remote area (outer metropolitan).

<table>
<thead>
<tr>
<th>Description</th>
<th>State 3</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to the road</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carefully disguised</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Under trees/logs/bushes</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Shallow burial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Deep burial</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
As for the first survey, the figures in the responses above and below do not total the 11 bodies requiring searches documented in Question 1 of this second survey. In the outer metropolitan area 13 bodies were located; of which, 6 were found under bushes, logs or trees, one was in a shallow burial and two were in a deep burial. Of the 4 found in the metropolitan area (Question 6 below), 2 were close to a road and one was carefully disguised.

<table>
<thead>
<tr>
<th>Description</th>
<th>State 3</th>
<th>State 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close to the road</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Carefully disguised</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Under trees/logs/bushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shallow burial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not described</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Discussion**

Australia is a country that still has vast tracts of land, private and publicly owned, able to be reached in some areas only by dirt roads. In this respect, it is a country that provides considerable opportunity for the clandestine burial of bodies. Some investigations involve searching large potential body deposit areas because little information is available to police with which to narrow the search zone. In the absence of a substantial collection of literature on searches for clandestine graves in Australia, this survey of Australian police jurisdictions provides
important information about how clandestine graves are most often located. The results do not include scientific evidence regarding trials of methods that may have been used but did not lead to body recoveries.

Data obtained through the survey are considered indicative rather than definitive, in terms of the number of searches conducted, bodies that have not been located through forensic investigations and the methods used to locate buried human remains. This is because of the incomplete response rate for the two surveys and the inconsistencies found in the responses. Despite these two qualifications, the data have value in relation to the aims of the survey and the results are not incorrect, but rather incomplete. As the first survey had a response rate of 71%, with five out of a total of seven possible jurisdictions providing information, the results of this survey may be taken as representative of the Australian situation regarding successful searches for clandestine graves for the period 1995-2000. The results of the second survey, with only two States responding, are of interest and are included for the sake of completeness of results, but are not used to draw any major conclusions in this discussion. As an aside, experienced police officers, during personal communications considered that there were many unfound buried bodies “out there”.

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The results of the first survey contain 23 cases in which five States conducted searches for bodies that were not initially found for the period 1995-2000. Considering this does not cover all possible cases within the responding States (according to the responding States themselves) and not all Australian jurisdictions, this number represents a substantial number of unfound victims. It is noted that these were the cases that resulted in the bodies being successfully located and does not include those that may remain unlocated. However, there are reasons to suggest that the reported figures are lower than might be the actual case:

1) Police necessarily record persons as missing in the first instance, in the absence of a body, unless there is significant evidence to prove they are dead;

2) To complete the survey, police officers had to manually collate the information by going back through individual files. Files may have been overlooked in the absence of a database from which queries of this nature could be entered and most often new or less experienced officers were asked to complete the survey;

3) The survey was not forwarded by individual jurisdictions to all branches to obtain complete jurisdictional data due to the logistics of providing a response to the survey. This related to the organisational structure of some police jurisdictions;
4) Although the survey did not require the presentation of any confidential data, it is speculated there may have been a reluctance to include all relevant cases as it may have been interpreted as reflecting on police capabilities to find murder victims or providing information that may have been viewed as confidential. The responses may have been considered sensitive to this extent;

5) Unsuccessful searches were clearly not included in the responses and this is a fault in the survey in not specifically addressing this item of information, although two States commented that there were additional persons presumed dead that had not been found and cases of suspicious circumstances documented on file.

All police services did not confine their responses to those cases not initially located and requiring searches for the defined survey periods. This may be a fault in the survey design, although it has resulted in a broader number of cases being included in some questions and not others. However, this does provide more information about where and how bodies have been located in Australia. Given the logistical problems in extracting the data, police services were extremely helpful in responding to this questionnaire and were genuinely interested in the research. One of the problems for police services in responding is that police are transferred across different units, and as this task was generally given to a lower rather than a higher ranking officer, it was
more likely to be someone who was not permanently attached to the unit responsible for conducting searches. This became apparent during the second survey when responses were followed up, because the respondents for the first survey had in almost all cases been transferred to a different unit, and newer officers did not understand the terminology in the questionnaire (for example, the acronym for Forward Looking Infrared as a search technique).

Of these 23 bodies identified in the first survey, 10 were found within 6 months of searches commencing, 2 bodies were found within 2 years, 4 bodies within 3 years, and 5 bodies within 5 years. State 1 did not indicate the length of time it took to recover the two bodies they documented as not being initially found. This could suggest the bodies were at that time unrecovered. Although subsequent responses provide information on body locations that outnumber these two cases, it is not known whether these two cases are included in this information.

As almost half of the 23 bodies were located within 6 months, and the remaining 13 took significantly longer (and State 1’s two are not included at all in this response), it would be of interest to know the reasons for the extra time taken to locate them. Possible reasons could include lack of resources within police jurisdictions, lack of information as to a target
search area, and uncertainty as to appropriate search techniques under difficult circumstances.

The highest number of cases reported for one State was 11. In this State (State 5), the method of location is only given for 6 of these bodies; one was accidentally found, and five were located by further information being obtained. No bodies are reported found by police search or any other means.

