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Ancient Maya Site Planning Principles:
A Case Study for the Preclassic/Classic Transition

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in

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by

Kathryn Ann Sorensen

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ABSTRACT OF THE DISSERTATION

Ancient Maya Site Planning Principles:
A Case Study for the Preclassic/Classic Transition

by

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Dr. Scott L. Fedick, Chairperson

Research focusing on the spatial planning of Preclassic (c.1000 B.C. – A.D.350) Maya communities is underrepresented in the field of Maya studies, with the majority of studies focusing on later Classic (A.D.350-A.D.900) and Postclassic (A.D.900-A.D.1520) period sites. It has been hypothesized that the ancient Maya used specific and formalized site planning principles at major urban centers of the Classic period as indicated by patterns in the archaeological record. There is also evidence from ethnohistoric and ethnographic accounts that small rural communities used cosmological site planning principles from the Contact period and into the present, suggesting some degree of cultural continuity in the layout of Maya communities. This dissertation research provides a case study exploring models of community structure using settlement pattern data along with archaeological, ethnohistoric and ethnographic data to provide insight into Maya social organization and community structure during the Preclassic/Classic period transition. Research was focused on a site located in the Yalahau Region of the Yucatán Peninsula, Mexico with a relatively short occupation period during the Late Preclassic/Early Classic transition, perhaps as short as 100-300 years. This short period of occupation allowed examination of the spatial layout of a Preclassic site without the overburden of subsequent, prolonged construction episodes, and will provided a snapshot of the spatial dimensions of a site occupied during a period in the Maya region that has not been extensively studied to date. Applicability of these models are examined through the analysis of the geographic patterning of architecture, as measured by the distribution of architecture at the site.

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CHAPTER 1: INTRODUCTION

This dissertation provides the results from a mapping effort that began in 1999 and continued until 2007 under the auspices of the Yalahau Regional Human Ecology Project (YRHEP), under the direction of Dr. Scott L. Fedick of the University of California, Riverside. Research was conducted at the ancient Maya site of T'isil, located in the Yalahau region of northern Quintana Roo, México.   Data collected for this dissertation provides some insight into the community structure of this ancient Maya site occupied primarily during the Preclassic/Classic transition period (200 B.C. - A.D. 600).

In the Maya region archaeologists recognize that there are similarities in the spatial organization of sites (Ashmore 1989, 1991, 1992; Coggins 1967; Fox 1996; Hammond 1981). The idea that the built environment of Maya communities reflects an intentional design suggests that the builders were using site planning principles when they constructed their homes, temples, towns and cities (Houk 1996).   Scholars hypothesize that these principles were based on Maya cosmology. In this dissertation, I examine the presence or absence of a number of site planning principles in the layout of the ancient Maya site of T'isil.

The primary goal of the research was to explore models of community structure using settlement pattern data to provide insight into Maya social organization and community structure during the Preclassic/Classic period transition. There are a number of community-planning models that have been developed and applied primarily to the Maya Classic and Postclassic periods, and almost exclusively at larger regional site centers. This research applies these models to the Preclassic/Classic transition at a smaller non-elite site. My primary research questions are: Do the community planning models we see in the Classic and Postclassic periods have their roots in the earlier Preclassic/Classic transition period? Do we see these models at relatively small communities occupied during this period?

I begin this dissertation with a description of the natural setting of the Yalahau region in Chapter 2. This region is a unique physiographic landscape because it is dominated by a series of freshwater wetlands, putting it in stark contrast to the arid karstic environment that characterizes the rest of the northern Yucatán Peninsula. Understanding the physical environment of the region will provide insight into the settlement patterns of the region and will provide the context for my research at T'isil.

Chapter 3 provides an overview of previous archaeological research done in the area. Until recently, the northeastern portion of the Maya lowlands has remained a poorly understood and little studied area. In particular, research in the Yalahau region was practically nonexistent until the 1990s, when a number of research projects commenced in large part due to the development of Cancun and the "Maya Riviera." Scholars believed that the northern lowlands were sparsely settled until the southern Maya world began to decline during the Late and Terminal Classic periods (A.D. 700-1050) and populations began to head into the northern Maya lowlands (Bey 2006:16). However, during the past twenty-five years, archaeological research has produced a fresh portrayal of northern Maya prehistory (Bey 2006:13), documenting much denser settlement and larger ancient populations than had been previously believed. Although this chapter provides a general overview of the relevant research in the Yucatán Peninsula, it focuses largely on research done in and around the Yalahau region.

Chapter 4 outlines the theoretical background used for analyzing the site plan of T'isil. The chapter is divided into four sections: the first section provides a brief overview of Maya cosmology, while the remaining sections provide an overview and critique of three models of ancient Maya community organization as well as the implications of these models on our understanding of the spatial layout of Maya communities occupied during the Late Preclassic/Early Classic transition. The models discussed include the Concentric Zone Model, the Quadrapartite Model, and Maya Civic Plan Model. Previous applications of these models have been primarily applied to Classic Period Maya sites (300-900 A.D.), or elite Late Preclassic/Early Classic period sites. Few studies have looked at them as they relate to smaller, non-elite sites. I have applied these models to the data collected from T'isil to see if any of these organizational principles are found in a smaller community occupied during the Late Preclassic/Early Classic transition and the results will be discussed in the final chapter of the dissertation.

Chapter 5 focuses on some of the methodological tools that I employed in my analysis of the spatial patterning of T'isil. I begin with an overview of the survey and mapping methods that were utilized when collecting the raw data necessary for my analysis. I then go on describe the use of Geographic Information Systems (GIS) technologies and how I used this technology to provide me with the information I needed to test various spatial models. I finish the chapter with a discussion of statistical methods I employed using the data from my GIS analysis. Finally, Chapter 6 presents the outcome of applying the spatial planning models to the T'isil data and summarizes recommendations for future research.

The contributions of this research are several. First, our research project has acquired and processed a large amount of spatial data describing a Maya Preclassic/Classic transition period site. Because the goal of the Yalahau Regional Human Ecology Project was to complete a full-coverage survey of the site, a large amount of information was collected and entered into geodatabases that are now available for many different kinds of analyses. Second, the application of the data to spatial models provides a more complete understanding of the community organization of this time period. Because of the long occupation of many Maya sites, the overburden of architecture prevents us from really seeing what a Preclassic/Classic transition period site looks like. At T'isil, there was a relatively short occupation period which provides us with a snapshot of the spatial layout of the site from this time period. And third, this research is one of a small number of extensive mapping efforts applied to a small-sized Maya site that developed during the Preclassic/Classic transition. Because so much emphasis has been on the larger elite sites in the region, my dissertation research at T'isil helps provide a more complete picture of what the common folk lived like, adding to a deeper understanding the ancient Maya culture.

CHAPTER 2: THE NATURAL SETTING

Introduction

In this chapter, I briefly introduce the environment of the Yalahau Region, located on the northeastern corner of the Yucatán Peninsula, in the Mexican state of Quintana Roo (see Figure 2.1). This region is a unique physiographic landscape because it is dominated by a series of freshwater wetlands, putting it in stark contrast to the arid karstic environment that characterizes the rest of the northern Yucatán Peninsula. Understanding the physical environment of this zone provides insight into the settlement patterns of the region and context for my research at T'isil, located within the Yalahau region.

The Natural History of the Yalahau Region

The Geology

Scientists have long recognized that the geological history of an area influences the subsequent development of biological communities, and the Yucatán Peninsula is no exception.

> The distinctive geology and hydrogeology of the region have had a strong effect on its biota as well as on the culture of its early indigenous inhabitants. Weathering residue of the exceptionally pure carbonate rocks has produced remarkably little soil cover, and may have significantly limited available trace nutrients. Furthermore, even though rainfall is seasonably abundant over much of the peninsula, water is readily available

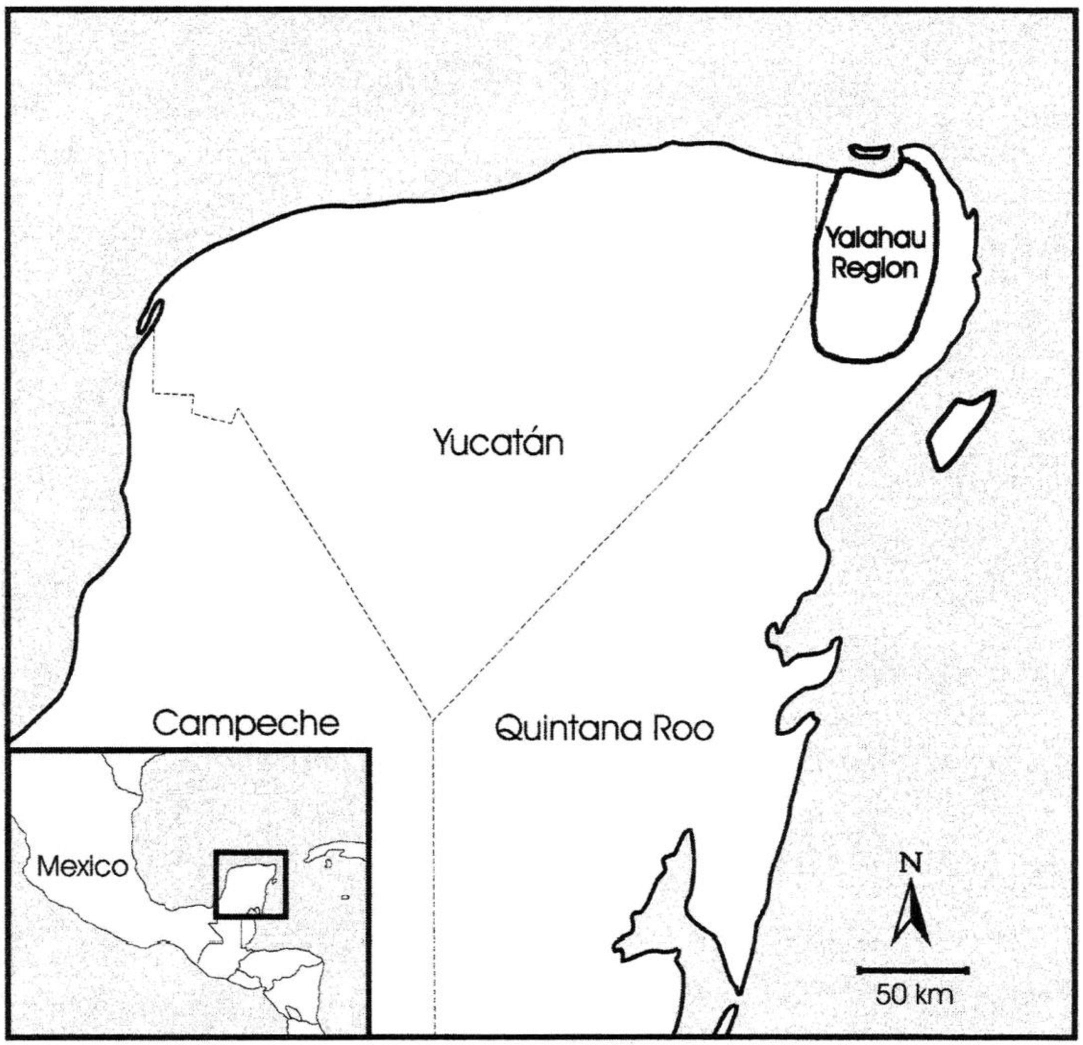


Figure 2.1. Location of the Yalahau region.

> only at specific sites because of the absence of surface streams [Perry et al. 2003:117].

This statement indicates the importance of the geomorphology of the Yucatán Peninsula, and its influence on the subsequent development the ecosystems upon which the inhabitants relied.

The Yucatán Peninsula is a gently-slanting limestone platform that extends north into the Gulf of Mexico between the Bay of Campeche and the Caribbean Sea. The southern portion of the peninsula is bounded by the Sierra Madre del Sur and Sierra de Chiapas of southern Mexico, and the Sierras of northern Central America. Formation of the peninsula was the result of tectonic activity occurring during the Cretaceous (145-65 million years ago), which resulted in the separation of North and South America. The Yucatán Peninsula is located on the Maya Block, a continental fragment that reached its present position as North America separated from South America in the Early Jurassic (200-145 million years ago) during the breakup of Pangaea (Graham 2003:32).

During the Cretaceous period and throughout most of the Tertiary period (65-1.8 million years ago), the peninsula was covered with a warm, shallow seabed (Graham 2003:15; Logan et al. 1969:7-9; Weidie et al. 1978:10). During the Cretaceous period over 1,000 m of limestone strata were formed, and during the Tertiary period another 1,000 m of sediments were deposited (Weidie 1985:1-19). These sediments were formed not only by the deposition of carbonate matter ($CaCO_3$) and coral reef material in the sea cover, but also by the restricted circulation of those waters (Weidie 1985). After a series of tectonic movements and sea level fluctuations, these sediments eventually emerged and were weathered, forming the characteristic karst topography for which the Peninsula is known.

Karst topography is shaped by thousands of years of the dissolving action of water on carbonate limestone bedrock. As rain falls, it acquires carbon dioxide (CO_2) which then percolates through the soil, picking up even more CO_2, forming a weak solution of carbonic acid. This acidic aqueous solution causes the bedrock to dissolve, creating fissures that increase in size over time. The result of this geologic process is a pitted, uneven surface, and the appearance of features such as *cenotes* (karstic sinkholes), underground drainage systems, and caves (LeGrand 1973; Rissolo 2003). The rapid percolation of water through the porous limestone led to the formation of underground aquifers that in turn sit on a lens of intrusive salt water that fluctuates in response to changes in sea level. Because of karstification, soils are generated more slowly than on nonsoluble rock. This is because in a karst area the bedrock is very soluble and dissolves relatively quickly in waters that transport minerals out of the area. In other types of topography, bedrock may weather slowly, but the minerals that are weathered out of the rock remain behind to be mixed with organic materials for soil formation. The Yucatán is well known for the relative lack of soils that range in depth from a few centimeters to a meter, with the exception of natural depressions known as *rejollados* and other low-lying areas into which soils are washed (Perry et al. 2003:120).

The northern Yucatán Peninsula is covered with a nearly-impermeable crustlike surface layer that is up to three meters thick. This layer is composed of a material known as calcrete, a hard subsoil encrusted with calcium-carbonate that was the raw material used by the ancient and modern Maya in the construction of their homes and public buildings. Beneath this is a layer of low-magnesium calcite, which lacks the cement-like qualities of calcrete (Perry et al. 2003). This much softer layer is known as *sascab*, a substance that the Maya have used as mortar in building and paving material since antiquity.

The Yucatán Peninsula has been divided into four distinct physiographic regions: 1) the Northern Pitted Karst Plain, 2) the Sierrita de Ticul, 3) the Southern Hilly Karst Plain, and 4) the Eastern Block-Fault District (Weidie 1985:3) (see Figure 2.2). The Yalahau Region is located within the Eastern Block-Fault District that is characterized by the Holbox Fracture Zone, a series of horsts and grabens that trend north-northeast. Horsts and grabens are elongated fault blocks of crust, ranging in size from a few centimeters to tens of kilometers in size that have been raised or lowered in relation to the surrounding areas resulting in a series of ridges and depressions (Tulaczyk 1993:181-188).

The Holbox Fracture Zone is approximately 100 km long from north to south and 30 to 40 km wide from east to west with the Yalahau region located in the north (Figure 2.3). Freshwater wetlands, referred to by locals as *sabanas* have formed in the swales of the fracture zone which suggests that the swales have hydraulic connection with the local groundwater system (Tulaczyk 1993:181). This is further supported by comparing

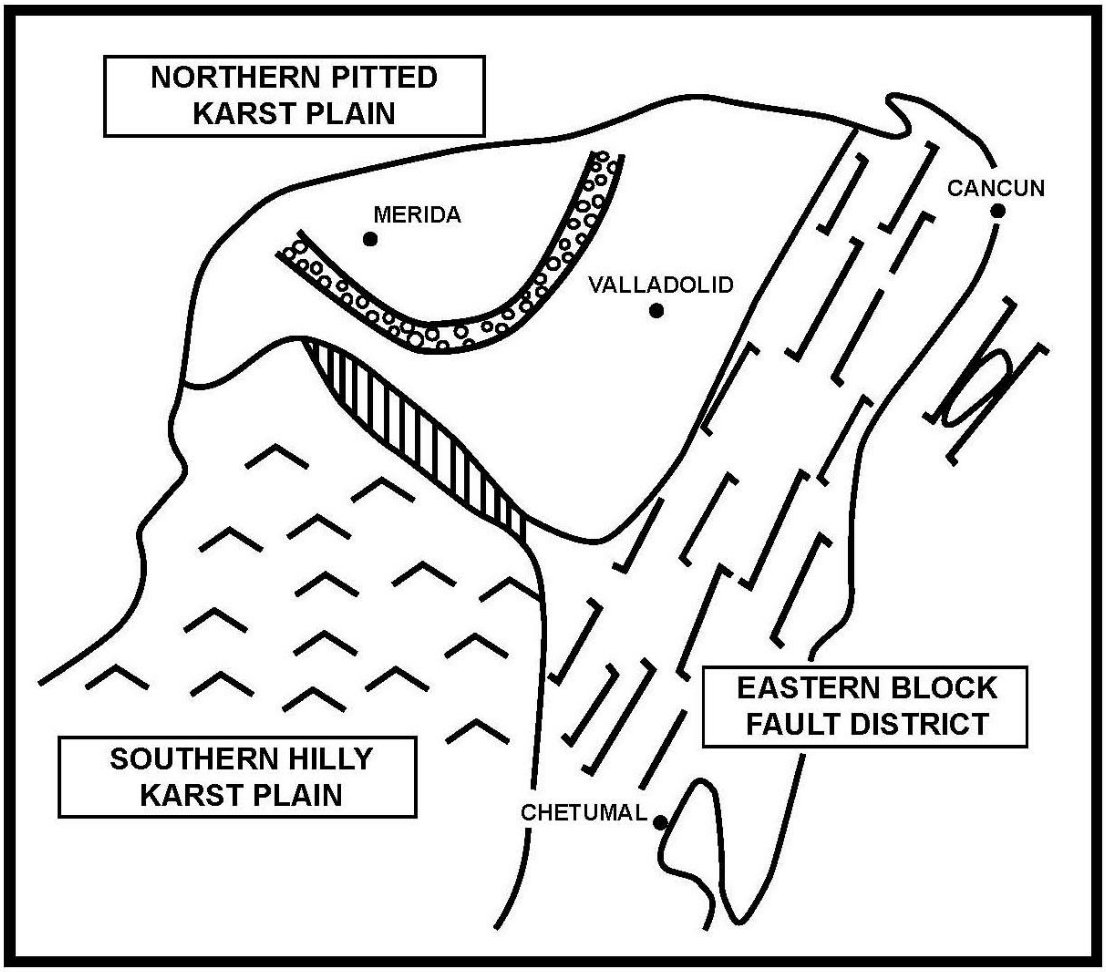


Figure 2.2. Physiographic Regions of the Yucatán Peninsula (after Lessing and Weidie 1988: Figure 1). The Yalahau region is located in the Eastern Block Fault District and is characterized by horsts and grabens that shape the wetlands.