When looking at the response to the method of location (Question 4) compared to the total number of cases requiring searches (Question 1), it is apparent the numbers are greater. Either a combination of methods were used in the body locations, or alternatively body location methods have been included for additional cases as was stated by one respondent (State 1). State 1 reported 2 bodies not initially found for this period but reports 8 cases of a body being located by passers-by (accidentally found), 8 through police ground search and 5 instances of further information. In a note attached to its response this State indicated these cases were all documented body locations for this period.

The methods of body location that resulted in most recoveries of bodies during 1995 and 2000 were through passers-by (accidental discovery) or police ground searches, with some substantial contribution from
informants (verbal information). There are 15 counts for passers-by discovering a body, 11 counts of police ground search recovering a body, 13 counts of further verbal information assisting in the location of a body, and one recovered inadvertently through excavation works.

Personal communications with each of the police services verified that ground search is still the most common search technique used because other methods have been little researched or verified as being reliable in Australia. Geophysical instruments were not used successfully to locate a body in the first survey but the ground penetrating radar (GPR) was reported as being successfully employed in the second survey to locate two bodies (for one case). It is inferred from these results that other possible methods such as chemical analyses of soils, the soil probe, electrical resistivity, electrical conductivity or aerial surveillance have not been successfully used in Australia by either consultants employed by police or police themselves. The results need to be weighed against the fact that the questionnaire did not ask for data on all methods attempted during searches, only those that had been found successful. In retrospect, this information would have been useful and should have been requested.

Most bodies for which searches took place during this period were found in remote areas or the outer metropolitan vicinity during 1995 and 2000.
There were 24 recoveries of bodies in the outer metropolitan area compared to 10 in the metropolitan area. Combined with the outer metropolitan area, this presents a total of 34 bodies located between 1995-2000. As noted, this is inconsistent with the total number of bodies requiring searches given in Question 1. Shallow burials account for 2 of those 24 found in the outer metropolitan area; 19 recoveries were found under trees, logs or bushes, 1 close to a road, 1 carefully disguised (method not stated) and 1 in a mineshaft. Of the 10 bodies found in the metropolitan area, 4 were found close to the road, 2 were carefully disguised (details not stated), 3 were located beneath trees, logs or bushes and one was in a shallow burial.

The second survey for 2000-2002 shows a similar pattern to the results, although there were only two responding jurisdictions, and as such are only summarily examined. Eleven murder victims were not found initially because their location was not known, yet there were 11 bodies recovered from the outer metropolitan area and 4 from the metropolitan areas in the same time period. Six of these bodies were found under trees, logs or bushes and 3 in either a shallow or deep burial, and 4 were located close to a road. One state reported a further 6 suspicious disappearances that involved searching for bodies.
Given that these reported figures do not capture those bodies that remain unfound and their location types are unknown, it is possible to speculate that there are a significant number of burials containing human remains. The many cases involving passers by and additional information assisting police in their search suggests that murder victims remain unlocated because of difficulties associated with finding unknown burials. In this survey it is the data that is not recorded that is of greater interest and lends weight to this serious problem.

An interview with a police officer in one State concerned a description of a successful location of a murder victim 17 years after her death. The woman had been buried in scrubland and when located was in a curled foetal position. The police searchers found that searching for soil depressions did not help as the landscape had seen two bushfires and a flood in the area since the year of death. The body was recovered by accident when an officer struck a spade in to the soil and struck something. This was when the search party was being brought to a close.

Conclusions

These results show that current practice within Australian police services for searching for clandestine graves is limited to ground searches, accidental recoveries of bodies and verbal information to assist in
recoveries. Geophysical instruments have been successfully used by one Australian police service, but others have not reported their successful use and this may be because there is little evidence for their utility in Australia for forensic cases. Geophysical instruments are expensive to hire, and there is limited experience amongst commercial companies in Australia of being involved in forensic cases (personal communications). It may be speculated that in the absence of successful search techniques, some bodies remain undiscovered.

These statistics, although relatively small in number because of recording practices, are significant. Not all States provided responses and for those that did, not all branch or regional offices were engaged in the survey. Records of “unfound” bodies are not kept in a manner that is easily accessible by police for specific aspects of cases such as the recovery of buried human remains in clandestine graves. The reasons for considering the likelihood of under-reporting of relevant numbers were stated and certainly, these statistics do not include all cases of unlocated bodies, as officially persons remain classified as missing rather than dead. Consequently, the number of unlocated bodies may in reality be much larger, as suggested by the additional suspicious cases cited by one State and those presumed dead quoted by another State. This does not detract from the value of the survey results obtained, as they may be considered
indicative of the need for further research and assistance able to be provided to police in conducting searches for buried human remains.

Police services are not established as research organizations but have responsibility for what is a difficult task in the varied Australian environment. However, as the agency responsible for conducting searches for clandestine graves, it is the primary beneficiary of improved techniques for body locations, excluding of course, the victims' families.
6 CULTURAL ANTHROPOLOGY AND CLANDESTINE GRAVES

“For the most part science is analytic and attempts to isolate and explain the relationships between two or more variables. …The problem is even more complex when we try to deal with human behaviour where motives play an important role…” (Hole and Heizer, 1965: 437).

The subject of this study is the location of a clandestine (or hidden) grave created as a result of murder. This section considers the anthropology of the clandestine grave and selection of a burial site in contemporary Australian society, which has not been addressed to date. The possibility is explored of establishing a cultural logic to the way in which murderers dispose of bodies, and examines the way in which investigations are structured that have implications for body location outcomes. This section is included in this thesis to provide a cultural context for the location of graves and is based on available data sources, and also involved a study of all Australian tabloid reports of bodies found for whom searches had been conducted. To this extent it is not an ethnographic or fieldwork based section, which was beyond the scope of this research.

The context for body searches is contemporary Australian society in which murder is not socially sanctioned. In hiding a body the murderer ostensibly seeks to avoid the consequences of his or her actions, namely murder, deemed a crime against the wider society and addressed through
the justice process. It is difficult to prove murder without a body, and a person remains classified as missing until evidence indicates death. This lends importance to the body as an object of evidence in the judicial system. The importance of the recovery of the body for police and prosecutors is increased as advances in forensic science offer higher probabilities of associating the murderer with the crime if the evidence (the body itself) is available.

Cultural anthropology aims to provide a framework for understanding human behaviour in the context of the society in which it occurs (Hole and Heizer, 1965). Culture and cultural practices are treated as learned within a social context as opposed to being biologically inherited (Gibbon 1939:3; Haviland, 1987:31). Social institutions and norms operate to define appropriate actions and to impose sanctions against non-conformity. In contemporary western societies, murder is subject to formalised sanctions that operate through the imposition of the law. Within the judicial and legal framework, murder (the taking of another’s life) is deemed the most heinous crime and carries the most severe penalties. An anthropological discussion of the clandestine grave and the location of buried human remains must consider two primary aspects; the factors concerned with the burial of a human being in a clandestine grave and how the modern contemporary society addresses its location, that is, the investigation phase.
There is minimal literature addressing the creation of clandestine graves, especially the cultural anthropology of this act. Cultural aspects are addressed peripherally in the literature about detecting buried bodies and are limited to acknowledgements of the influence of human behaviour and cultural restrictions on the depositing of the body (for example, Killam, 1990:8). There is literature on the sociology and psychology of murder, death in its broader sense, but not on the act of creating a clandestine grave. Literature discussing graves, such as the recoveries of burials, tombs or explorations of cemeteries are discussed in terms of what they may represent or reveal symbolically about societies (Aries, 1974; Binford, 1981; Boddington et al., 1987; Metcalf, and Huntington, 1991), or descriptively rather than analytically from an archaeological perspective (Hole and Heizer, 1965: 401) or as an analysis of mortuary practices (Chapman, 1987). Some psychological based literature regarding the behaviour of serial killers describes the disposal of bodies in terms of geographical patterning (Kocsis, 2000). Sociologists have provided extensive literature addressing deviance and deviant behaviour, in which murderers are included.

There is no anthropological framework or exploration of the act of creating a clandestine grave, what it represents, the continued nature of this practice and whether it is used in particular murder situations or by
certain types of persons. Concealment of a body indicates the individual understands that his or her actions are at odds with the contemporary social order. The degree of purposefulness of this activity is not understood, which if explored further, may assist in investigation techniques and the structuring of search activities.

Murders occur and bodies are hidden. Some are buried in clandestine graves; some of which are found accidentally, some found through police investigations and some are not found. It is impossible to quantify the number of bodies buried in clandestine graves each year, partly because the numbers of bodies found in clandestine graves are not tallied systematically and of course it is impossible to quantify those not found. However, some extrapolations may be made. In 2003 - 2004 there were known 305 victims of homicide recorded in Australia (Australian Institute of Criminology Crime Facts Info, No. 108, 11 October, 2005). There are also approximately 30,000 people that are reported missing in Australia each year of which approximately 99% are found (Henderson et al., 2000). This means around 300 people are not found each year. Pinto and Wilson (1990) suggest that police consider a proportion of these will have been the victims of murder. Police informed me during interviews for this research that there was a belief there were many unfound bodies “in the bush”. For the families of those persons not found, each unlocated individual is important.
The events that surround the creation of a clandestine grave follow a sequence. Firstly, a person (or persons) is murdered. The circumstances of the murder may have involved planning or may be the result of an unpremeditated violent action. It may have involved witnesses or not. As a result of this action there is a body (a deceased community identity) and the perpetrator, now deemed a murderer by any person knowing of his or her actions. Two courses of action now follow; the murderer (or another with a vested interest in the murder) either leaves the body at the scene of the crime or attempts to conceal the body from discovery. The murderer resumes their lifestyle and usual obligations. The victim does not and may be reported missing. Once reported missing to police they are classed as a missing person and an official investigation will begin. The investigation will continue on the assumption they are still alive until evidence suggests otherwise. Initially then, there will not be a search for a body.

A clandestine grave is created when the murderer places the body in a grave that is not in a legal cemetery and the victim's identity is not placed at the gravesite. What does a person who has become a murderer know about disposing of a body and what are the options available in contemporary Australia? Two main factors form the parameters of those
options: opportunity (including environment), and cultural practices and patterning that relate to the disposal of a body.

The attitudes towards the dead or death form the basis for how people deal with corpses (Chamberlain and Pearson, 2001:12), and these necessarily are learned. Mainstream culture in contemporary western societies such as Australia promotes burial (or cremation and burial of the ashes) for the disposal of bodies, as demonstrated in the industries surrounding this practice, including cemeteries and their management. There are known existing conventions for the disposal of the dead (Chapman, 1987). Advertisements feature the promotion of pre-paid burials. It could be argued then that clandestine graves are used as a means for disposing of murder victims because burial is a culturally familiar method of body disposal. There is a known way in which bodies are disposed of in this culture and a clandestine grave may be seen as an adaptation of this practice.