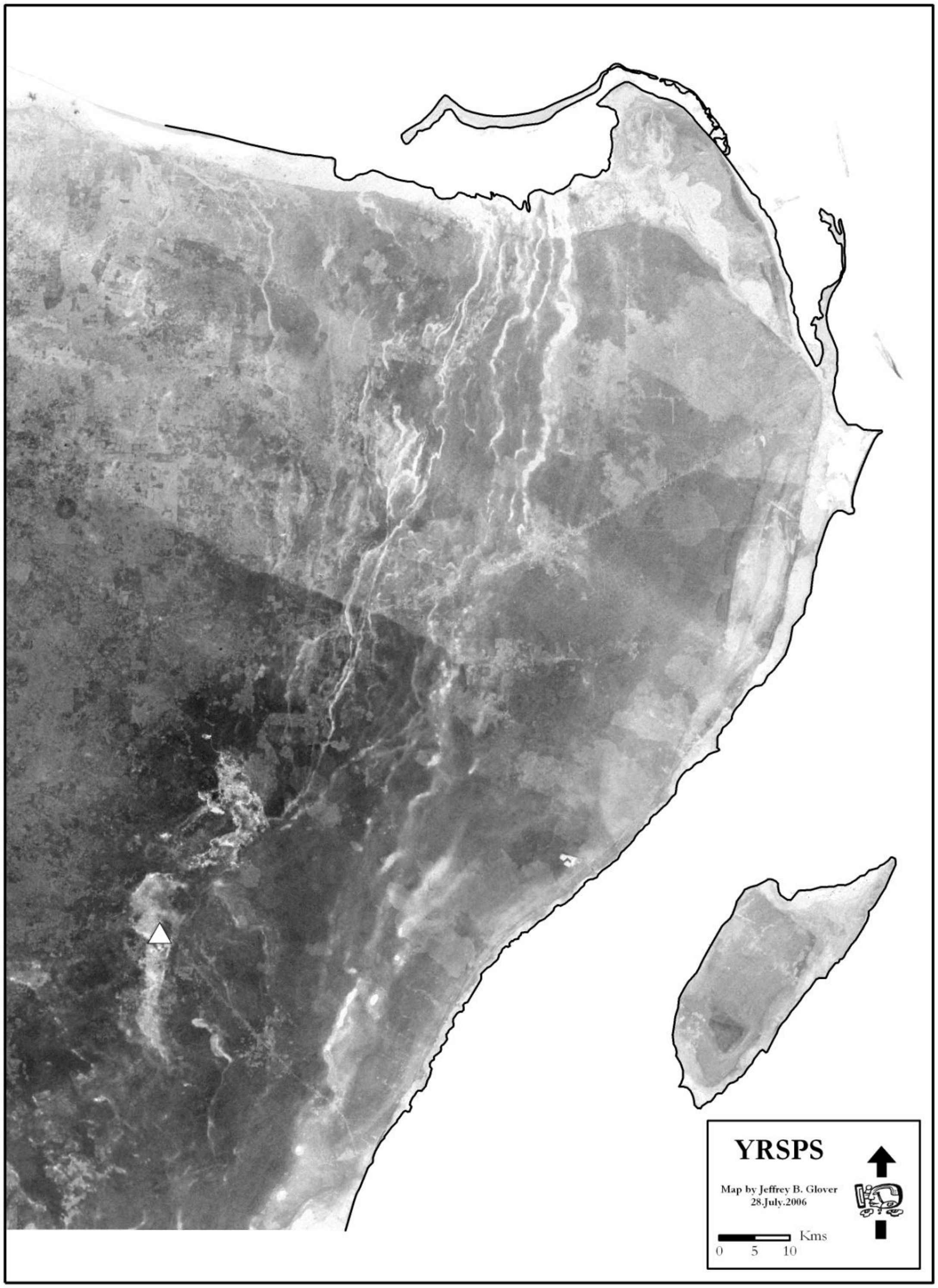


Figure 2.3. The Holbox Fracture Zone extends from the north coast south to Cobá. Lighter colored depressions indicate the presence of wetlands. The image is from SRTM mission, map by Jeffrey Glover (2006).

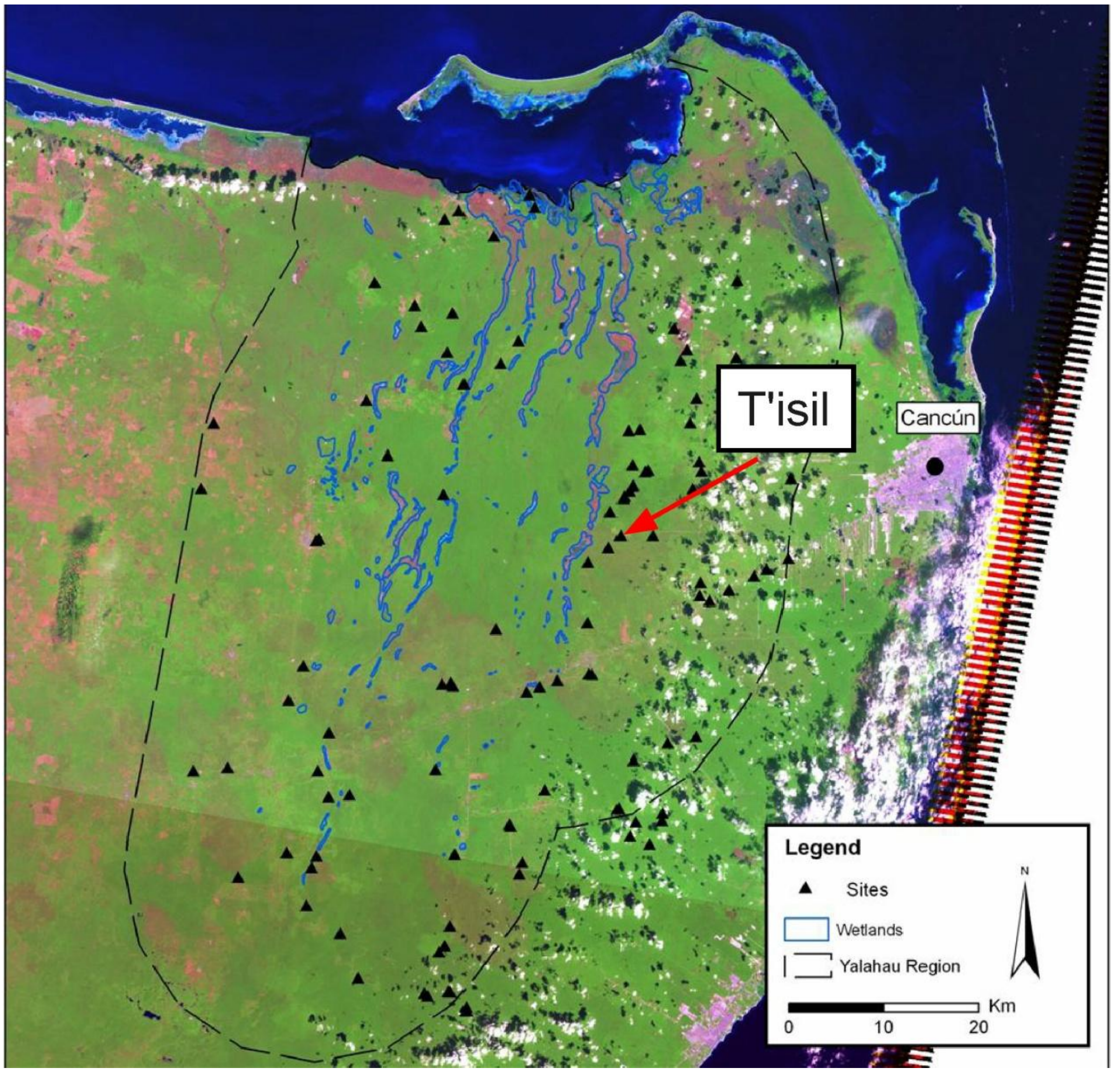


Figure 2.4. LANDSAT image of the Yalahau Region (Map by Jeffrey Glover 2006).

measurements of the water levels in the swales with the water levels in *cenotes* and wells from nearby villages. The Holbox swales are flat-bottomed features with abruptly steep walls that are easily recognizable on LANDSAT images (see for example, Figure 2.4) because their bottoms are covered by wetland vegetation with a low biomass in contrast to the surrounding forest (Tulaczyk 1993).

The northern Yucatán Peninsula overlies a rapidly flowing freshwater lens that floats on a regional saltwater intrusion and the Holbox Fracture Zone is located in an area where the freshwater lens is about 120 m thick (Tulaczyk 1993). This is in contrast to the rest of the peninsula which averages between 30 and 70 m in thickness, except in the coastal areas due to the intrusion of salt water (Beddows 2003:239; Lesser and Weidie 1988).

What makes the Yalahau region unique in the northern Maya lowlands is the accessibility to fresh water. Even though there are no rivers or lakes, fresh water is readily available in the region. Because the water table is only a few meters below the surface, fresh water can be obtained through the construction of wells or from the proliferation of *cenotes* dotting the landscape. The wetlands are also a valuable source of water for both consumption and irrigation and research indicates that they were in use during ancient times (Anderson 2001; Bell 1998; Fedick 1998; Morrison 2000). A further discussion on wetland manipulation can be found in Chapter 3 of this dissertation.

The Climate

The Yalahau region is characterized by an area of anomalous rainfall (see Figure 2.5) that ranges between 1400 mm/yr and 2000 mm/yr (Schultz 2003:93). This puts the region in stark contrast to the rest of the northern peninsula, as some areas of which can have as little as 500 mm/yr in the northwestern part of the peninsula and less than 1,000 mm/yr in the center (Giddings and Soto 2003:81). This anomaly is the result of a phenomenon known as the “double sea breeze" effect. Sea breezes from the Gulf of Mexico converge with breezes developed in the Caribbean, forming thunderstorms that generate the heavy rainfall of the Yalahau (Folan et al. 1983). The high rainfall, in conjunction with the horst and graben structure contributed to the formation of the wetlands in the Holbox Fracture Zone. Average temperatures in the Yalahau range from 23°C in January to 28°C in May. There are pronounced wet and dry seasons, with the dry season beginning in December and ending in late May, with another short dry season in August (Schultz 2003:94).

The Soils

The northern Yucatán is covered by a thin lens of soil composed of organic debris and limestone fragments (Isphording 1974) and this relative lack of soil gives the impression that this is an area of low productivity. However, a growing pool of research that indicates the Maya were able to thrive in this environment for centuries, creating large population centers and feeding up to several million people (Gómez-Pompa 2003; Fedick 1996; Turner 1990).

Figure 2.5. Rainfall Amounts in the Yalahau Region (after Isphording 1975:Figure 11).

There is a limited amount of knowledge about soils that develop from carbonates in tropical climates and few analyses of Yucatán soils are available (Perry et al. 2003:119). It has been hypothesized that the soil found in the northern Yucatán have are made up of a combination of dissolution of the carbonate rock that makes up the peninsula; dust from Central American volcanoes and dust from remote sources such as wind-blown material originating from West Africa (Perry et al. 2003:119). However, recent studies by Sergey Sedov and his colleagues (2006) are attempting to rectify this deficiency.

Sedov and colleagues (2007; 2008) have divided the soils of the Yalahau region into two categories, the wetlands and the uplands, formed by differing pedogenetic (soil formation) processes. The upland soils are predominantly Leptic Phaeozems and Rendzic Leptosols (as defined by the World Reference Base, 1998), composed of weathered silicate clay and iron oxides combined with organic material, generally less than 30 cm in depth (Sedov et al. 2007). In the wetlands, soils are Leptic Calcisols (WRB 1998) formed by a biochemical calcite precipitation and are covered by a periphyton (algal) crust. The areas of transition are covered by Calcisol soil over Cambisol soil which seems to indicate a recent expansion of the wetlands (Sedov et al. 2007). Researchers previously thought that upland soils are thin due to transport by rainwater toward the lowland areas, wetlands and sinkholes (*cenotes*). This seems to be contradicted by recent research that indicates the soils of the wetlands are primarily the product of redeposition of biochemical calcite precipitation from dissolved carbonates, mostly by algae (Sedov et al. 2008). Sedov et al. (2008) also found that in the uplands, there was short-distance soil transport toward the karstic features (cracks, hollows and small depressions) that were used by the Maya in both antiquity and modern times in homegardens (Fedick et al. 2008).

In spite of the thin soils found in the Yalahau region, the ancient Maya were able to sustain high population densities through resource management and intensive agriculture (Culbert and Rice 1990; Fedick 1996). This is due to specific soil formation processes of the region that have produced upland soils that lack the acidity, low humus content and poor structure of soils found in other humid tropic regions (Sedov et al. 2007; Sedov et al. 2008). In contrast to other soils found in other humid tropics, there is sufficient calcium carbonate dissolved from the limestone bedrock to provide pH values that are close to neutral and formation processes have produced soils that do not have a tendency to become hard and compact. While upland soils do demonstrate a lack of phosphorous, a chemical necessary to soil fertility, there is evidence that ancient Maya farmers were collecting and transporting phosphorous-rich periphyton (an algae, that when dried weighs almost nothing) from the wetlands for agricultural purposes (Fedick et al. 2000; Morrison and Cózatl-Manzano 2003:401-409; Palacios et al. 2003:389-399).

The Flora

The Yalahau region has been characterized as a "complex mosaic of soil resources and vegetation zones," comprised of seasonal to perennial wetlands, and upland areas that are well drained and dominated by semi-deciduous tropical forests (Fedick et al. 2000:133). Dunning et al. (1998:92) have included the Yalahau region as one of the 27 defined “adaptive regions” in the Maya Lowlands that have environmental characteristics that differentiate them from adjacent areas (see Figure 2.6).

There is a great deal of biodiversity to be found in the world’s tropical forests, with most of the research focused on the wet tropical forests. Schultz (2003:92) notes that little attention has been paid to dry tropical forests, even though they comprise a larger geographic area than the wet tropical forests. Floristic composition of the region is influence by soils that are shallow, calcareous and highly permeable (Read and Lawrence 2003:85) and the presence of a prolonged dry season (in the case of the Yalahau region, beginning in December and running through late May) produces an ecosystem that is characterized by plants and animals possessing adaptations specific to that particular environment. These factors combined to produce an environment that
is one of the richest and most diverse areas in terms of the biota in the northern Maya Lowlands (Schultz 2003:92), providing some insight into why the ancient Maya chose to settle at sites like T'isil, located on the periphery of the wetlands.

Studies by Schultz (2003; 2005) in the El Edén Ecological Reserve, located on the eastern side of the Yalahau, have characterized the vegetation of the region into five major types representative of the greater bioregion: (1) aquatic vegetation; (2) tintal; (3) acahuales; (4) selva mediana; and (5) savanna.

(1) *Aquatic vegetation* - The Yalahau region contains some 300 separate wetlands, covering a total area of about 134 km^2 (Fedick 2003:341). A variety of vegetative zones are found in the wetlands, supporting "distinct vegetative zones that differ depending on the duration of annual flooding" (Fedick 2003:342). Some of the wetlands are seasonally

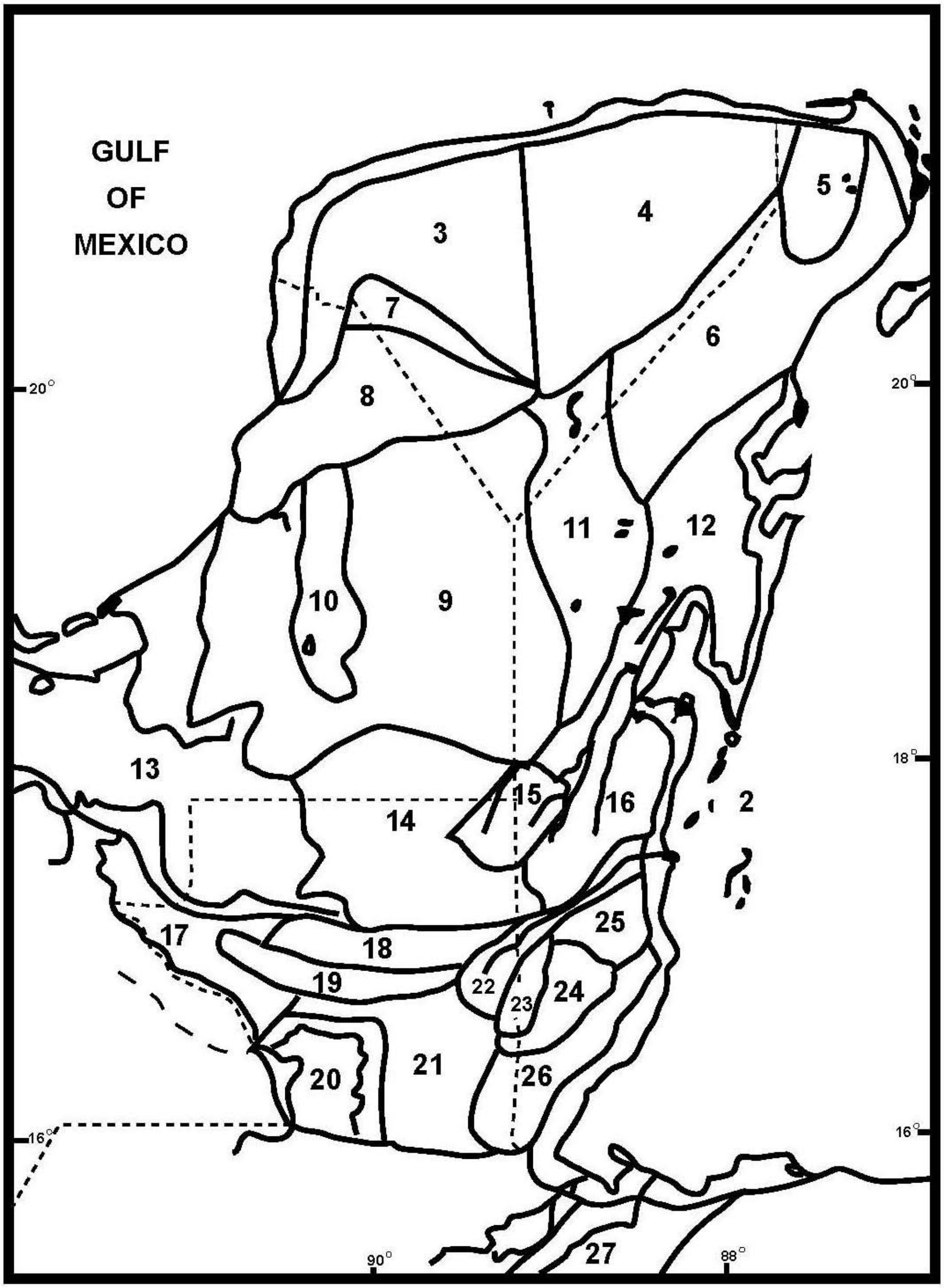


Figure 2.6. Adaptive Regions of the Yalahau (after Dunning et al. 1998: Figure 1).

inundated with small pockets that contain water throughout the year that are locally known as *lagunas*. One of the most common plants found in the *lagunas* is the cattail (*Typha dominguensis*) whose rhizomes, shoots and pollen are utilized by people in many different parts of the world as a nutritious food source. The cattail has been identified at various Maya sites but has not been discussed as a food source (Fedick 2003:351; Lentz 1999:9). Another plant that is commonly found in the wetlands is saw grass (*Cladium jamaicense*) which has edible shoots but is not as productive a food source as cattail (Fedick 2003:351).

The annona tree (*Annona* sp.) which bears edible fruit is found in seasonally-inundated areas of the wetlands, and several species have been recovered from ancient Maya sites as well (Fedick 2003:351-352). Also found in the wetlands are the water-lily (*Nyphaea sp.*) and the tasiste palm (*Acoelorraphe wrightii*). This palm grows in abundance, has edible berries, and is used for thatching material and construction.

Also potentially important is periphyton, an algal mat that attaches to larger plants or inorganic materials, whose economic value is its potential as an agricultural fertilizer because it is high in phosphorous and nitrogen content. There is evidence that it was possibly harvested for use in ancient Maya gardens and fields (Fedick 2003:352-353; Morrison and Cózatl-Manzano 2003:401-409).

(2) *Tintal*: Tintal is a seasonally inundated forest that is "patchy with thickets of trees and shrubs crowded on rock outcrops interspersed with open areas of sedges and occasional trees" and dominated by the *palo tinto* tree (Schultz 2005:312). The *palo tinto*

tree (*Haematoxylon campechianum*) was used as a fabric dye until the early 1900s when commercial dyes became available (Fedick 2003:354).

Also found in the tintal is the nance tree (*Byrsonima bucidaefolia*), a Maya delicacy with sweet fruit that is mentioned in the *Popol Vuh* (the K'iche' Maya book of creation) as a favorite of the lord Seven Macaw. In the Maya region today, locals eat the fruit and make it into wine (Fedick 2003:352; Schlesinger 2001:263; Tedlock 1985:90). A number of herbs such as *Cuphea gaumeri*, *Spermacoce verticillata, Heliotropium ternatum* and *Evolvulus alsinoides* are present as well (Schultz 2005:312).

(3) *Acahuales*: Acahuales are secondary/secessional semi-deciduous forest with stands between 7 and 10 meters high and a closed understory that is impassable (Schultz 2003:95; 2005:312). An economically valuable tree found in the acahuale is a variety of sapote (*Manilkara zapote*), previously utilized as a source of fruit and chicle, or latex used in chewing gum. The wood of the sapote is dense and very slow to decay and has been found in ancient Maya buildings used as lintels (Mathews 2009:12-13; Schlesinger 2001:144-147). Also found in acahuales are fiddlewood (*Vitex gaumeri*), known as *ya'axnik* in Yucatec Maya, which has been used for medicine, fodder, building material, wood for tools, and as nectar for the stingless bees found in the area (Rico-Gray et al. 1991; Schultz 2003:100).

(4) *Selva Mediana***:** The selva mediana is a medium statured, semideciduous forest, more than 50 years old, with trees that are between 10 and 15 meters in height. The sapote, black chechem (*Metopium brownie*) and fiddlewood (*Vitex gaumeri*) are also found in the selva mediana (Schultz 2003:107; 2005:312).

(5) *Savanna***:** Savanna (locally known as *sabanas*) areas are dominated by sedges (*Cladium jamaicense*) (*Eleocharis spp.*) and the tasiste palm (*Acoelorraphe wrightii*) (Schultz 2003:95, 2005:312).

<u>The Fauna</u>

The Yalahau region is a biologically diverse region containing many species of animals that were utilized by the ancient Maya. A number of fish species (of the family Cichlidae) are found in the wetlands, as well as the crocodile (*Crocodylus acutus*), both food sources for the Maya. Various species of turtles (mud/musk turtles of the family Kinosternidae and pond/box turtles of the family Emydidae) are present, also an important source of protein for ancient Maya. The Maya ate turtle eggs as a source of calcium, and burn marks on shells found in excavations indicate they may have been roasted in their shells (Schlesinger 2001:222).

A number of animal species utilized as food resources inhabit the Yalahau region, including the paca (*Agouti* paca), coati (*Nasua narica*), hispid pocket gopher (*Orthoheomys hispidus*), agouti (*Dasyprocta punctata*), jaguar (*Panthera onca*), red brocket deer (*Mazama americana*), white-tailed deer (*Odocoileus virgianus*), spider monkey (*Ateles geoffroyi yucatanensis*), howler monkey (*Alouatta pigra*), peccary (*Tayassu tajacu*), ocellated turkey (*Meleagris ocellata*) and the armadillo (*Dasypus novemcincuts*) (Goossens 2005; Schlesinger 2001).

Another economically important species found in the wetlands is the apple snail (*Pomacea flagellanta*), which was exploited by ancient Maya as a food source (Moholoy-

Nagy 1978), and could have been collected or cultivated in El Edén area (Fedick 2003:352).

Conclusion

After examining the environment of the Yalahau region, it is clear that the site of T'isil is ideally located to take advantage of the flora and fauna found in the wetlands and surrounding forests. The site's proximity to the wetlands provided the inhabitants of T'isil with a water-rich location that was manipulated in ancient times for agricultural purposes (discussed in more detail in chapter 3), as well as access to the edible wetland resources such as the tasiste palm and apple snails (Fedick et al. 2000:145). The wetlands may have also provided a rich source of fertilizer in the form of periphyton, which would have been a significant agricultural aid in their gardens. The surrounding forests provided building materials and provided a habitat to a number of animal species such as the agouti, deer, peccary and turkey that were utilized as a food source. The amazing amount of biodiversity found in the region goes a long way toward explaining why the ancient Maya may have decided to settle in this area.

CHAPTER 3: PAST INVESTIGATIONS

Introduction

Until recently, the northern Maya lowlands, and in particular the northeastern portion of the lowlands, "[has] remained one of the least understood and most marginalized areas of the Maya world" (Bey 2006:13). However, development of the "Maya Riviera" and the establishment of *Instituto Nacional de Anthropología e Historia* (INAH) offices in Cancún and Chetumal have increased archaeological research in the area (Shaw and Mathews 2005:3). Scholars previously believed that the northern lowlands were sparsely settled until the southern Maya world began to decline during the Late and Terminal Classic periods (A.D. 700-1050) and populations began to head into the northern Maya lowlands. However, during the past 25 years, archaeological research has produced a fresh portrayal of northern Maya prehistory (Bey 2006:13), documenting much denser settlement and larger ancient populations. In particular, research in the Yalahau region was practically nonexistent until the 1990s, when a number of research projects commenced.

Early Archaeological Research in Northern Quintana Roo

The earliest archaeological research in the northern Quintana Roo area began with the explorations of Stephens and Catherwood in 1841. Stephens (1962[1843]) account of their travels describes stops in Quintana Roo at such places as Isla Mujeres, Cozumel and Tulum, with a stop at the coast port of Yalahau. Stephens and Catherwood did not travel to the interior of the region, but Stephens does include the earliest recorded mention of a site in the Yalahau region, Kantunil (now known as Kantunilkin).

Augustus and Alice Le Plongeon published accounts of their travels in Quintana Roo during the late 1800s, detailing visits to Isla Holbox, El Meco and Isla Mujeres (Le Plongeon 1889; Salisbury and Le Plongeon 1877). Several others have documented sites in the area, including Teobert Maler (1971) in 1891, Arnold and Frost (1909) and Case (1911) in the early 1900s. William H. Holmes, curator of Anthropology at Chicago's Field Columbian Museum, also visited many of the same sites (Andrews IV and Andrews 1975) during the 1890s and documented sites such as Isla Mujeres and El Meco with maps, photographs and drawings (Holmes 1895).

Contemporary Archaeological Research

Expeditions to the coast were conducted by George Howe (1911) of the Peabody Museum, later followed by Sylvanus G. Morley and Jesse L. Nussbaum in 1913 (Con Uribe 2005). These expeditions were short due to resistance from "hostile natives". However, the Carnegie Institution of Washington (CIW) conducted the first academic studies during the twentieth century in order to study a "civilization in a pure state, relatively free from adulteration by alien cultural elements" (Morley 1943:205).

The CIW sent expeditions to northern Quintana Roo in 1916, 1918, and 1922 under the direction of Sylvanus Morley. Included in these expeditions were Samuel K. Lothrop, Oliver G. Ricketson, Thomas Gann, and John Held, producing the first understanding of the area as a cultural province (Lothrop 1924; Morley 1943). Gann returned to the region in 1925 and 1926 to continue his research (Gann 1927).

Journalist Gregory Mason and anthropologist Herbert J. Spinden of the Peabody Museum of Harvard were part of the 1926 Mason-Spinden Expedition that traveled up and down the coast of Quintana Roo by schooner. They documented sites as they went, including Muyil and Chunyaxche. Although Spinden's notes were never published, Mason wrote several books about his discoveries (Mason 1927, 1931).

An interdisciplinary group of Mexican scholars, sponsored by the Mexican government, formed the *Expedición Cientifica Mexicana in* 1937. As part of the expedition, archaeologist Alberto Escalona Ramos documented 36 sites both on the coast and inland, and is most notable for being the first scholar to conduct research in the Yalahau region (Escalona Ramos 1946). The five sites in the Yalahau region documented by Escalona Ramos include El Cenote, Santa Maria, Kantunilkin, Oxlakmul, and Chanchen.

William T. Sanders (1955, 1960) conducted settlement patterns research in northern Quintana Roo during the 1950s, mapping and test-pitting in order to establish the first ceramic sequence for the area. Sanders work in the Yalahau region focused on nine sites, seven of which were previously undocumented. These sites include Leona Vicario, Kilometer 14, Vista Alegre, Solferino, Monte Bravo, Kantunilkin, El Diez, Chiquila and Santa Maria (Sanders 1955). E. Wyllys Andrews IV, supported by the Middle American Research Institute (MARI), conducted research on coastal sites in 1955, 1956 and 1963 (E.W. Andrews IV et al. 1974). His studies of the marine and faunal remains represented one of the first studies of subsistence patterns in the area (Con Uribe 2005:21).

Numerous other studies were conducted at coastal sites, including the Harvard-Arizona Cozumel Project, under the direction of Jeremy Sabloff and William Rathje (Sabloff and Rathje 1975) as well as projects at El Meco (Andrews and Robles Castellanos 1986), Xcaret (Con Uribe 1991) and Xamanhá (Hernández Hernández 1992). Although the Yalahau region was first introduced to the archaeological community by Stephens and Catherwood in the 1840s, the Yalahau region remained relatively unexplored by archaeologists until much later.

Research in the Yalahau Region

As mentioned, Alberto Escalona Ramos (1946) was the first archaeologist to conduct research in the area. Although his research was focused outside of the Yalahau region, he did document a number of sites in the Yalahau, including Kantunilkin, Chanchen and Santa Maria.

The first large-scale reconnaissance was conducted by William T. Sanders (1955, 1960) who was working with the Carnegie Institution in 1954 and 1955, and was primarily interested in the Postclassic sites of the region. Because his goal was to construct a regional ceramic chronology, Sanders visited 40 sites in Quintana Roo in 1954 and collected artifacts through surface collection and test excavations. Nine of these sites (Vista Alegre, Chiquila, Solferino, Monte Bravo, Santa Maria, Leona Vicario, Kantunilkin, El Diez, and Kilometer 14) were located in the Yalahau region, and seven of these were previously undocumented (Sanders 1955).

Karl Taube and Tomás Gallareta Negrón (Gallareta Negrón and Taube 2005; Taube and Gallareta Negrón 1989) investigated the site of San Angel, which contains Postclassic mural paintings, with funding from the National Geographic Society. Taube and Gallareta mapped some of the larger architecture and recorded the murals. Their research documented the art, architecture and sculpture of the San Angel area. They found the art and architecture to be quite sophisticated and of comparable quality to that found at other Late Postclassic sites in the Yucatán such as El Meco and Mayapán. The ceramics, architecture, murals and other artifacts strongly suggest ties to the east coast and an orientation to coastal trade rather than subsistence agriculture (Gallareta and Taube 2005:111).

In addition, an INAH rescue project was conducted in 1992 and 1993 during the construction of a toll highway that runs between Cancún and Mérida, during which 13 sites (La Sombra, El Ideal, El Tintal, Valladolid Nuevo, Chan Dzonot, Los Tuchos, Leona Vicario, El Haltun, El Corchal, Chen Tunich, Chan Kahal, El Taman, and Yalamuul) were recorded. These sites consisted of small residential architecture, most of which were previously undocumented (Pantoja Díaz 1997: 179-183).

The Yalahau Regional Human Ecology Project

In 1993, Scott Fedick and Karl Taube initiated the Yalahau Regional Human Ecology Project (YRHEP) in order to investigate ancient Maya settlement patterns, land use, and political organization in the wetland-dominated region of northern Quintana Roo (Fedick and Taube 1995). Taube, professor at the University of California, Riverside, was interested in the region because of the Megalithic style architecture found at the site of El Naranjal. Most scholars believed that Megalithic architecture was confined to the western half of the peninsula (Mathews and Maldonado Cárdenas 2006:98; Fedick and Taube 1995), and had not previously been documented in the Yalahau region. Taube (1988) was familiar with the area because he had conducted dissertation research on ancient Yucatec new year rituals in the region during the 1980s. Fedick, also from the University of California, Riverside, was drawn to the region because of his interest in investigating the possible utilization of the wetlands in ancient Maya agriculture. Because of sparse modern populations and a dearth of archaeological research in the area there was a general impression that the Yalahau region was a "cultural backwater." Thanks to the inception of the YRHEP, this notion has been disproved.

The primary goal of the YRHEP is "to develop and test models of ancient political organization that address the relationship between hierarchical social relationships and management of resources in the Yalahau region" (Fedick and Taube 1995:2). In furtherance of this goal, Fedick continued as project director after the first field season until 1998, when he was joined by co-director Jennifer Mathews of the Department of Sociology and Anthropology, Trinity University, San Antonio, Texas.

Since 1993 archaeological projects conducted under the auspices of the YRHEP have documented and studied a number of sites in and around the wetlands of the Yalahau (see Fig. 3.1) (Amador 2005; Amador and Fedick 2002; Anderson 2001; Bell

1998; Fedick 2000, 2001, 2002; Fedick and Hovey 1995; Fedick and Mathews 2001, 2005; Fedick, Mathews and Morrison 2007; Fedick and Taube 1995; Glover 2006; Glover and Amador 2001; Lorenzen 1999; Mathews 1998; Morrison 2000; Rissolo 2001, 2003).

Much of the earliest work in the Yalahau region centered in and around the site of El Naranjal (also referred to as Tumben-Naranjal), a Late Preclassic/Early Classic site located at the south end of a wetland (Fedick and Hovey 1995; Fedick and Mathews 2001; Fedick and Taube 1995; Lorenzen 1999, 2004; Mathews 1998; Rissolo 1997, 2001; 2003). Limited excavations and surface collections of ceramics from Naranjal were analyzed by Boucher and Dzul, who concluded that the site was occupied during the Late Preclassic and Early Classic periods (ca. A.D. 100 and 450) (Boucher and Dzul 1998). Project members conducted a settlement survey of the area and documented a sample of residential Monumental architecture associated with the nearby wetland (Fedick and Hovey 1995).

Between 1996-1998, Dominique Rissolo documented 20 caves in the Yalahau region, all of which contained seasonal or permanent pools of water. Additionally, the caves exhibited evidence of human modification and a large amount of cultural materials. Because of the abundance of fresh water found outside of the caves, Rissolo believes that the caves were considered sacred environments and were used in the religious rituals. Rissolo also constructed the first ceramic chronology of the Yalahau region identifying material from the Middle Preclassic to the Late Postclassic (Rissolo 1995, 2001, 2003).

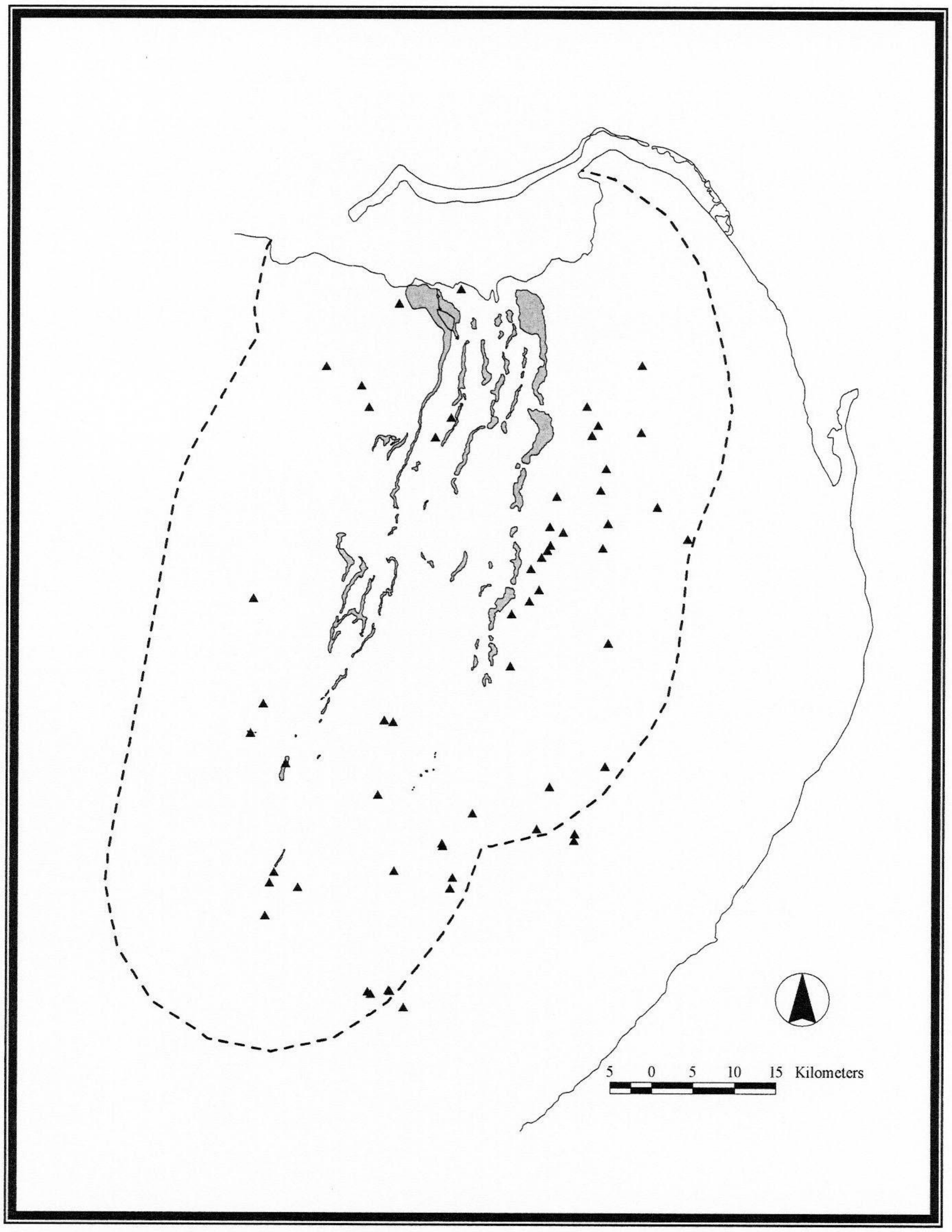


Figure 3.1. Sites Documented and Studied by the YRHEP.