Hole and Heizer (1965) apply the principle of uniformitarianism to human behaviour, positing that when confronted with similar situations, people behave in fundamentally similar ways. It is difficult to consider murder as a situation or experience that individuals respond to from experience. With the exception of serial killers, there is little to suggest that murderers and those disposing of a body have had any prior direct
experience to pattern their subsequent behaviour. There is an argument to be made that popular media offers vicarious experience to murderers wanting to dispose of a body and that popular media substitutes for direct experience. An article based on an interview with a person who murdered his mother and her husband in Australia states that the murderer based his plan of murdering the couple by drugging from “cheap movie” (Crooks, 2005). He later hired a trailer, wrapping the bodies in a quilt and drove the bodies to a national park and buried them in a shallow grave. The article did not discuss why he chose to dispose of them in that way, or the origins of that idea given it was not thought he had not previously committed murder. The creation of clandestine graves is not limited to the inexperienced murderer, however, as repeat murderers have used clandestine graves to conceal bodies. One example is the case known as the Truro murders in which several young women were buried in clandestine graves in South Australia (Mykyta, 1980).

Clandestine graves in Australia can be seen as a practical option for the disposal of a body. The alternative options to burying a body in a clandestine grave in Australia carry inherent risks. These are;

- Burning the remains. This carries a risk due to fire restrictions in Australia;
• Storage carries a risk of discovery (case examples from the tabloid survey discussed later include storage in barrels and cemented in wheelie bins);

• Dismemberment and separate placement (including burial) of body parts separately means a greater risk of discovery because there are more places of disposal. This also requires a place and instruments to do this without leaving further evidence;

• Leaving a body where it is not readily seen, such as beneath logs, under leaves or bushes, or even disposed of in rivers, dams, lakes, at sea, or in dumps and landfill sites, and in remote less travelled areas (source: results of national police survey undertaken as part of this study, case histories presented in the literature, and personal communications with police in Australia, United Kingdom and United States).

Although it would be possible to move a body from one burial place to another this requires effort and increases the potential for being observed and leaving evidence linking the murderer to the crime. It also means a considerably more amount of thought invested in disposing of the body. There is a time factor in that the body will begin to decay and emit detectable odours, attracting any scavenging animals. A cultural risk in any form of body disposal activity is the need to reduce the likelihood of being informed upon. Accordingly, this decreases the amount of
assistance available to him or her in disposing of the body and therefore a murderer is forced to act in relative isolation. Burial, as opposed to other body disposal options, is proposed as a likely course of action in cultural anthropological terms in Australia because of the following perceptions:

- A clandestine grave is less likely to be discovered accidentally in areas where people do not frequent;
- There are many such areas in the Australian environment;
- Scavengers may dispose of the body in more remote areas;
- Other people are less likely to see one digging a grave and placing a body within it in remote areas;
- The more time that passes before any discovery is made, the less likely it may be felt the evidence would link the murderer to the victim;
- Burial in an area seemingly not directly connected with the victim or murderer will lessen the likelihood of discovery;
- Burial away from the site of the murder will lessen the likelihood of discovery;
- The instruments for burial required are readily available, that is a shovel, pick, crow-bar and a car for transport.

There are few comparable actions to disposing of a body in a clandestine grave. However, one parallel familiar cultural practice in Australian
contemporary society that warrants mention is the burial of dead pets in
backyards. Pets, including large dogs, have been buried in the backyards
of homes and are seldom declared when the house is being sold, and this
has been an accepted practice. A body is an organic substance, like a pet,
that will be subject to decay. It is biodegradable and it may be for this
reason that pets have been buried as a usual cultural practice in
backyards. From articles published in the media discussed later in this
section, backyards have been used for the disposal of bodies in Australia.
One such case involved a person being buried under a newly created
strawberry patch in Adelaide, 2004 (Appendix 2).

There are reasons why burial in a backyard would not be expected to be a
commonplace occurrence. Firstly, suspicion might arise from a freshly
dug hole found in a home when an associate, friend or relative was
missing. Suburban backyards risk scavenging from domestic dogs and
other animals such as rats. In addition, the Australian suburban
environment is changing because houses are no longer built on the
Australian standard “quarter acre block”; suburbs are characterised
increasingly by smaller duplexes and townhouses or houses built in
denser patterns (often with little or no land) and living in greater
proximity to others offers greater opportunity for the observation of
one’s activities, including the digging of holes or new garden features. It
is therefore likely that even burying one’s pet in the backyard may not be
as commonplace as it was once. Indeed, pet cemeteries are now being established to meet this need.

Another comparable practice retold in children’s stories is that of burying treasure. Stolen treasure is buried in an area known only to the thief using a shovel. Often a map is drawn and hidden or the place is memorised using land features. It is not known if murderers draw a map of a clandestine grave. In the case of a buried body a key difference is that it is not an object that is likely to be retrieved or to have lasting value; it is an object that the murderer wishes to remain buried and unfound. Some murderers may view their deed as an accomplishment and there may be a “trophy” value attached to the body and the grave.