Jennifer Mathews' dissertation research focused on the dating and distribution of Megalithic style architecture at El Naranjal and other sites across the region (1998). Scholars had previously documented Megalithic architecture in the eastern half of the peninsula at sites such as Aké and Izamal and has been dated primarily to the Late Preclassic and Early Classic periods (ca. 330 B.C.-A.D 550; chronology follows Robles 1990). The architecture at El Naranjal is very similar to the Megalithic style found at Aké and Izamal, which suggests a closer interaction between sites in the region than had been previously recognized (Fedick and Mathews 2005; Mathews 1998; Mathews and Maldonado 2005). Mathews (2001) extracted charcoal inclusions found in the architectural mortar at El Naranjal and dated them using the AMS radiocarbon method, obtaining results placing the architecture between 32 B.C. and A.D. 545, firmly across the span of the Late Preclassic/Early Classic transition. Distribution of the Megalithic architecture led Mathews (1998) and Fedick (Fedick et al. 1995) to propose that at one time a regional *sacbe* (ancient roadway) connected the modern port community of Puerto Morelos with the site of Ti'ho, now known as Mérida. Mathews continued this line of research using contact-period documents, archaeological survey, mapping and excavation, historic maps and ethnographic interviews with local peoples and documented the presence of the *sacbe* and its re-use in the *chicle* and lumber industries during historic times (Mathews 1998, 2000, 2001, 2003; 2009; Mathews and Lizama-Aranda 2005).

Graduate student Karl Lorenzen (1999, 2004) also conducted research at El Naranjal for his doctoral dissertation, centering his work on the Postclassic reoccupation of the site where he studied Late Postclassic shrines and altars built on top of architecture constructed during the earlier occupation of the site. The occupational history of El Naranjal is much like that of the entire Yalahau region in that the predominant period of occupation was during the Late Preclassic/Early Classic period, followed by a depopulation that continued until the Late Postclassic period. Lorenzen hypothesizes that these shrines were meant to justify re-occupation by showing direct ties to past ancestral relations (Lorenzen 1999, 2004).

In 1995 research began that was centered on and around the wetlands of the El Edén Ecological Reserve, focusing on the manipulation of the wetlands by the ancient Maya via construction of rock alignments located within the wetlands (Anderson 2001; Bell 1998; Fedick 1998, 2003; Morrison 2000). Under the direction of Fedick, 78 rock alignments were located in the El Edén wetlands, the longest of which was over 700 m (Fedick 1998, 2003; Fedick and Morrison 2004; Fedick et al. 2000). Fedick and Morrison (2004) hypothesize that the rock alignments were designed to manipulate the flow of water in the wetlands for agricultural purposes. Although the rock alignments themselves have not been dated, sites from the surrounding areas date to the Late Preclassic or Early Classic, suggesting that the rock alignments had been constructed around the same time as the sites were occupied. Andersen's research (2001) concluded that wetland manipulation may be a viable alternative to swidden agriculture, providing evidence of the adaptability of the ancient Maya to the various microenvironments found throughout the Maya area.

Bethany Morrison (2000) conducted research at Makabil, a small settlement located approximately two km from the El Edén wetland. She concluded that the settlement there dates to the Late Preclassic period and its inhabitants were likely tending and cultivating the wetland. Additionally, Morrison found evidence that periphyton (an algal mat growing in the wetlands and consisting of algae, bacteria, fungus and small mollusks) were being transported from the wetlands to Makabil, probably for use as a soil amendment for agricultural purposes. Periphyton is rich in phosphorous and nitrogen which are found in low levels in the soils of the Yalahau region (Fedick 2003; Morrison and Cózatl-Manzano 2003; Novelo and Rosaluz 2003; Palacios-Mayorga et at. 2003; Sedov et al. 2008).

In 1997 Julie Bell (1998) conducted a survey of *cenotes* in the El Edén area and concluded that not all of the *cenotes* surveyed had associated settlements; however, all of the settlements in the survey area were associated with *cenotes*. Bell further concluded that the sites that contained elite and/or monumental architecture were associated with large *cenotes*, while those sites with only residential architecture were associated with well-like *cenote* (openings less than four m in diameter). Bell also found that communities associated with *cenotes* in the El Edén area were surrounded by good agricultural soils and were located well outside of the potential flood zone of the wetlands.

Glover and Amador conducted archaeological reconnaissance in the Yalahau region conducted by Glover and Amador and documented 48 previously unrecorded sites (Amador and Glover 2001; Glover and Amador 2001). Amador (2005) constructed a regional ceramic chronology for the Yalahau region based on excavations at eight sites in the area. Data indicates that the area was predominantly occupied during the Late Preclassic/Early Classic period with a later Postclassic re-occupation.

Jeffrey Glover's (2006) dissertation research looked at models of spatial relations within and between communities in the Yalahau region. According to Glover, the Yalahau region has a different occupational history than the majority of the Maya lowlands, whose settlement dates predominantly to the Late or Terminal Classic period, while occupation in the Yalahau region appears to date primarily to the Late Preclassic and Early Classic periods. Glover's research documented only the largest architecture at the sites in his study area, but his reconnaissance at these sites led to his observation that T'isil's strikingly dense settlement pattern stands out as an anomaly in the region (2006:734).

Lance Wollwage analyzed soil cores collected in the Yalahau region in order to determine the regional fluctuations in water levels and how they structured sediment deposition and pedogenesis (2008). Wollwage found data supporting the idea that water levels in Cenote T'isil, a *cenote* located in the middle of an extensive Late Preclassic settlement and the nearby wetlands, were much lower level (at least one meter) than they are today. During the Late Classic period, water levels rose considerably, seemingly corresponding to the depopulation of the area. Further, he found that during the Late Postclassic period, water levels were lower, again corresponding to the re-occupation of the area.

Research at the Site of T'isil, Quintana Roo

Fedick first documented T'isil during his reconnaissance in 1993, and intensive research has been conducted at the site since 1998 (Fedick 2000, 2004, 2005; Fedick and Mathews 2005; Glover and Amador 2001; Sorensen et al. 2003). The project initiated a full-coverage mapping effort, along with a systematic surface collection and test-pitting program (discussed in detail in Chapter 5) with the goal of investigating the community layout and socioeconomic organization of this small site.

The ancient community of T'isil is located approximately 15 km south of the El Edén Ecological Reserve, within the boundaries of Rancho Santa Maria, owned by Mr. Michael Baker (see Fig. 3.2). When Fedick first identified the site in 1993, only a small number of mounds were visible in the cleared fields of the rancho. Mr. Baker invited project members back to the site in 1997, and they produced a preliminary map. At that time it became apparent that the site was quite extensive and centered around a seasonally inundated *cenote* (Fedick 2000). The site was so named because *T'isil* is the Yucatec Mayan word for vanilla, which grows in and around the *cenote* (Figure 3.3). Mr. Baker and the Baker Family Foundation provided the funding used to initiate research was ongoing at the site for several seasons.

During the 1998 field season, a preliminary site map documented some of the more obvious structures in the cleared area of the site as well as architecture along an equestrian trail constructed by the owner that runs through the forested portion of the site.

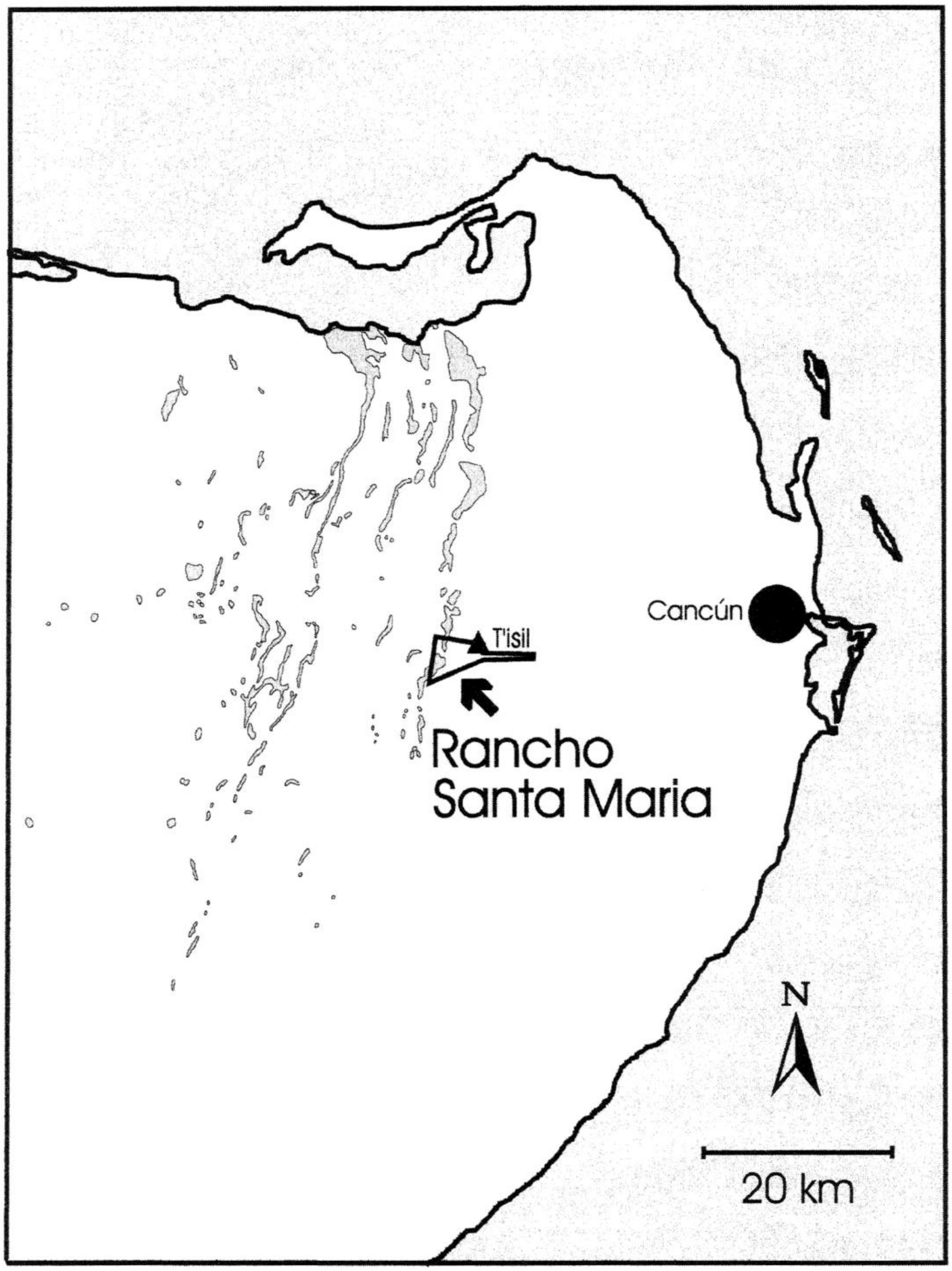


Figure 3.2. Location of Rancho Santa Maria (map by Fedick 2000).

Figure 3.3. Vanilla Plant at Cenote T'isil (Photo by Scott Fedick).

Mapping continued through the 2007 field season and a full discussion of the mapping procedures and results can be found in Chapter 5.

Anna Hoover's M.A. thesis (2003) explored the Postclassic re-occupation of the larger architecture at T'isil. Hoover conducted surface collections, surface scrapes and detailed mapping from a number of large structures located adjacent to the seasonally-inundated *cenote*, finding evidence of Late Postclassic shrines and altars. Hoover noted that although the Postclassic re-occupation was small, they utilized existing architecture from the Preclassic period for both ritual and domestic activities.

Michelle Goossens (2005) performed faunal analysis of materials recovered from test excavations at T'isil as part of her M.A. thesis. Goossens concluded that a wide variety of animals, the majority of which were mammals, were utilized by the inhabitants of T'isil, including the tiger shark (*Galeocerdo cuvier*), boa constrictor (*Boa constrictor*), American crocodile (*Crododylus acutus*), nine-banded armadillo (*Dasypus novemcincuts*), domestic dog (*Canis familiaris*), white-nosed coati (*Nasua narica*), long-tailed weasel (*Mustela frenata*), white-tailed deer (*Odocoileus virginianus*), red brocket deer (*Mazama* americana)collared peccary (*Tayassu tajacu*), paca (*Agouti paca*), agouti (*Dasyprocta punctata*), pocket gopher (*Orthoheomys hispidus*), and eastern cottontail rabbit (*Sylvilagus floridamus*). Further, Goossens found that most of the faunal material was not burned, indicating that they inhabitants probably stewed, roasted or boiled the meat rather than cooking directly over a fire.

Jeffrey Vadala (2009) conducted a three-dimensional analysis of the site center of T'isil, looking at how the placement of architecture may have influenced the social dynamics of its inhabitants. Vadala concluded that certain areas of the site were constructed for private rituals, while other areas were set up for public viewing. His three-dimensional view of T'isil can be used to create virtual walkthroughs of the site.

Conclusions

Previous archaeological research in northern Quintana Roo, and the Yalahau region in particular, provide the backdrop to the settlement pattern study at T'isil. Understanding the settlement patterns of the larger area provides context as to when and why T'isil was established in its location adjacent to the wetlands, and how the community was organized and to compare and contrast T'isil with other sites in the region. Previous research supports the idea that the Yalahau region was primarily occupied in the Late Preclassic and Early Classic periods with a limited Postclassic re-occupation and data indicates that the site of T'isil falls neatly into this timeline. T'isil, like many of the sites documented by the YRHEP, is located adjacent to extensive wetlands that were likely manipulated for agricultural purposes and its inhabitants appear to have utilized a large variety of the local fauna. T'isil was a densely populated, small site with a spatial layout that is anomalous when compared to the other sites documented in the Yalahau region.

CHAPTER 4: THEORETICAL ORIENTATIONS

Introduction

As briefly outlined in Chapter 1, my dissertation applies three spatial models and assesses how they pertain to the ancient Maya site of T'isil. I begin the chapter with a discussion of my theoretical orientation and a brief overview of Maya cosmology. I then describe and critique the Concentric Zone Model, the Quadripartite Model, and the City Plan Template Model and how they have been applied to archaeological sites in the Maya region. All of these models attempt to explain the spatial organization of ancient Maya communities, and of course all of these models have been tied to Maya cosmology. This chapter provides the theoretical background necessary for analysis of these models as applied to the site of T'isil.

Theoretical Orientation

Archaeologists have always been interested in space and the way that people transformed, interacted with, and exploited it, recognizing that people have modified space both consciously and unconsciously for a variety of purposes. The way that ancient peoples thought of space and how they modified and used it for activities such as subsistence, social interactions or religious rituals has been of interest to archaeologists who use a variety of tools to tease out the meaning of what the ancient inhabitants left behind.

One way to approach the analysis of space is through settlement pattern archaeology. Gordon Willey defined settlement patterns as

> the way in which man disposed of himself over the landscape in which he lived. It refers to dwellings, to their arrangement, and to the nature and disposition of other buildings pertaining to community life. These settlements reflect the natural environment, the level of technology on which the builders operated, and various institutions of social interaction and control which the culture maintained. Because settlement patterns are, to a large extent, directly shaped by widely held cultural needs, they offer a strategic starting point for the functional interpretation of archaeological cultures [Willey 1953:1].

Willey's groundbreaking work demonstrated how settlement patterns studies can provide insight into the environmental strategies and social organization of a society.

Early settlement archaeology was mainly concerned with the interaction of humans to their environment and this sentiment was documented by Chase and Chase (2003:321) who stated

> the primary goal of settlement archaeology has been to understand how humans distributed themselves over a given landscape. For the most part, settlement archaeology has incorporated an ecological approach that examines the relationship of environment or natural landscape factors to the physical location and density of human settlement.

Settlement data has been used to answer questions about social and spatial organization using models such as Central Place Theory, settlement hierarchies and other less ecologically-oriented approaches (Glover 2006; Hammond 1974).

Archaeologists studying the settlement patterns of the ancient Maya have recognized a number of site planning principles or spatial templates in the layout of numerous Maya centers, indicating considerable planning and meaningful arrangement in the way buildings, monuments and open spaces were placed and utilized on the landscape (Ashmore and Sabloff 2002:201). According to Ashmore (1989), site planning can be defined as deliberate, self-conscious settlement patterning that can be seen at varying scales from the individual structure to the regional landscape, and is based on the spatial etiquette of a particular culture or subculture.

In the Maya region, there is evidence that sites may have been laid out according to ideology based on a cosmology originating in the Preclassic period. According to Ringle (1999:185) some aspects of temple architecture found at Preclassic sites continue into the Classic period as evidenced by places like the North Acropolis and Mundo Perdido of Tikal. Ringle suggests that Preclassic organizational principles and the way they were symbolically expressed were flexible enough to continue to shape the more complex periods that followed. Ringle also maintains that the continuity evidenced in many of the spatial components of ancient Maya communities was the result of segmentary political organization among many Maya polities whose weak leadership relied on ritual to perpetuate the legitimacy of the burgeoning Classic period elite without forcing a drastic restructuring of society (Ringle 1985:185). This cosmology may have eventually evolved during the Classic period into a means by which Maya rulers symbolically reinforced their membership in an elite group through ritual or by replicating layouts of important centers for the purpose of political affiliation (Ashmore

1991; Ashmore and Sabloff 2002). Other factors, such as the presence or absence of resources, may indeed have influenced spatial order and perhaps explain some of the variability at Maya sites, but there does seem to be some underlying ideological principles that were considered when the sites were constructed.

Because this dissertation relies heavily on a discussion of Maya cosmology, I feel it is important to define the term 'cosmology ' as "a theory or philosophy of the origin and general structure of the universe, its components, elements and laws especially those relating to such variables as space, time, and causality" (Flannery and Marcus 1999:351-352). Some scholars have suggested that cosmology may underlie almost every facet of ancient Maya life, including kinship organization, political organization and subsistence (Ashmore 1989; Mathews and Garber 2004:49; McAnany 1995).

Maya archaeology has been heavily influenced by the perceived patterns expressed in architecture and the “built environment” that may reflect how the Maya conceived and imbued the places they built and occupied with meaning (Webster 1998). This chapter examines these principles and discusses the sources of information upon which they are based, as well as explores the presence of these patterns in the Preclassic period by analyzing the spatial components of the site plan at T'isil's. There are four sections in this chapter. The first section is a brief overview of Maya cosmology. The following three sections provide an overview and critique of three models of ancient Maya community organization as well as the implications of these models on our understanding of the spatial layout of Maya communities occupied during the Late Preclassic/Early Classic transition. Although these models have been applied to a small number of the larger Late Preclassic/Early Classic period sites, they have been primarily applied to Classic period Maya sites. I have applied these models to the data collected from T'isil to see if any of these organizational principles are found in a small non-elite community occupied during the Late Preclassic/Early Classic transition, the results of which are discussed in Chapter 6.

Maya Cosmology

Many archaeologists in the Maya area have examined site planning principles and their relationship to cosmology (Ashmore 1991, 1992; Ashmore and Sabloff 2002; Coe 1965; Freidel et al. 1993; Guderjan 2007; Houk 1996; Kowalski and Dunning 1999). These authors examined the layout of sites such as Quirigua, Tikal, Uaxactun, Uxmal, Cerros, Blue Creek and Dos Hombres and concluded that the layout of the sites was influenced by cosmological principles. Because this dissertation looks at the relationship between a number of spatial models and their relationship to Maya site planning principles, it is necessary to lay the foundation of my analysis by providing a brief overview of Maya cosmology.

Because of the scarcity of written records from the Pre-Contact period, archaeologists have relied heavily on the direct historical approach to reconstruct some aspects of ancient Maya cosmological beliefs. Extracting ancient Maya cosmological beliefs based on the application of ethnohistorical knowledge, and applying it to the earlier material culture of previous time periods has been characterized as tenuous (Smith 2003). However, similarities between the Postclassic and earlier Maya can be viewed not as unrelated so much as a possible continuum, and that application of ethnohistoric materials, used critically, can help us reach a better understanding of earlier time periods (Mosher 2004:37). Work with contemporary Maya peoples (Palka 2005; Vogt 1969) has shed light on our understanding of an ancient Maya cosmology. Mosher (2004) suggests that conceptual models derived from ethnography, iconography and ethnohistory (e.g. Fox et al. 1996; Palka 2005; Vogt 1969) can then be compared against the archeological record to help develop a clearer picture of ancient Maya cosmology.

Many scholars have examined the Maya conception of world order (Ashmore 1991; Coggins 1980; Friedel at al 1993; Mathews and Garber 2004; McAnany 1998; and Tedlock 1985). All members of Maya society, from kings to commoners, believed that it was their duty to keep the world an ordered place, and failure to do so would result in punishment (illness, accident, or death) by the gods (Sharer 1996:33). To the Maya, disorder is evil, which is represented by "the chaos that preceded creation and which constantly threatened to reassert itself" (Farris1987:574). Cosmic order must be constantly reasserted and this order could be maintained by recreating the order of the cosmos in the structure of everything from altars to communities.

The Ashmore Model

Ashmore (1989, 1991) hypothesizes that cosmology helped shape spatial templates that have been identified in Maya centers beginning in the Late Preclassic period through at least the Classic period. These cosmological concepts include:

1) A universe consisting of multiple layers, which includes a multilayered sky where the ancestors reside, the natural world, and a watery underworld where supernaturals lived;

2) The unification of these layers with time through the movement of celestial bodies like the sun, moon and Venus;

3) Vertical connections linking the various layers (e.g. *cenotes* and caves linking the natural world with the underworld, or the four *bacabs* holding up the corners of the sky).

4) A division of the world into four parts that correspond to cardinal directions with a center, and each part associated with specific colors, flora, fauna and gods.

Here I provide a brief overview of the four basic concepts articulated by Ashmore that underlie the discussion of the spatial models discussed subsequently in this chapter.

<u>A Multilayered Universe</u>

The Yucatec Maya thought of the universe as consisting of the visible earth sandwiched between the two invisible worlds. The celestial realm consisted of 13 layers presided over by the *Oxlahuntiku* (in Yucatec Maya *oxlahun* is "thirteen," *ti* is "of" and *ku* is "god"). The natural world was located on top of the nine layers of *Metnal* (also known as *Xibalba* in K'iche'), the Maya underworld, and was presided over by the *Bolontiku* (*bolon* is "nine" in Yucatec Maya) (Sharer 1994:523). They envisioned the natural world as resting on the back of a turtle or a crocodile, floating in a primordial sea (Schele and Mathews 1998:37-39). At the center of the world is the great sacred tree, or *ceiba*, supporting the sky. The corners of the skies are held up by the *bacabs*, or supernatural beings that are associated with *Chacs*, the Maya rain gods (Roys 1933:99-100; Sharer 1994:532). According to Davíd Carrasco (1990:104), the Maya believed that a cosmic order permeated all of these layers and that human society would be stable as long as it operated as a microcosm of this order.

Time, Space, and Celestial Bodies

Ancient civilizations were understandably intrigued by the heavens since the regular movement of the sun, moon, stars and planets provided them with something both dependable and orderly, an anchor for their ideology, and the ancient Maya were no exception (Aveni 2001:1). The Maya integrated religion with a sophisticated astronomy, and ancient Maya art and codices reveal a Precolumbian pantheon of astronomical gods (Milbrath 1999:1: Taube 1992). The Maya, like many other sophisticated ancient civilizations, believed that celestial luminaries were gods who actively influenced human destiny and earthly events (Milbrath 1999:1). It was the movement of the sun, moon, planets and stars that defined the universe in time and place, providing visible manifestations of the supernatural realm (Sharer 1994:523).

Vertical Connections

The Maya believed that there was a very real connection between the various realms of the universe. For example, caves and *cenotes* found throughout the Maya area were thought of as direct entrances to *Xibalba*, making them both sacred and dangerous places. Temples were conceived of as manifestations of a *witz* (mountain monster) (see Figure 4.1) and the entrances represented caves through which rulers and priests could enter to communicate with the lords of *Xibalba* (Holland 1964; Sharer: 1994:524). The intersection of horizontal (layers of the universe) and vertical (points connecting the horizontal layers) space is the *axis mundi*. This is often represented by the World Tree (the ceiba) located at the center of the world, whose branches support the heavens and whose roots connect the living world with the underworld (Sharer 1994:288).

The Four Quarters

For the ancient Maya, the earth was flat and divided into four quarters, the corners of which were correlated with a cardinal direction (Coe 1999; Coggins 1980; Schele and Freidel 1990). Each cardinal direction was associated with its own tree, bird, color, and gods (Coe 1999; Schele and Freidel 1990). The east was associated with red, the north with white, the west with black, and the south with yellow. The earth was seen as pivoting around a central point, or *axis mundi*. The heavens were also divided into four quarters and supported by the *bacabs* (skybearers), each associated with the


Figure 4.1. Monster mouth at Ek Balam (Photo by Jennifer Mathews).

appropriate color and a particular set of rites. This quadripartite divisioning of the natural and supernatural world was reflected on scales from territories and cities, down to the *milpa* (field) and altar. This pattern has been related to the completion of cyclic completion of the solar and calendrical cycles (Coggins 1980).

In the Maya universe, humans were the center of a spatial frame defined by cardinal points and a vertical axis (*axis mundi*), an ideation that appears repeatedly in the construction of symbolic space (Tuan 1977). This conceptualization was recreated and repeated in the layout of individual buildings, villages, ritual centers and even at a regional scale.

The following spatial models are all based on the connection between the layout of ancient Maya communities and the cosmological beliefs of the members of those communities. The concepts outlined briefly above will be discussed in more depth as they relate to the models being examined in this dissertation.

Quadripartite Model

As stated by Gordon (1971:211) "The practice of dividing the circle of the horizon into four cardinal directions is almost universal, appearing among well-separated peoples of diverse cultural origins." The rising and setting of the sun was surely observed carefully by ancient people. Their observations likely established mental maps that included the cardinal directions. Cognitive cartographers hypothesize that humans made mental representations of key spatial ideas, such as the "cardinal direction cross" that is the intersection of lines whose terminal points end at north, south, east and west, dividing the earth into four parts with a center (Woodward and Lewis 1998). Evidence for this can be seen in the fact that the concept of four quarters is found embedded in the cosmology of cultures around the world. For example, the urban core of the fourteenth century Hindu capital of Vijayanagara, located in southern India, was delineated into four distinct areas by a series of walls and roads. Fritz and Michell (1987:114-120) have construed the quarters as ceremonial, administrative, public and royal residential areas, with a centrally placed ritual precinct. Roads radiate outward from the ritual center linking the city with its dependent territories. The ancient Chinese also had a concept of four directions with a center (Nakayama 1966: 448-449). The typical ancient Chinese city plan was a walled rectangular or square divided into quarters by main streets on north-south and east-west axes (Johnston 1983:195). Quadripartite divisioning is also found among the Hopi (Geertz 1984:215), Navajo (Lamphere 1969:286-289), Pawnee, Cheyenne (Hall 1997:99) and other Native American cultures.

Many researchers have examined the Maya perception of world order (Ashmore 1991; Chase and Chase 1998; Coggins 1980; Freidel et al. 1993; García-Zambrano 1994; Guderjan 2004; Mathews and Garber 2004; McAnany 1998; Tedlock 1985) and have noted the Maya perception of a world divided into four quarters, with a center. The four-part theme in Mesoamerica is equated with cyclic completion, and is connected to the apparent annual solar path (Coggins 1980:727; Milbrath 1999:70-74). The Maya used this quadripartite idea in constructing spaces as a reflection of the microcosm of their perceived world. To the Maya, the ordered universe consisted of a “quincunx” made up of four parts and a center, as well as an apex and a nadir (see Figure 4.2) (Pugh 2001).

The quincunx has deep roots and seemingly permeates all levels of Maya culture. William Hanks (1990:349) said "Altars, yards, cornfields, the earth, the sky, and the highest atmospheres are described in terms of the five-point cardinal frame."

Watanabe (1983) conducted research among the Mam of Guatemala and used language to construct a cognitive model of Mayan cosmology. According to Watanabe, the Maya concepts of time and space are intertwined. The Mam words for the cardinal directions are related to the path of the sun across the sky. The Western concept of directions east and west seems to coincide with the Mam concepts of the sun rising in the east and setting in the west. In fact, the Mam term for east, *okni*, comes from the verb 'enter' and the term for west, *elni*, from the verb 'go out' (Watanabe 1983:712). What is different are the concepts of north and south. Among the Mam and other Mayan dialects, the words for north and south often do not refer to cardinal directions but to intermediate vertices of the solar path. The Mam term for north (*jawni*) comes from the verb *jaaw*, meaning 'go up" while south (*kubni*) comes from the verb *kub* meaning 'go down.' The Tzotzil Maya refer to north and south arbitrarily as 'sides of the sky' (Vogt 1969:298), while the Mam use the terms quite often to refer to elevation (Watanabe 1983:712). Watanabe (1983:713) suggests that the association of *jawni* and *kubni* with north and south might be an artifact of Spanish conquest. Nevertheless, it is clear that the Maya conceive of a four-part partitioning of the earth and the heavens.

A further connection between time and space can be seen by the way the Mam divide the day into four periods: morning, noon, afternoon and night, periods which

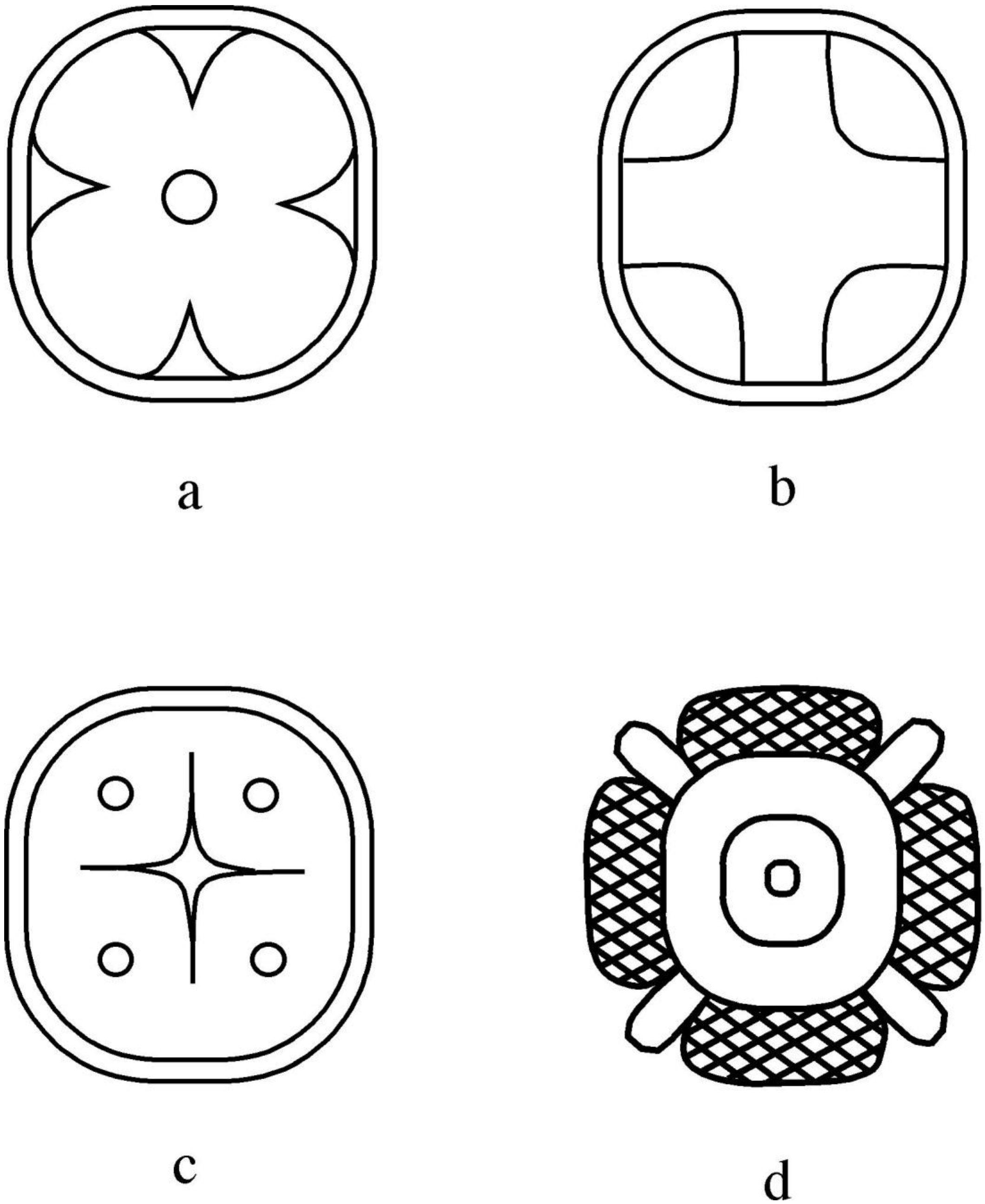


Figure 4.2. Maya quadripartite glyphs/signs: [a] *Kin*; [b] *Kan*; [c] *Lamat*; and [d] zero or "completion." (After Mathews and Garber 2004: Figure 1).

correspond to the sun's position between the four principal directions of Mam space. According to Watanabe, "both time and space are mapped onto the same set of directional coordinates derived from the passage of the sun through the heavens" (ibid. 1983:716). It is evident that the Maya conception of both time and space has a quadripartite component that is reflected in many aspects of their culture, past and present.

To the ancient Maya, quadripartite partitioning and the layering of space are metaphors for world creation, and used to evoke supernatural power, concepts that have roots extending back to the Middle Preclassic and also seen in the ethnographic present (García-Zambrano 1994:220; Mathews and Garber 2004:49). The *Popol Vuh*, or "Council Book" of the Quiche Maya, tells the story of creation where the world had been created, destroyed and re-created three times before the present era. In the fourth, or present era, the first humans (the four founding fathers) were created from corn dough and the Maize god completes the creation of the universe by constructing a house whose sides define the four corners and four sides of the universe (Tedlock 1985). Because partitioning is a metaphor for creation, it is used to invoke supernatural involvement in mortal events (Mathews and Garber 2004). The following passage from the *Popol Vuh* illuminates the importance of the concept:

> the fourfold siding, fourfold cornering,
> measuring, fourfold staking,
> halving the cord, stretching the cord
> in the sky, on the earth
> the four sides, the four corners, as it is said,
> by the Maker, Modeler,
> mother-father of life, of humankind
> From the Popol Vuh [Tedlock 1996:63-64]

The importance of the central position is an integral part of the quadripartite concept. The *ceiba* tree (the tree of life) is at the center of the world with its roots in *Xibalba* and its branches in the heavens. The tree, when presented in cross form, represents the ecliptic of the sun (Reilly 1990:38; Mathews and Garber 2004:51). Reilly (1994:83-84) has suggested that two Olmec period celts from Arroyo Pesquero, Vera Cruz, illustrate the concept iconographically, portraying the First Father/Maize God (and by association, the king) as the axis mundi at the center of sociopolitical and religious power and authority (Reilly 1990:38, 1994:83-84; Taube 1996:44).

Quadripartite principles are a key feature of Late Preclassic Maya architecture and can be seen at several Preclassic structures at Cerros (Freidel and Schele 1988:561). Structures 6B and 5C both show material spaces in which ceremonies organized in the *quincunx* arrangement, as described in ethnohistorical literature would have been carried out (Freidel and Schele 1988:561). On the outside of structure 5c is a four-part design that depicted the cycle of the Sun and Venus as well as the Ancestral Heroes. Someone standing on the landing, four steps up from the base, would have been visually in the center of the façade and would have completed the *quincunx* design. Freidel and Schele further note that there are four enormous post-holes on top of the structure that would have been too big to be just roof supports. These holes likely would have held giant poles such as those depicted as animate tree frames on Izapan monuments (the concept of "world trees") (Freidel and Schele 1988:561).

Quadripartite site-planning is also seen at numerous Classic period Maya sites including Tikal (Ashmore 1991), Quirigua (Ashmore 1989), Uaxactun (Coggins 1980), Ek Balam (Bey et al. 1997), Copan (Maca 2006), and Mayapan (Pugh 2001:247-258). For example, at the Late Post-Classic political and ritual center of Mayapan, there are five serpent temples that form a *quincunx* layout at the heart of the site, defining the site's ritual district (Pugh 2001 247-258). These temples depict scenes of creation and destruction, reflecting the cyclical nature of Maya time. Each of these five temples is located in temple assemblages that appear to have been associated with a specific elite official.

The quadripartite concept can also be seen in the layout of *sacbeob* (ancient raised roadbeds), that had practical as well as ritual significance. Diego de Landa observed that there were four entrances into Maya communities, each one coming from one of the cardinal directions (Tozzer 1941:135-140). Each entrance was marked by two heaps of stone "facing each other" (Tozzer 1941:135-150). Each of the four roads led to the home of the *principal* (a type of town councillor) which implies a four quarter divisioning (Coe 1965:102).