The principal reason proposed for placing a body in an unmarked grave is the concealment of the body. The body is an object that requires some physical distance placed between it and the murderer, to disconnect any linkages with the crime, and to avoid discovery of the body itself. There may be other motives such as denial of the crime and preserving a social role in the community that will be impacted upon by the process that would be initiated if the murderer were identified. In the absence of information directly from the murderer, this is speculation. By burying the body in a clandestine grave, the discovery of the death of this person is delayed and the actual “murder” may go undiscovered for a time.
In theory, burial of a body would appear to be a straightforward option and this may be a contributory factor to the use of clandestine graves. Burying a body is a cumbersome and energy taxing task. There are several factors that must be considered including selecting a place of burial, transporting the body, carrying the body to a place of deposit (either from a vehicle, or from the murder site to a hole), the physical demands of digging a hole for burial, and disguising the site. From personal communications with police (too frequent to cite individually), it would appear that where a body is buried, the graves tend to be shallow because it is difficult to dig a deep hole with a shovel and in most instances police consider there is very little preparation beforehand. In one case in which the author was involved, the murderer had pre-planned the disposal of the body and had dug a hole in a remote area of South Australia. However, the murderer could not locate the hole and was forced to dig another at the time of burial, according to the informant. The final grave was reported to have been only 0.3m deep. It is interesting that the burial was shallow because the area was remote with no people about or houses, meaning that there was time to dig a deeper grave. One reason could be that as the area was remote, there was little perceived risk of discovery and a shallow grave would serve the purpose as well as a deeper one. Alternatively, it could be that the effort of digging proved too arduous under the circumstances.
The burial must be done unseen by potential informants. The need for secrecy is imposed through the encouragement of information being provided to police from “the community”. Punitive measures are threatened to those who “aid and abet” crimes, in the form of legal sanctions, which places at risk those who knowingly assist a murder to dispose of a body or withhold critical information from the police. It is surmised that there is also a risk of punitive measures being exacted on informants by a murderer themselves (in the form of threatened violence), who has already demonstrated they are capable of significant violence towards another. To counteract this threat police provide mechanisms for anonymous information being passed to police (such as toll free telephone numbers) or offer protection and security, or engage in reduced penalty bargaining where an informant may also have committed other crimes. For a murderer, this has an isolating effect and may mean that digging a grave is relatively solitary activity, which increases the likelihood of a shallow grave.

It has already been stated that there is no collated source of information on bodies found in clandestine graves. The only such sources are those presented in this study and it is unlikely these provide a complete picture for the reasons discussed previously. A public source of information was used to examine the frequency of human bodies and/or skeletal remains
found in Australia; all Australian newspaper articles featuring human bodies and/or skeletal remains found in Australia during the calendar years 2000 – 2004. This of course only incorporates those bodies found in clandestine graves and cannot include those not found. It is not suggested these reported cases constitute all bodies found in Australia during this time period as there may be cases that are purposefully not made known to the media by police.

The analysis considered the number of bodies located in this timeframe; the location types in which they were found; the methods of location and the time lapse between approximate time of death (or disappearance) and location. The Factiva search engine was used and some 12 600 “hits” or cases of found bodies were recorded (exclusive of repeat articles). Certain case types were then excluded: those bodies found immediately after being murdered (with no attempt made to hide the body and usually left at the site of the murder), remains washed up on beaches or found in rivers, suicide cases and occasions of accidental death. After these exclusions there were 184 reported human remains that were not immediately located after death or disappearance over this four year period across Australia. It is important to note that these figures are those reported in readily available tabloid articles and only cite cases of located bodies. The number of outstanding unlocated bodies can only be guessed.
Of these 184 reported media cases, 170 were found within 12 months from the time of death. One body was found 78 years after death (or being reported missing); two were located after two years; one after three years; two after four years; one after five years and two after seven years. These figures contrast significantly with those obtained from the national survey of police jurisdictions, supporting the suggestion of under-reporting for various reasons.

Table 2 below describes the types of locations in which the human remains were found. The majority (154 or 84%) of reported bodies found were located in outer metropolitan or remote areas. There were 98 bodies located in what was described as bushland, national parks or reserves in the articles. A total of thirteen reported locations of individual human remains explicitly involved burials; one of these was in a deep grave (approximately 1.5 – 2.0m) and four burials were reported in suburban backyards. Eight of these reported burials were shallow graves in remote or scrub areas (one was on a beach). This does not mean more were not buried; it means that the article did not specify the circumstances of the body.
<table>
<thead>
<tr>
<th>Location type</th>
<th>Number of persons found*</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outer metropolitan or remote areas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bushland</td>
<td>69</td>
<td>6 of these were in bushland in the suburbs</td>
</tr>
<tr>
<td>Reserves/state forest</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Shallow graves</td>
<td>8</td>
<td>6 in bushland, 1 in recreation area, 1 on beach</td>
</tr>
<tr>
<td>Deep graves</td>
<td>1</td>
<td>In reserve</td>
</tr>
<tr>
<td>Mangroves/wetlands</td>
<td>3</td>
<td>1 wetlands</td>
</tr>
<tr>
<td>Country road</td>
<td>12</td>
<td>Found by or in close proximity to a road</td>
</tr>
<tr>
<td>River, lagoon</td>
<td>10</td>
<td>Found in a river/lagoon itself</td>
</tr>
<tr>
<td>River bank</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Creek</td>
<td>9</td>
<td>Found in a creek bed (often dry)</td>
</tr>
<tr>
<td>Swamp</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Quarry</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dam</td>
<td>3</td>
<td>Found in remote property dams</td>
</tr>
<tr>
<td>Cliff base</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Underwater cave</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>In car on property</td>
<td>6</td>
<td>Bodies within cars in remote areas</td>
</tr>
<tr>
<td>Drain</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Metropolitan areas</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shallow graves</td>
<td>4</td>
<td>4 in backyards</td>
</tr>
<tr>
<td>Suburban (street, backyard, near river, buildings)</td>
<td>13</td>
<td>4 in parklands</td>
</tr>
<tr>
<td>Golfcourse</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Mangroves</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Garbage tip</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>In wheelie bin</td>
<td>3</td>
<td>1 was cemented into the bin</td>
</tr>
<tr>
<td>Drain</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>184</strong></td>
<td></td>
</tr>
</tbody>
</table>