This pattern of four roads leading out from the center of the site in cardinal directions has been observed at sites such as Ek Balam (Bey et al. 1997), San Gérvasio on Cozumel Island (Freidel and Sabloff 1984; Freidel et al. 1993:161-162), Seibal (Tourtellot 1988), and Cobá (Navarette et al. 1979). The pattern at other sites, such as El Naranjal, is not as clearly defined (Mathews and Garber 2004:55). At El Naranjal, *sacbeob* have been identified in the northern and western positions, with a possible road on the eastern side as well (Fedick and Taube 1995:14; Reid 1995). This is a pattern that is also seen in protohistoric and contemporary Maya villages (Tozzer 1941:139-140;

Redfield and Villa Rojas 1934:114; Thompson 1930:62). These roadways have been linked to pilgrimages and ritual processions (see Figure 4.3) (Ringle 1999:204).

One such ritual is the Uayeb. The Maya 365-day year was divided into 18 "months" (*uinals*), made up of 20 days, plus one month of five "nameless" days known as Uayeb, "the resting or sleep" period of the year (Schele and Freidel 1990:81). These five days were considered very unlucky. Michael Coe suggests that the Uayeb, or New Year ceremonies, were related to lineages and ancestors. Coe (1965:99) proposed that the Postclassic Uayeb rites of the northern Yucatec Maya were actually models of ancient Maya communities.

According to Coe (1965:106:109), the ideal Maya community is conceived of as divided into four endogamous *tzuculs*, or wards consisting of exogamous patrilineages. This seems to be a spatial representation of what is written in the *Book of Chilam Balam of Chumayel* which describes the four founding lineages: “These were the four lineages from heaven, the substance of heaven, the moisture of heaven, the head-chiefs, the rulers of the land: *Zacaal Puc*, *Hooltun Balam*, *Hochton Poot*, and *Ah Mex-Cuc Chan*” (Roys 1967:147). References to the founding lineages are also found in the *Popol Vuh*, whose power and authority come from their association with the four fierce jaguars: *Balam Quitze, Balam Acab, Mahucutah,* and *Iqui Balam* (Mathews and Garber 2004:51; McAnany 1995:27, Tedlock 1985). Lineages organized in a quadripartite manner have been noted at Itzamkanac (Scholes and Roy:1938:609-610),

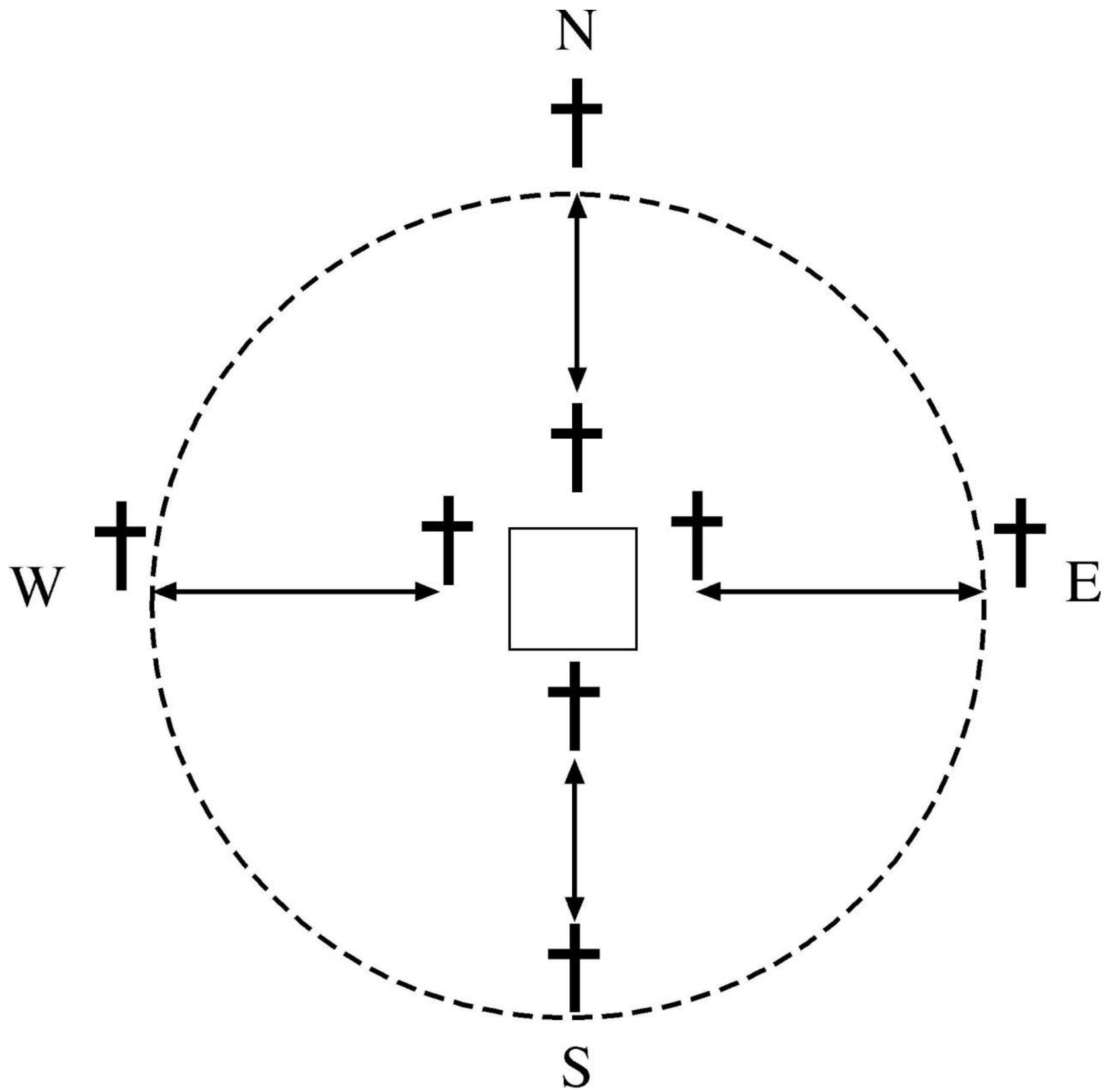


Figure 4.3. Layout of town and locations of cross shrines - (after Mathews and Garber 2004:55).

Utatlán (Fox et al. 1996:815), Mayapan (Proskouriakoff 1962:91), Chichén Itzá (Roys 1933:139-140), and ethnohistorically at Ox Mul (Fox et al. 1996:815).

García-Zambrano (1994) synthesizes and analyzes the rituals of foundation and layout of Mesoamerican sites based on manuscripts written by indigenous peoples in the 1500s, shortly after the arrival of the Spanish. He describes "a basic conception of the land encased in a quadrangular frame crossed by diagonals" (García-Zambrano 1994:227) and suggests that the layout of communities was meant to replicate the Mesoamerican conceptualization of the universe.

According to Coe (1965), the four part organization of the new year ceremonies reflects the four barrios, or wards. Each of the four wards is associated with a color and with a cardinal direction. Coe suggests that the new year rites are linked to the annual rotation of political and religious authority through the four wards. In the New Year ceremonies, lineages from the four quarters rotate responsibilities for the fiestas and other obligations associated with the new year (Coe 1965; Mathews and Garber 2004:50). In fact, the five day new year festival has been described as a rite of passage, in which separation is marked by the last day of the 20 day month, the liminal period is the five day Uayeb, and the incorporation period is the first day of the new year (Taube 1988:12).

Each ward within a Yucatecan community was headed by an *ah cuch cab* (translated as "bearer of the community"). The *ah cuch cab* were aged wealthy commoners who represented their wards in the town council. According to Coe (1965:103), the most important office was that of the *holpop* (head of the mat). The man to hold this position was chosen every year in a counter-clockwise pattern of succession from among the four wards (Coe 1965:106). Like the "cargo" of contemporary Chiapas, occupancy of the office was tied to the calendar year.

At a larger scale, Coe (1965:108) uses the Maya state of Tayasal, an independent state founded by the refugee Itzá from Yucatán and the last stronghold of Maya civilization until late in the seventeenth century, as an example of quadripartition. During the last days, Tayasal was made up of four quarters, each ruled by a *batab*. The four quarters pattern is supported by both ethnohistoric and archaeological evidence as outlined previously and can be linked to Maya cosmological beliefs. Data from T'isil will be used to determine whether there is any evidence that this Preclassic/Classic period transition site shows any evidence of quadripartition.

Concentric Zone Model

Geographer Ernest W. Burgess first proposed the concentric zone model in 1925 when he hypothesized that urban land use could be classified as a series of concentric zones (Park et al 1925). Burgess, along with fellow sociologists Robert E. Park and R. D. McKenzie, published *The City* in 1925, which was a collection of essays examining the social behavior of Chicago at that time. The concentric zone model appeared in a chapter by Burgess entitled *The Growth of the City: An Introduction to a Research Project*. Burgess was looking at the physical expansion of the city as "a framework against which the relationship between population mobility and social organization can be studied" (Scargill 1979:35). Burgess' ideas were influenced by plant and animal ecologists who were studying outward growth that takes place by invasion and succession, with the replacement of one dominant group by another, following an invasion of the territory of the latter by the former (Scargill 1979:36).

The model is illustrated by a series of concentric rings or circles used to characterize the types of land use that resulted from urban expansion (Figure 4.4). According to this model, a city grows outward, beginning with a central business district in the middle, followed by a second zone characterized by industry and poorer-quality housing where newly-arrived immigrants were housed. The third ring consists of modest houses occupied by the middle class, followed by the fourth zone made up of larger, better-quality homes for middle-class families. And the outermost ring, known as the commuter zone, would be occupied by people living in the suburbs who commute to the city center to work. According to Burgess, urban communities become socioeconomically stratified as the more affluent population moves outward as the zones located in the inner rings begin to deteriorate due to the aging of the housing and changes in the desirability of certain zones for various kinds of households (Logan et al 1980).

Burgess believed that these zones evolved organically as a result of competition from different socio-economic groups for land, the underlying idea being that city growth results in an invasion and succession pattern from waves of immigrants moving into the city, occupying the zone closest to the central district while the more wealthy families would move further and further out from the center in an attempt to put distance between themselves and the immigrants.

In the inner zones, older single-family homes would be converted into multi-family structures, accompanied by a change in the racial or ethnic composition of the

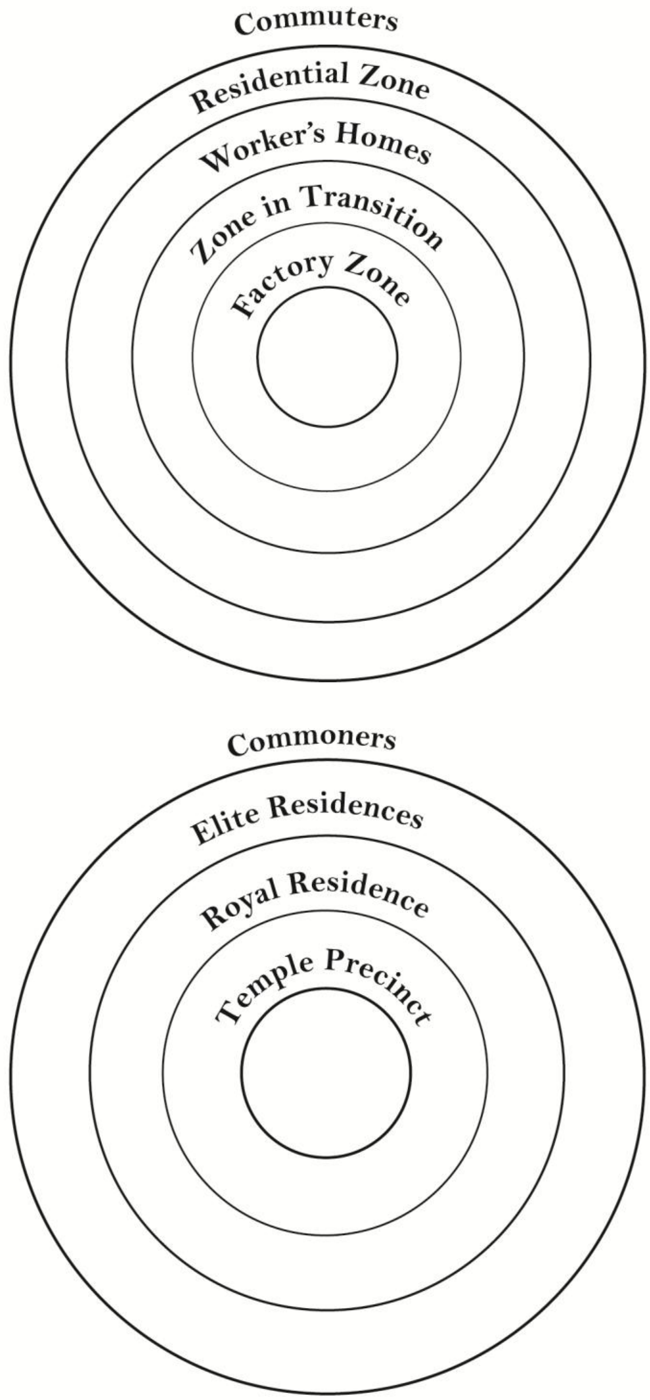


Figure 4.4. Burgess Model and Maya Model of Concentric Zonation.

community. The "age of housing, low-income and minority population and social heterogeneity should be associated" with a decline in rates of single-family construction and high rates of multi-family housing (Logan et al. 1980).

However, Burgess' model has been critiqued by geographers, sociologists and archaeologists (Anderson et al 1961; Arnold et al. 1980; Dear et al. 1997; Logan and Semyonov 1980; Smyth et al. 1995). Michael Dear and Steven Flusty (1997) point out that Burgess' model is based on a lot of assumptions, such as "a uniform land surface, access to a single-centered city, free competition for space, and development taking place outward from its central area." Hoyt (1933) argues that "non-rational" factors, such as promotion and advertising, can also influence the direction of development.

One of the earliest applications of the concentric zone idea as applied to Maya communities can be found in the writings of Bishop Diego de Landa (Tozzer 1941). De Landa authored the *Relacion de las Cosas de Yucatán*, in which he writes about the religion, language, culture and writing system of the contact period Maya. De Landa (1937[1566]) described community organization by stating that:

> Their dwelling place was as follows: in the middle of the town were their temples with beautiful plazas, and all around the temples stood the houses of the lords and the priests, and then [those of] the most important people. Thus came the houses of the richest and of those who were held in highest estimation nearest to these, and at the outskirts of the town were the houses of the lower class.

These communities were usually situated around *cenotes* or caves that acted as conduits to the watery underworld, representing the *axis mundi* of the community (Brady and Ashmore 1999).

Michael Coe proposed this model of Maya community organization in archaeological literature in 1965. Coe proposed a concentric zone model for community structure, which he based on ethnohistoric evidence from Yucatec Maya communities. According to Coe (1965:102), everything known archaeologically about Post-Classic Yucatec settlement patterns shows that the temple or temples were located at the center of each community, with the houses of the lords and of the priests, *la gente mas principal*, not far from the temples. Coe's model of community structure combines both the concentric zone and the quadripartite concepts (see previous discussion of the quadripartite model in this chapter).

With this model applied to the Maya region, we should expect to find the *cenote* or cave surrounded by the most impressive architecture, marking the residences of the elite and temples of worship and the more modest architecture further on the periphery of the community. This pattern reflects the unequal distribution of social power, with architecture acting as the symbolic form of communication, expressing the relative importance of the individual. Social differentiation within the community is expressed through an individual's proximity to the site center, and the access to the supernatural realm, the temples and *cenote*, which that proximity brought.

Patricia McAnany (1995) discussed the principle of first occupancy, in which the lineages of the "founding fathers" of a community had preferential access to land and resources. Since *cenotes* and caves were of significance to the ancient Maya cosmologically, it would stand to reason that the founding fathers would choose to locate their residences and build their public architecture adjacent to these natural features. The practice of burying the most revered ancestors under the floor of houses and within large funerary pyramids in the center of cities and villages (McAnany 1995:1) allowed the living to maintain a direct connection to the dead - what McAnany calls "living with the ancestors." The physical presence of an ancestor gave symbolic and material weight to the claims of the descendants because "ancestor veneration was a critically organizing force in all sectors of Maya society" (ibid).

The application of the Concentric Zone Model to the Maya area seems to be almost the inverse of the model that Burgess first described. In the Burgess model, the most valuable "real estate" is located at the periphery of the community (Park et al. 1925:127) , while in the application to Maya sites the most prestigious architecture is found at the core of the site. However, both applications of the model divide the community into concentric rings of differentiated use and architecture.

In the Maya region, this model has been suggested both explicitly and implicitly and a number of archaeologists have applied the concentric zone model to their research. Kurjack (1974:94) states that analysis of the architecture at Dzibilchaltun revealed three concentric zones, occupied by people of different social status, with the most prestigious groups being located nearest to Cenote Xlacah at the center of the site. Kurjack argues that vaulted buildings reflect wealth and status, and his analysis was based on the distribution of vaulted architecture at the site. According to Kurjack, the three zones are comprised of: (1) the central group, a heavy concentration of vaulted architecture in about a quarter of a square kilometer near Cenote Xlacah; (2) the central aggregate, a clustering of vaulted ruins in an elongated area of over 3 km. surrounding the central group; and (3) the peripheral sphere where small groups of vaulted ruins are widely spaced. All three areas contained unvaulted buildings, but these appeared mostly in the peripheral ground and were least frequently found in the central group.

This model has been applied to Late Classic Cobá (Folan et al. 1979), because the site exhibits a pattern of continuous architecture that radiates out from a central administrative and religious core. Folan hypothesizes that Cobá was organized in a concentric pattern with the elite living near the site center and the commoner living in the periphery. Sylvanus Morley's research at Uaxactun (1947) led him to state that the site was organized with the public and religious buildings located around courts and plazas in the site centers, and the elite living around them. The non-elite architecture could be found extending outward from there in every direction.

Scarborough and Robertson (1986:159-160) observed that the Concentric Zone model can be applied to the Late Preclassic site of Cerros. They divided the site into three zones - the Central Precinct, composed primarily of monumental architecture and the most densely built-up area of the community; the Core Area, composed of compact residential and civic structures and bounded by a curvilinear canal; and the Periphery, which is made up primarily of residential structures, with little civic architecture to be found.

Clearly, there are many archaeologists who have applied the Concentric Zone Model at numerous sites throughout the Maya region. However, the application of this model in the Maya area is not without critics. Some scholars argue that it is necessary to look beyond architectural remains to assess the model by systematically analyzing artifacts and ecofacts that would provide a comparable and independent set of data with which to assess the model's applicability (Smyth et al. 1995:329-330). Ford and Arnold state that "interpretations of Classic Maya settlement patterning are based heavily on assumption rather than the analysis of measurable archaeological evidence" (1980:714). They argue that many Maya archaeologists used visual inspections of architecture when they concluded that high status residences are located close to the civic-ceremonial center of Tikal, while less impressive architecture is found at greater distances from the center. They feel that visual inspection is not enough and that it is necessary to systematically and quantitatively analyze residential units in order to fully evaluate the Concentric Zone Model.