*All figures cited are separate individuals and are not double counted in other location categories.
In general, the newspaper articles did not provide many details about the circumstances of the locations, and most often it simply read that a body had been “found”. Police as part of their investigative strategies may influence the degree of detail reported by the media. The means of location was analysed based on information contained in the newspaper articles. From table 3 below 56% of the articles did not state the means of location. It is of note that 35% of reported bodies found were accidentally located by passers-by or people in the course of their work (such as farmers, road workers or park rangers). This percentage could be higher if they include a portion of those “not stated”. Police were reported to have located only 8% (2 accidentally and 4 of these cases through an informant). The two bodies found by Aboriginal trackers were whilst searching for another victim (not those bodies found). There was one description of the use of ground penetrating radar to search the cemented base of a pool under which it was suspected a body was buried but this was unsuccessful.
Table 3: Means of finding bodies 2000 – 2004. (As reported in Australian tabloids).

<table>
<thead>
<tr>
<th>Means of location</th>
<th>Number of individuals</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passers-by/bushwalkers</td>
<td>49</td>
<td>In the course of people’s work activity</td>
</tr>
<tr>
<td>Workers</td>
<td>15</td>
<td>4 found through a “tip-off”, 2 found whilst on a different case</td>
</tr>
<tr>
<td>Police</td>
<td>14</td>
<td>4 found through a “tip-off”, 2 found whilst on a different case</td>
</tr>
<tr>
<td>Aboriginal trackers</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Clairvoyant</td>
<td>1</td>
<td>Family of a missing person engaged a clairvoyant</td>
</tr>
<tr>
<td>Not stated</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>184</strong></td>
<td></td>
</tr>
</tbody>
</table>

The principal methods that lead to the discovery of a buried body are accidental discovery (passers-by or bushwalkers, other accidental discoveries by people in the course of their work) and informants providing knowledge to the police. The information derived from this analysis of tabloid reports supports that obtained from the police survey. It does not suggest detection of buried human remains through proactive searches conducted by police.

Environment presents a context in which to enact culturally influenced behaviours (Hardesty, 1941:8). The evidence above suggests the use of environmental opportunities that would fulfil the need for concealing the body; for example, the use of wheelie bins that are now emptied by
robotic trucks (minimising immediate discovery); dams on remote properties, quarries and in abandoned cars on properties. The majority of the bodies (98) found in this analysis however, were located in what was described as bushland, national parks or reserves, away from metropolitan areas. It is possible, however, that these are only the bodies that are found and more effective concealment is in a clandestine grave that is not so obvious to find.

Australia’s context is one in which it is easy to reach scrubland from any city, including national parks and reserves. For a murderer to dispose of a body in the Australian environment, it is a practical step to drive a proximate distance from home to reach bushland. It is not significant in terms of kilometres from the centre of cities or townships, either perceptually or physically. Such distances may be considered great in other countries but here they are not an impediment. It is of interest that there were twelve bodies found relatively close to country roads. It is ironic that although being deposited in scrubland or bush areas with what would be expected to have minimal pedestrian traffic, the majority of bodies are discovered by accident by passers by or bush walkers as has been demonstrated from both the results of the police survey and reported cases in the media.
A murderer is directly responsible for the disposal and handling of the body and for reasons of secrecy, has minimal input from others. In contrast, most people in a modern society have no contact with dead people (bodies) unless they are in a medical, emergency service, coronial or funereal related profession. The management of the disposal of a dead person is the responsibility of other professionals and the family of the dead person are spectators with some input to style related decisions of the burial process. The murderer will either have no support systems for this situation or they will be restricted and rely heavily on a trust relationship. It is likely both previous experience and degree of planning will significantly impact on the final disposal site selected. The extent of this experience, if any, and the impact on site selection or method of body disposal is an area that has not been previously explored. Not all clandestine burials involve prior experience and planning and it may be the lack of prior experience that results in body location.

The grave and act of burial emulates the normative contemporary western cultural practice of burying a person when they have died, but omits the recognition usually accorded the dead. If “a culture system represents a balance between opportunities and the satisfaction of necessities” (Hole and Heizer, 1965: 451) then the disposal of a body and the creation of a clandestine grave meet this description as a choice within the operating frameworks and limiting parameters in the
environment of modern societies. However, it is emulation only to a limited extent; there are key significant differences between a clandestine grave and a ritual burial in contemporary Australian society.

In a formalised burial:

- The death of the person is made public (to friends, family and the wider public, by way of newspaper notices, and a death certificate is drawn up as officially recorded documentation of an event);
- The ceremony of death is important;
- Funeral preparations are made (the body is treated according to cultural norms, and may involve embalming, formally robed or dressed, viewing of the body, cremation), and the relevant rituals of laying the body to rest that is open to friends and family;
- Lasting memorials are created, such as headstones, plaques, or shrines;
- In particular, the dead body is personified and in fact is once more treated as a “baby” to be taken care of with tenderness and reverence.

The feature distinguishing a clandestine burial from a formal burial of a member of the community is the imposition of anonymity on the gravesite and person buried. The death of the individual remains unknown outside the circle of those responsible for the murder; the
victim's post death wishes (or Last Will and Testament) are ignored; the victim is totally disempowered and depersonalised, being transformed into an object to be disposed of and destroyed. The person who has disposed of a body in a clandestine grave has deprived the dead and their family of a culturally appropriate burial, and in some cases, impacted on family beliefs associated with an after-life.

Therefore, although in both circumstances a body may have been buried, the main differentiating factors are firstly, the social sanction and public acknowledgement of death; secondly, the elements of care and respect given to the individual; and thirdly, the preservation of the dead person's identity. Usually, after death, people intervene “to prevent what comes naturally” (Chamberlain and Pearson, 2001:12) which is decay and eventual anonymity. In contrast, in the case of a murder, the object of a clandestine grave is to ensure destruction of the remains, to facilitate decomposition and to avoid the discovery of evidence. The degree of thought that is placed into clandestine graves by the murderer is not a known factor, because it would be useful to examine how often bodies are buried in clothing or items that might impede decomposition such as plastic or carpet.

Aries (1974) in an historical study of western attitudes to death, states it is a modern concept that “the dead person should be installed in a sort of
house unto himself, a house of which he was the perpetual owner or at least the long-term tenant, a house in which he would be at home and from which he could not be evicted” (1974:22). In the Middle Ages, responsibility for the dead was assigned to the Church. The exact location of the grave or burial site was not considered significant, and accordingly monuments or inscriptions were not the norm. In contrast, in modern societies, a gravesite has become a significant memorial to the individual. A clandestine grave deprives an individual in contemporary western society of that memorial. In many ways it could be viewed as a duplication of the “paupers’ grave” or those of the Middle Ages. It has not been explored whether those people buried in a clandestine grave share any common social characteristics, such as socio-economic status, sex, age at death or whether the perpetrators share common characteristics in choosing this method of body disposal.

Strange (2003), in researching working class graves in the United Kingdom, states that graves are significant in terms of providing a focus for grieving, a genealogical link and continued ownership of the corpse. Pauper graves (or unmarked graves) in contrast, removed ownership of the dead from the family, negated the dignity of the dead and “ruptured the language of loss”. She discusses how notions of a “decent” burial were associated with both a desire to “care” for the dead and to provide an identity and respectability for the dead. In time the social order
changed and people became more mobile, so that they were no longer associated with one parish or town. Accordingly, the grave became an important marker and document, identifying people and their fate (Snell, 2003). The clandestine grave removes ownership of the grave and the dead person from their closest ones. Further work could be undertaken in ascertaining whether clandestine graves tend to be created by murderers who have little relationship with the victim or if there is some wider purpose in depriving the victim of an identity.

Collier (2003) notes from research on American culture, that there is greater emphasis placed on “the self in the present for recent generations” and this is reflected in the treatment of the dead and regulated burials. The clandestine burial represents the deprivation of the opportunity for memorialising the final “resting place” of the individual in modern society. Formal or regulated burials are usually placed in a collective area (cemeteries) set aside for this purpose regardless of religious denomination. The clandestine grave is an antithesis to this practice; the burial is in an unknown place until discovered, it is unmarked, the identity of the person within is unknown and it is removed from other burials.

Police are responsible for the management and the conduct of searches for missing persons and unlocated bodies. When a report of a missing
person (or murder) is given to police, a criminal investigation will proceed, directed by police acting on behalf of the social populace. It is not an activity that is the responsibility of individuals. Police are responsible for obtaining relevant information to direct the course of the investigation and are the recipients of information provided by the public relating to crimes. As public servants funded by the government, the investigation is considered to take place in an impartial public arena rather than the private “for profit” sector. Progress on cases that have been publicised in the media and are considered to have “caught the public eye” will be reported back to the community in a controlled way by police investigators. For example, details of a case may be withheld to assist later in a court trial, or to address consistency of witness statements.

A murder investigation remains open in most cases until the body is found and the investigation resolved judicially. Interviews with members of the police suggest that there is a belief that the longer a search continues, there is less likelihood of the body being found without some further information coming to light. Searches are usually resource intensive because they are based on using several personnel to ground search areas that is time-consuming.
Police receive a considerable amount of information about the possible locations of graves from informants, as evidenced in the national police survey undertaken as part of this research, and discussions with police officers. The culture of modern societies fosters the use of informants because positive value is attached to their information; not least of which may be reduced punishments for the informants' own offences. These informants may be observers of “suspicious” actions, people who have either been eyewitnesses to the burial (often assisting) or who have been given a later account by the murderer of the events around the burial. In cultural terms, it could be posed that accomplishments to most people lack value until shared. There may be several reasons for the murderer to share his or her actions; to enhance their reputation as someone who has committed a “socially heinous” crime and flouted the law by disposing of the body; to incur fear amongst peers (and therefore future manipulation of people and consequent social empowerment); and to engage others via shared knowledge as accessories after the fact. In effect, murder serves to place the perpetrator as an outcast of the mainstream society and sharing their knowledge serves to connect them to a group in some way. In doing this, it creates sources of potential information for police. In Australia, advertising an anonymous toll-free telephone line established by police serves to obviate the Australian cultural taboo of “not dobbing in one’s mates”.
An additional way of counteracting this taboo is to appeal to a sense of helping the community “catch” the person who committed such an anti-social crime, with the implication that it could happen to someone else, including a member of one’s own family. When a person is reported missing, the case may be shifted to the public arena by way of publicising the fact in tabloids, printing photographs of the missing person and imploring members of the community to come forward with information. This does not happen in all cases, but is an important means whereby police may obtain knowledge that assist in identifying an area in which to search for a body.