Arnold and Ford agree that there was ranking (social class) of some kind in the Classic period. Based on this assumption, upper-class individuals had the power or wealth that was necessary to manipulate a labor force for both public and non-public architecture. Lower status individuals would have had to do the work themselves, which would have restricted them to building smaller and less elaborate architecture. According to the Concentric Zone Model, the larger architecture of the upper class would be located adjacent to the ideological center of the site, while those of lower status would be situated toward the periphery of the community. Arnold and Ford (1980:716) tested the model at

Tikal, using a detailed map of the central nine square kilometers of the site (Carr and Hazard 1961). Using a tau-B rank correlation method for the test (discussed in more detail in Chapter 5), they concluded that there was no correlation between proximity to central precincts and status, and therefore labor investment cannot be used as an indicator of status. Furthermore, they stated that if assumptions about within-site settlement patterns are not what is commonly believed to be true, it then calls in to question other assumptions about the socioeconomic and political organization of the ancient Maya as well.

With this critique in mind, I use a volumetric analysis of the architecture found at the site of T'isil. The method for the volume calculations used in my analysis is discussed in Chapter 5 utilizing a quantitative approach, the results of which are discussed in Chapter 6.

City Plan Template Model

Many archaeologists would agree that the ancient Maya utilized certain planning principles that were both sophisticated and deliberate when building their communities (Ashmore 1989, 1991; Ashmore and Sabloff 2002; Aveni 2001; Coggins 1980; Ringle 1999; Schele and Freidel 1990). Maya cosmology and politics were the prominent factors influencing spatial patterning, however factors such as environmental factors, engineering, economics can be observed in the layouts of Maya sites (Ashmore and Sabloff 2002). The placement of architecture and the creation of spaces can convey cosmological and/or political meanings that may be difficult to understand after an original site layout has been modified by years of growth and change due to the long occupation periods seen at many Maya sites (Ashmore and Sabloff 2002:201). Evidence supports the idea that the Maya used the built environment - that is the placement of buildings, monuments, and open spaces, as a physical expression of cosmic order.

The earliest analyses of Maya site layouts focused on orientation to astronomical phenomenon, a trait seen throughout Mesoamerica (Aveni 2001; Milbrath 1999; Šprajc 2005). More recent investigations of Maya site planning have shifted toward an examination of the symbolism of the built environment (Ashmore and Sabloff 2002; Gonlin and Lohse 2007; Mathews and Garber 2004; Ringle 1999) based on the premise that the underlying cosmological bases for the patterns we see at most Maya sites include the idea that there is a universe made up of multiple levels, with the ancestors residing in the heavens among the various gods and an underworld populated by various other gods, unification of these layers by identifying cyclical movement of celestial bodies (sun, moon and Venus) through these various layers, quadripartite division of the world, and a vertical connection between the earth and other layers which is manifested in the placement of architecture (Ashmore 1989:273).

The Preclassic period provided the roots of many Classic period rituals and there is an amazing amount of continuity between the two periods. Some aspects of temple decoration and architecture carried over from the Preclassic into the Classic, and excavations have revealed that some of these Preclassic sacred spaces, like the North Acropolis and Mundo Perdido at Tikal, had been used for centuries (Ringle 1999). Ringle states that this suggests that the Maya developed organizational principles early in their history that were flexible enough to be used for ordering more complex Classic and Postclassic period sites (1999).

During the Classic period, site planning principles that had their foundations in cosmology originating in the earlier Preclassic were used by the elite to reinforce their authority by using parallels between the time and space of the gods and the time and space of humans (Carrasco 1990). Reproducing the cosmos on earth by means of architecture and creation of sacred spaces linked the Maya elite to the heavenly realm. The transition from the Preclassic to the Classic period was characterized by a developing sociopolitical complexity, and economic and ideological manipulations were crucial to that development. Site planning was used to reinforce the legitimacy of the elite through the incorporation of cosmology into site planning and monumentality (Arie 2001:14).

The layout of structures on cardinal axes helps define the Maya *axis mundi* (Ashmore 1989, Ashmore and Sabloff 2002:203; Eliade 1959; Tuan 1977). The two axes may represent the path of the Sun and the Milky Way, using architecture and ritual movement, to re-enact the creation of the universe (Freidel, Schele and Parker 1993:87-95). Archaeologists have observed that there was a shift in axial domination from east-west in the Preclassic to north-south in the Classic, which may indicate a change in the way that the Maya conceived of political authority (Ashmore 1989; Ashmore and Sabloff 2002:210). The shift in orientation represents a change from supremacy of the sun and other celestial bodies, to an increasing importance of the king and dynasties (Ashmore and Sabloff 2002; Freidel and Schele 1988). Kings and rulers were the living *axis mundi*, bringing the divine into the terrestrial level of existence (Carrasco 1995). Ashmore and

Sabloff (2002) suggest that this axial shift reinforces the idea that Maya civic space was endowed with ritual and political meanings and that this space was being manipulated as a means of legitimizing power. There is evidence that the shift in axial domination was occurring at smaller sites as well during the Late Preclassic. Research shows that by the Late Preclassic "north" was being expressed as "up" at Cerros, a relatively small site in Belize (Ashmore 1989:275-276; Scarborough and Robertson 1986). Freidel's analysis of the site indicates that the placement and iconography of Str. 5C-2nd, located atop the northern end of a platform, impling north as up (Freidel 1986; Schele and Miller 1986).

During the Late Preclassic period we begin to see a shift from the household as the locus for sacred activities to the construction of monumental architecture, such as temples as the focus of ritual activity (Ringle 1999:198). Small temple pyramids are seen occurring both singly or in association with domestic groups. This pattern is evident at larger sites like Seibal (Tourtellot 1988:277-284) and El Mirador (Ringle 1999:190), as well as at smaller sites like Komchén (Andrews and Ringle 1992). According to Ringle (1999), these local temples seemed to act as residential organizational nodes that pertain to “a series of long-established local corporate social groups each with its own idiosyncratic service center or ‘chief’s establishment” (Tourtellot 1988:377). The temple is in many cases associated with open areas or platforms that may have been used for public ceremonies or dances, indicating the importance of centralized performance and display (Ringle 1999:198). Ashmore (1989:279) postulates that plaza plans or templates were formulated by the Late Preclassic and these templates are often repeated at various sites in this time period and later in the Classic period.

Coggins (1980) was the first to note the importance of four-part design in Mesoamerica. She argued that twin-pyramid groups, such as that found at Tikal, horizontally map the daily vertical path of the sun. Pyramids located at the east and west of these groups map the rising and setting points of the sun, while the north and south structures indicate points between sunrise and sunset (Ashmore and Sabloff 2002:202-203). In other words, what we would perceive as north and south would metaphorically represent the heavens and the underworld (Ashmore and Sabloff 2002:203). According to Ashmore (1989), this would imply that stelae of rulers located in the northern enclosures of these groups would symbolize their transportation to the heavens, joining them with the sun and their royal ancestors. Symbolism like this would have helped the ancient Maya kings reinforce the legitimacy of royal power. The best known example of this would be at the Great Plaza at Tikal, where north is the location of the tomb of ancestors and their stelae at the North Acropolis. This is also evident in the twin pyramid groups at Tikal, such as Group 4E-4, where a stela of a rule is located in the center of the north side of a quadripartite platform (Coggins 1980:729-730).

At many Classic period Maya sites, there is evidence of what is referred to as “functional dualism” (Ashmore 1989; Coggins 1980). Many sites have complementary paired districts, one to the north used for public rituals that are devoted to ancestor veneration (symbolized by carved-stone monuments), and the other to the south being the palace or private residential compound. Ashmore has observed this pattern at Quirigua (1984) while Coggins (1967) observed this pattern at twelve centers located within 100 km of Uaxactun in the Petén.

Building something to mimic something else is one way to imbue that space with political “aura". Spaces that are constructed to look like a place of authority give behavioral clues to those who interact within it (Ashmore and Sabloff 2002:203). According to Suzanne Preston Blier (1987:2), “Architecture is integrally identified with human activity, experience, and expression, for, in ordering space, architecture also orders human action.” Ashmore and Sabloff (2002:203) hypothesize that many of the Classic period Maya civic centers were constructed to emulate other centers by replicating certain elements of architecture and space. This was a “voluntary and self-conscious symbolic identification of the lesser power with the greater" (Ashmore 1989:280).

As Ashmore and Sabloff (2002:203-204) note, colonial architecture in the Americas was built to re-create past and present European capitals, often being built upon the razed central buildings of indigenous civilizations. This was done in order to symbolically proclaim the authority of the conquerors. Low (1995:757) describes how the Spaniards superimposed their own cities on the same sites as existing centers so that the indigenous populations would recognize a new authority. The modern cities of Mexico City and Mérida (previously Tenochtitlán and Tihoo, respectively) are examples of how a dominant culture can obscure a less powerful one (Low 1995:757).

Ashmore (1992) uses the example of Teotihuacan’s *talud-tablero* style and the N15° orientation as an example of a center that was often emulated, and which may have had an influence on the shift in orientation at Maya centers. During the first century

A.D., Teotihuacan was dominated by a north-south axis and had a great impact on parts of Mesoamerica in and after the fourth century (Carrasco 1990:56).

Architecture is not simply a object manufactured for a specific use or to symbolize a specific idea. Architecture retains links with those who manufactured it at the same time that others newly appropriate it, allowing the built environment to guide behavior, shape values, and act as repositories of meaning that shift and change (Lawrence-Zúñiga 2001). There are Maya texts that show evidence of the influence of Teotihuacanos in the politics of the Maya Lowlands beginning in A.D. 378 (Ashmore and Sabloff 2002:204; Stuart 1998) and Coggins (1980) argues that this may well have impacted Maya civic plans during the Classic period.

Cosmology and political emulation may have been significant influences on civic planning, but Ashmore and Sabloff (2002:201) caution that any site is the product of decisions made over many generations. If you have continuity in governance, it is likely that you will see less change, than when governance changes (Ashmore and Sabloff 2002:204; Barrett 1999:253; Steinhardt 1986). As archaeologists, the ease with which we are able to decipher a sites planning principles will be a direct result of the duration and complexity of its political history (Ashmore 1989; Ashmore and Sabloff 2002:202; Tourtellot and Sabloff 1994:91).

Ashmore (1991:200) states that Classic lowland Maya cities used "repeated architectural elements" in their layout. Ashmore's analysis of Tikal (1991:200) outlines these elements:

1. Site organized around a marked north-south axis

2. Formal or functional dualism between north and south - twin pyramid groups.
3. Elements located to the east and west to form a triangle with the north, and frequent "suppression of marking the southern position."
4. Presence of a ballcourt marking transition between north and south
5. Frequent use of causeways to emphasize connections among the cited elements, thereby underscoring the symbolic unity of the entire layout .

Most archaeologists seem to agree that cosmology played a role in the layout of Maya communities. However, Ashmore and Sabloff's argument that the "position and arrangement of ancient Maya buildings and arenas emphatically express statements about cosmology and political order" (2002:201) is not without critics. Smith (2003, 2005) agrees that the spatial layout was likely tied to cosmological beliefs, but thinks that Ashmore and Sabloff's model was not backed by empirical evidence. Smith noted some scholars believe that research of this kind might be influenced by modern spatial paradigms and in order to infer cosmological influences "research in this area requires rigorous and explicit methods if it is to have credibility within the archaeological community" (2003:222). Smith stated that directional cosmology has little or no iconographic or epigraphic evidence and that Mesoamericanists should take a step back and think about whether "Mesoamerican cosmograms were ever expressed in architecture and urban planning" (2005:220). According to Smith, because we do not have written descriptions of the intentions of the ancient Maya rulers and elite, archaeologists should rely on empirical data in order to infer the cosmological meaning behind spatial planning (Smith 2007:6).

My research was not focused on whether the spatial layout of T'isil was meant to emulate the layout of any of the larger civic-ceremonial sites in the Yalahau region. Instead I chose to examine the site and look for the presence of any of the components or repeated architectural elements as outlined by Ashmore because the Late Preclassic/Early Classic transition was a period of significant socio-economic change in the Maya region. T'isil is not a large civic-ceremonial site and was occupied for a relatively short time period that spans the Late Preclassic/Early Classic transition and because of its short occupational history (and lack of architectural overburden) there is an opportunity to discover whether or how some of these planning elements might have been utilized during this earlier time period. The presence of these elements at this key transitional period in Maya history could illustrate a change in the ideology. The results of my analysis are presented in Chapter 6.

Conclusion

Clearly there is evidence at numerous Maya sites that some sort of deliberate and meaningful planning principles were being used. There seems to be a preponderance of evidence that ceremonial architecture in the Maya area can be interpreted as an ideological text that exhibits Mayan principles of cosmic and ancestral order. Cosmology is evident in the patterns of systematically calculated orientations, and changes in the patterns of orientation may well be linked to changes in ideology. Modification in the civic spaces of Maya sites may reflect "social change, conflict and political contestation" (Fox 1996:484).

These site planning principles have been exhibited at varying levels, from individual structures to site centers. Construction of architecture and space has its roots in Preclassic cosmological ideology that was later appropriated during the Classic and Post-Classic periods to reinforce and legitimize concepts of elite power when the nature of kingship was modified. Changes in the layout of many sites reflect a transformation from the supremacy of the sun and other celestial bodies, to the dominance of the Maya rulers who symbolically linked themselves and their ancestors to those same heavenly bodies.

Cosmology seemingly underlies the layout of all Maya sites, but the desire to emulate powerful civic centers as a means of enhancing political aura may have been the impetus for other sites to mimic the spatial order of those larger, more powerful centers. This can be seen archaeologically, although at those sites with longer and more turbulent histories this may be more difficult to discern. But whether the cosmological elements used by Classic Maya rulers were used in the spatial templates of smaller non-elite communities is another question altogether. Maya spatial planning can be very complex, but it is not impossible to peel back the layers to reveal the underlying principles that helped shape them.

CHAPTER 5: METHODS - SURVEY, MAPPING AND GIS

Introduction

Having provided the theoretical background on which my work is based in Chapter 4, I now turn to methods, or how the archaeological data used in my analysis was gathered. This chapter focuses on some of the methodological tools I employed in my analysis of the spatial patterning of T'isil. I begin with an overview of the survey and mapping methods that were utilized when collecting the raw data necessary for my analysis, followed by a description of the excavation methods used and radiocarbon dating. I then describe the use of Geographic Information Systems (GIS) and how I used this technology to provide me with the information I needed to test various spatial models. I finish the chapter with a discussion of statistical methods I employed using the data from my GIS analysis.

Survey and Mapping

Introduction and Overview

Scott Fedick initially visited and recorded the ancient Maya site of T'isil in 1993 during general reconnaissance of the Yalahau region (Fedick and Taube 1995). The site of T'isil is approximately 20 km west of Cancún, and about two km east of a large freshwater wetland (see Figures 2.1-2.2). T'isil is located on the private lands of Rancho Santa Maria, which was owned by Mr. Michael Baker during all mapping activities that were undertaken at the site from 1998 through 2007 (see Figure 3.2). Mapping and surface collection were initiated at the site in 1998, and off-structure test excavations have also been conducted over several seasons (Fedick 2000, 2001, 2002, 2004, 2005, 2006, 2009). In December of 2008, Rancho Santa Maria was sold to E-Sol International Corporation (ESIT), based in Reno, Nevada, U.S.A. Field research at the site of T'isil ceased after the 2007 season at the request of ESIT.

Mapping conducted at T'isil through 2007 has documented approximately 73% of the site, which covers an estimated 2.3744 km^2 (237.44 ha). A total of 1270 structures have been systematically mapped at the site, and an estimated 466 structures remain in the 27% of the site that remains unmapped (63.78 ha) (Figure 5.25).

Ceramic analyses indicate that the earliest occupation at T'isil occurred sometime during the Middle Preclassic period (ca. 700 B.C. – 450 B.C.), as indicated by ceramic groups Kin, Juventud, and Achiote. However, these represent less than one percent of all ceramics recovered through excavations (Ochoa 2004). The vast majority of ceramics obtained from both surface collections and excavations indicate that the main occupation at T'isil took place at the transition between the later part of the Late Preclassic and the early part of the Early Classic periods (100 B.C. and A.D. 350/450). The dominant ceramic groups include Tancah, Sierra, and Carolina (Ceja 2002; Ochoa 2004; see also Fedick 2004; Fedick and Mathews 2005). Depending on differing chronological assignments of some of the Late Preclassic/Early Classic ceramic groups, the main occupation of T'isil is represented by roughly 80-90% of all recovered ceramics (see Fedick 2004b). Small amounts of ceramics represent the Early Classic (e.g., ceramic groups Aguila, Batres, and Saban), and the Terminal Classic (e.g., ceramic groups

Dzibiac, Kukula, Muna, and Vista Alegre) with more certainty. Approximately five percent of the total ceramics were identified as Postclassic (e.g., ceramic groups Mama, Matillas, Navula, and Payil).