Killam (1990) is one of the few sources in which there is an attempt to theorise about where a body may be deposited, although his framework is premised on psychological theory. He uses the term “dump- site analysis”, stating that cases generally fall into two categories; those bodies dumped hurriedly in an area little known to the murderer, and those bodies taken to areas that are well known to the murderer. This is supported by studies undertaken on cognitive mapping and geographical profiling. However, in practical terms these two categories cover most options available to a murderer. The distinction rests on the degree of planning placed in the disposal of the body and suggests that if the murderer is in a hurry to be rid of the body they are more likely to go to somewhere less familiar. It is not possible to test this hypothesis in
Australia with the evidence at hand. It is equally likely the reverse could be true. This is an example of one way of constructing search methods based on predicting the movements of a murderer, based on psychological frameworks, as discussed by Kocsis (2000).

In recent times there has been a growth in the interest of forensic science as a means of aiding criminal investigations. This is attested to by the proliferation of popular television series that feature crimes being solved through forensics, forensic novels and non-fiction books, and the demand for forensic courses at universities. Forensic science promotes a belief in the capacity of small items at a crime scene to be linked to an individual committing a crime. Examples are hair, fingernails, saliva, pollen and soil. The assumption is that such individual trademarks may then be matched with the perpetrator of a crime. The sequence of actions is to find identifying trademarks and then search for the person(s) who match these trademarks. The popular media serves to reinforce a belief in the power of police via forensics to “bring about justice and catch the bad guy”. Detecting buried bodies does not have a single ready solution, but there is a high degree of expectation placed in technology, particularly geophysical technology to locate buried bodies. An example is a newspaper article that features the contracting by police of an expert in ground penetrating radar to solve crimes (example in Appendix 3).
In cases where a body is not located there is opportunity to engage external consultants for assistance, however, there may be pressure within the police service to maintain an appearance of being able to successfully locate a missing body “in house”. Commercial firms do not conduct searches unless police engage consultants for this purpose. As police conduct searches for buried bodies as public servants, expertise in this area from outside the police, such as forensic anthropology is considered a public service and there is no source of funded research into this field. Based on the results of the national survey of police services and the limited number of bodies found by police in the tabloid reports it may be extrapolated that searches for bodies missing for increased periods of time may not be subjects of intensive resources.

A loss of a person through disappearance differs from a tragic death because the circumstances are known and there is a closure created through the burial process. When a person is missing, presumed dead but the body has not been located, there is a sense of tragedy and an expectation that “society” will help to find the body, in the form of public resources (specifically the police). This is seen as an untypical death and it is considered relatively rare because there are relatively few unfound bodies publicised from the time their graves are not located. However research from this study shows that such incidents are not so rare and
that one reason why buried human remains are not found immediately after death is because search techniques have not been refined.

The act of creating a clandestine burial is consistent with the act of reducing the chances of the body being found in order to avoid the cultural consequences of being charged with a socially unacceptable act. In this age of forensic and chemical advances, for a murderer it is also about destroying a primary source of evidence linking him or her to a crime. In cultural anthropological terms, burial of a body as a method of disposing of a murder victim may be seen as an action that derives from a cultural norm in the first instance and has been a cultural practice of man for centuries. It is also reminiscent of disposing of refuse or an object that is not wanted. Soil provides a repository that will not itself erode readily or be destroyed (for example, if buried hidden in a house it may be burned or destroyed).

People are buried in clandestine graves in Australia. There is potential for improving the location record and decreasing the timeframe in which clandestine graves are located. From the publicly available information sourced in this section, searches for missing persons should include reserves and scrubland areas within suburban zones and outer metropolitan areas, areas that may be relatively close to accessible roads. Using information from the experimental research in this study will also
assist in search strategies. There are aspects of the anthropology of the practice of burying a victim in a clandestine grave that could be further explored; if murderers consider the burial site a place to return to for any reason and this may depend on the relationship with the victim, perceptions of likely burial places; the amount of planning that is involved in disposal of the murder victim and if concealment of the body is the only motivating factor for a clandestine burial. An important area of further study would be information from convicted murderers who have disposed of bodies in clandestine graves and more information about the circumstances in which they were found. Where bodies have been buried in clandestine graves, undertaking an anthropological exploration reveals more unknowns than the scarce available data can provide and requires more research. A separate study is required to properly address these aspects. It is hoped that this section points to the value of further research in this area from within the anthropology discipline and that the information provided adds to the context in which this experimental research has been initiated.

It is not expected that murder will cease in contemporary Australian society, and denser living circumstances may well prompt the stressors that give rise to murder. Clandestine graves are clearly being created and used for the disposal of bodies. What cannot be considered in this study
are those bodies that have not been found due to the inadequacy of search techniques.