Summary of the Methods and Results: 1998-2005

Establishing the Mapping Grid

Mapping at T'isil has been an ongoing process since 1998. In that first year, general reconnaissance of the site was conducted, and a preliminary map was produced of some of the structures located in cleared fields and along an equestrian trail that passed through a forested section of the site (Fedick 2000). In 1999, the land owner began re-clearing and burning secondary vegetation in an old pasture in the northern half of the site. At that time, a 100-m interval grid was established and the resulting 100 x 100 m grid sections were subsequently used as the basic mapping units (Fedick 2000). The grid was established using an optical transit (Schneider TT-300/BD-3) and stadia rod, and a metric tape for smaller scale horizontal measurements. The grid was aligned to true north, with a declination set at 30 minutes east (in 1999). The southwest corner of each 100 m grid square was designated with numbers increasing from south to north, and letters running alphabetically west to east (the letter O was not utilized to avoid confusion with the number 0). The grid origin (0 northing, A easting) is an imaginary point located outside, and to the southwest of, the site perimeter (see Figure 5.1). Elevations for all grid points

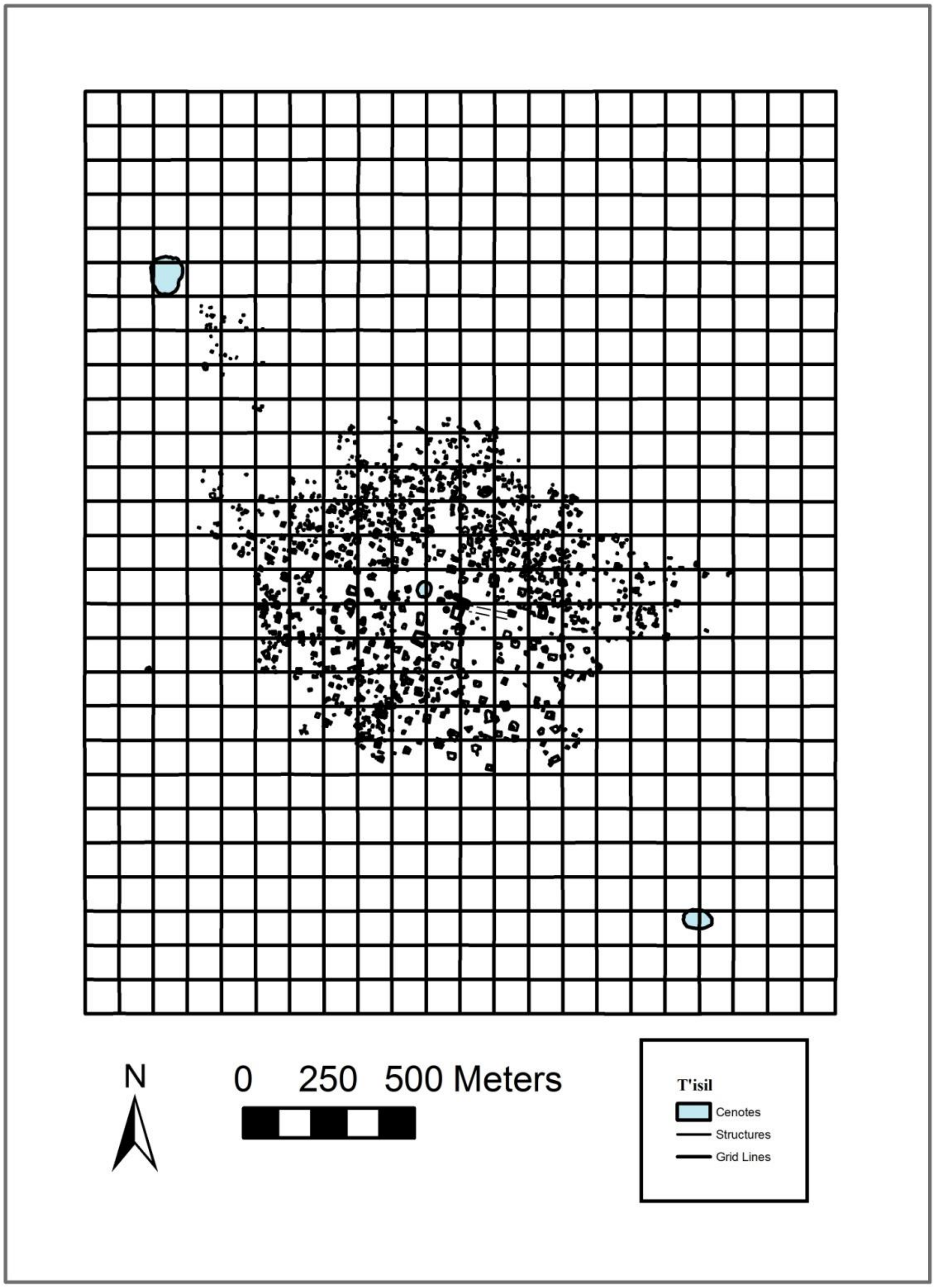


Figure 5.1. The T'isil Grid.

and subsequent site mapping are in reference to an arbitrary 40 m elevation assigned to grid corner 18E, the site datum. A Universal Transverse Mercator coordinate for grid corner 18E was established with the use of a Global Positional System receiver as Zone 16Q; 04-81-482 East, 23-34-395 North, in reference to the 1927 North American Datum of Mexico.

Computerized Mapping Methods

All data collected on standardized mapping forms were entered into a computerized database using Microsoft Access. This database is linked to a computerized Geographic Information System (GIS) mapping program (initially ArcView 3.0, then ArcGIS 8.0 beginning with the 2005 field season, and ArcGIS 9.3 for 2007). The GIS generates unique data layers for the mapping grid, mapping substations, and all points recorded during mapping each individual feature. Once the points have been entered into Microsoft Access and linked to the GIS, the points are joined to create outline forms for the structure or other feature as it appears in the field notes. This process was done on a daily basis in order to recognize and correct any errors in field recording or data entry. The final GIS version of the T'isil map is referenced to the Universal Transverse Mercator grid.

Field Mapping Methods

Feature Designations

Features were numbered sequentially in each 100 m X 100 m grid section. Feature designations and abbreviations are: structure (STR), property wall (PW), *chich* mound (CH), *sacbe* or roadbed (SB), feature of undesignated function (FEAT), *cenote* (CN), and micro-*cenote* or other small natural cavity (CV). The full designation for a feature would include the grid section designation and the feature number, such as 12K-STR-11 (Structure 11 located within grid section 12K). In the case of structures, when one or more foundations or substructures are present on top of a numbered structure (usually a large platform), each substructure is identified by a letter. For example, if Structure 11 is a platform that supports three smaller substructures or foundations, the platform is designated STR-11, and the substructures are STR-11a, STR-11b, and STR-11c.

For mapping purposes, a structure is defined as a foundation of limestone blocks with rubble fill that at one time supported a perishable pole and thatch structure, or wall braces placed on limestone bedrock that also could have supported pole and thatch. Property walls are defined as free-standing walls built of limestone. *Chich* mounds are low piles of gravel not more than 3 m in diameter, often with a perimeter of larger cobbles. A *sacbe* is defined as a raised, limestone roadbed, while a feature is any man-made structure of indeterminate function. *Cenotes* are defined as large sinkholes with rocky limestone edges that are connected to the water table, or are seasonally inundated with water. A micro-*cenote* is defined as an opening in the limestone that is wide enough and possibly deep enough to fit a vessel of some sort, with the idea that if cleared, it might reach to the water table.

Mapping Methods in Cleared Areas

Mapping crews consisting of three to four project members first surveyed a grid section, and marked each feature with flagging tape. Before beginning the mapping of features, they set up an optical transit on a known grid point, and used the known point to establish a temporary mapping datum or substation near a feature or group of features. Crew members conducted mapping at a scale of 1:200 (1 cm = 2 m). Crew members recorded the data collected on standardized forms (see Figure 5.2 Standardized Mapping Form). Crew members then drew maps of each individual structure or feature on printed graph paper (see Figure 5.3) by hand while in the field to check the accuracy of points taken. Teams used a Brunton pocket transit (International model) mounted on a tripod, and metric tapes for mapping individual features. A hand-level (5 X magnification) and stadia rod measured elevations for each mapping point relative to the mapping datum. Enough data are compiled while mapping each structure to provide measurements of the approximate volume of each individual structure as well as features of undetermined function represented by rubble mounds. Mapping points taken at corners or angles along the outside perimeter of the rubble mounds (designated outside points), and corresponding points taken along the upper edge of rubble mounds (designated inner points) provided the data used to calculate volume. When a structure or feature was small and had no discernable elevation, crew members mapped outer points, with one

Proyecto Yalahau		Data Entered ____		Page __ of __		Names:	Date:
Section	Station/Pt.	HI	H. Angle	Distance	Middle	Damage	Comments

Figure 5.2. Standardized Mapping Form.

Proyecto Yalahau Page ___ of ____ Names: ______________ Date:________________

____ Data Enterec

1cm = 2m

Section	Structure Numbers	Substation UTM Coordinates	Accuracy

Figure 5.3. Map Grid Form.

inner point taken at the highest location. Features mapped as *chich* mounds are represented as single points (the point being recorded at the center of the mound), with the diameters of the *chich* mounds recorded on the standardized mapping forms. After completion of mapping, crew members labeled each feature with an inscribed aluminum tag attached by wire to a rock and placed on a small pile of rocks located on top of the feature.

Project members mapped the cleared area of the site during the 1999-2001 field seasons (Fedick 2000, 2001, 2002). Prior to each season of mapping, the land owners cut and burned the low annual growth, resulting in excellent ground visibility for mapping (Figure 5.4). Toward the end of each mapping season, as rains set in, the fields were sown with grass seed that quickly covered the fields, providing pasture for cattle (Figure 5.5). Mapping of the main cleared area produced a cross section of the site, extending beyond the bounds of the site to the east and west, and covering a total area of 55.18 ha (Figure 5.6). Mapping was also completed at that time within a cleared field located north of the west end of the main cleared area that covered another 5.25 ha (Figure 5.6). The cleared fields surveyed in 1999-2001 cover 60.43 ha.

Two smaller cleared areas were systematically surveyed in 2005 (Fedick 2006). The first additional cleared area is a citrus orchard of 5.68 ha located adjacent to the west end of the main cleared area, centered on grid section 16D (Figure 5.6). We recorded no structures or features in the citrus orchard. The second small cleared area of 1.39 ha surrounded a horse corral adjacent to the east end of the main cleared area, centered on

Figure 5.4. Area of T'isil cleared by annual burn (Photo by Scott Fedick).

Figure 5.5. Burned area covered with grass (Photo by Scott Fedick).

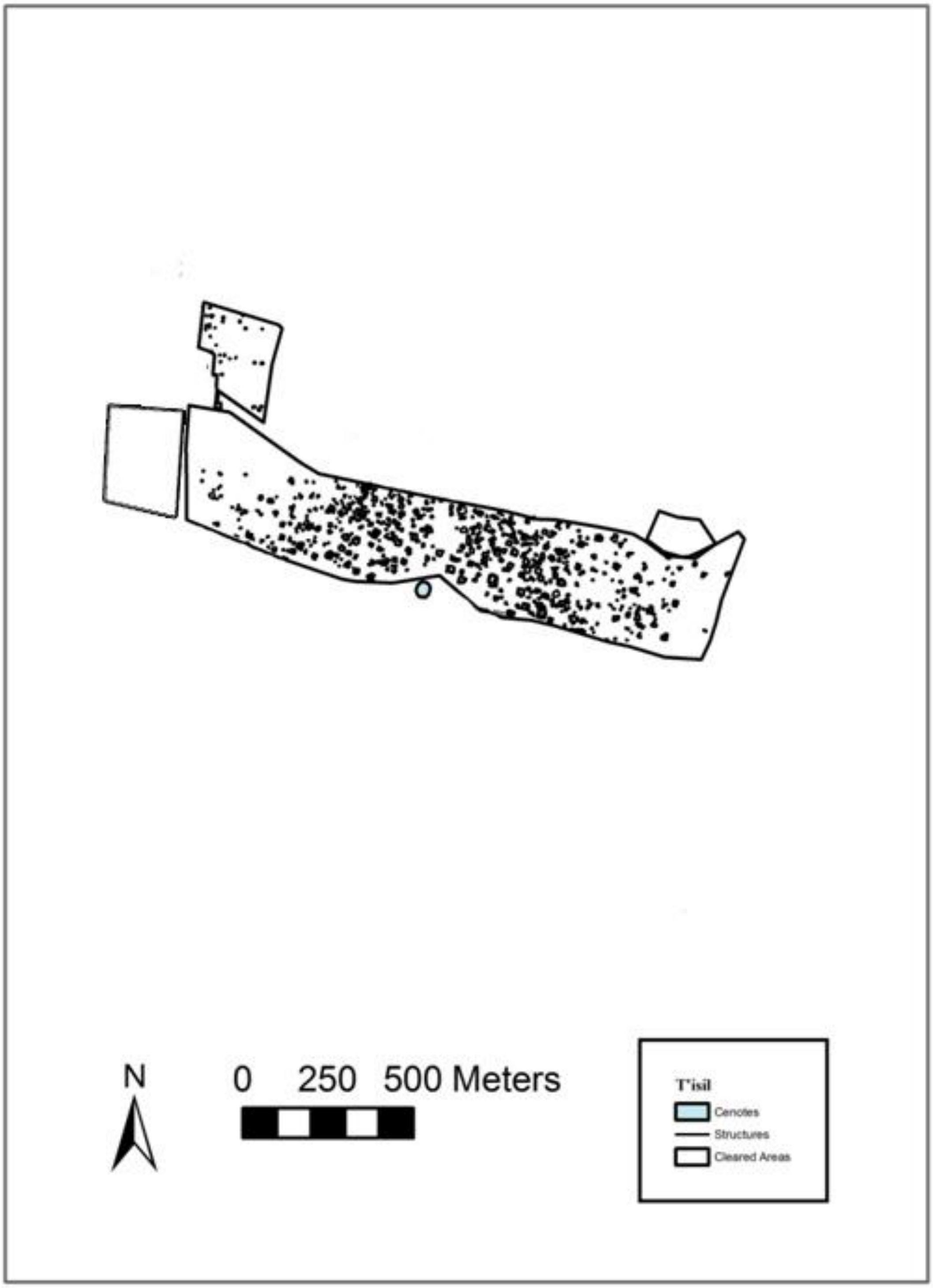


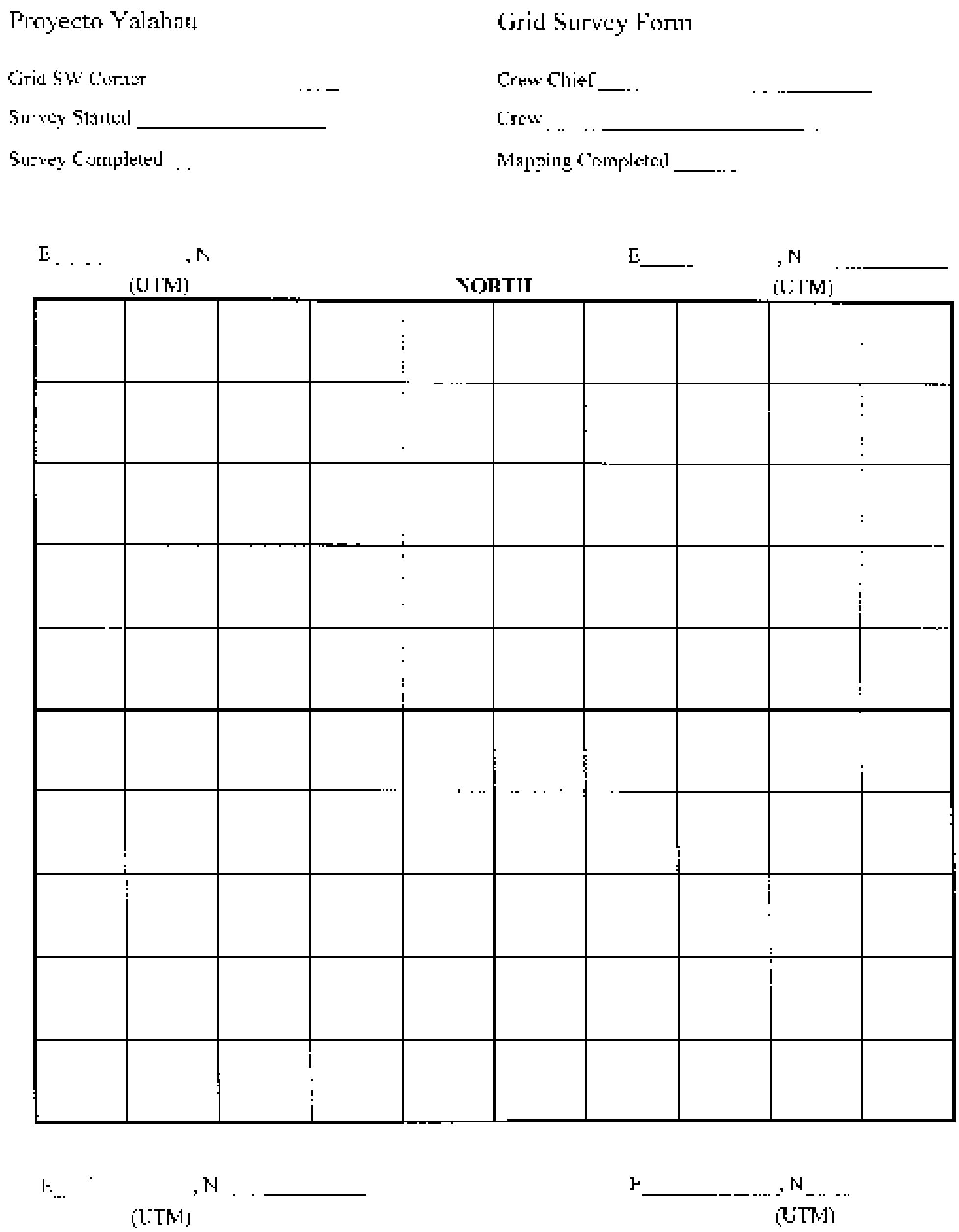
Figure 5.6. Map of Cleared Areas (Outlined).

grid section 14U (Figure 5.6). The corral area contained no ancient structures, but we recorded two large, upright limestone slabs (Figure 5.6). Mapping within the cleared areas of the site resulted in the recording of 550 structures, 200 *chich* mounds, 23 features of undetermined function, 38 property walls, three *sacbe* segments (recorded as a single feature, as formed a single alignment), and 25 micro-*cenotes*. It should be noted that these final counts for mapped features in the cleared area vary slightly from those supplied in the earlier annual reports, as the designations for some features were altered when the definition of *chich* mounds was clarified from being smaller than 3 m in diameter to an area of less than 7.07 square meters (the equivalent area of a 3 m radius circle). Beginning with the 2001 field season, mapping was extended into the forested areas of the site to the south, applying the same mapping procedures used in the cleared areas. Mapping in the forest included all or part of nine grid sections, and resulted in the recording of an additional 25 structures, one feature of undetermined function, one wall, and two micro-*cenotes*. Using the same mapping procedures in the forest as had been applied in the cleared area of the site proved to be inefficient, requiring a substantial amount of work with machetes to clear the sight-lines for the optical transit that were needed to establish mapping datums for individual features or clusters of features.

Mapping Methods in Forested Areas

Mapping at T’isil was resumed in 2004 with modifications of earlier methods intended to increase the speed of field work while minimizing disturbance to the forest surrounding the remainder of the site (Fedick 2005; Sorensen 2005). Beginning in 2004, a Global Positing System (GPS) receiver (Garmin 76S) was used instead of an optical transit to extend the mapping grid in the forest and to establish individual mapping datums. The mapping director provided a list of grid corners and the corresponding UTM coordinates to each field crew to assist in identifying grid corners and boundaries. As in previous seasons, mapping crews of three to four project members conducted the survey, but rather than establishing 100 m grid sections with an optical transit, one crew member used a GPS receiver to keep track of the approximate boundaries of the grid section in which they were working. Crew members identified structures and features, marked them with flagging tape, and a rough map of the grid section was sketched on a standard form (Figure 5.7) as the survey was conducted.

After the completion of survey in one or more grid sections, the crew returned to conduct formal mapping. They used a GPS receiver to establish the mapping datum for each feature, or cluster of spatially associated features. The GPS receivers have an averaging function that can provide locational data with increased accuracy. Crew members let GPS units run continually for a period of time until enough locational points had been collected to average the data for greater accuracy. Our procedure for establishing each mapping datum involved averaging at the location for about 45 minutes, generally resulting in a position that was estimated by the receiver to be within one meter of horizontal accuracy. While the horizontal accuracy of GPS positions is quite good, the vertical (elevation) aspect of positions is problematic, and therefore was not used for mapping in the forest. When using the GPS to establish a mapping datum,



Proyecto Yalahau

Grid Survey Form

Grid SW Corner ____

Crew Chief ____

Survey Started ____

Crew ____

Survey Completed ____

Mapping Completed ____

E ____ , N ____ (UTM)

NORTH

E ____ , N ____ (UTM)

E ____ , N ____ (UTM)

E ____ , N ____ (UTM)

Figure 5.7. Grid Survey Form.

we assigned an arbitrary elevation of 40 meters because the actual elevation was unknown and the terrain relatively flat. Other than assigning a uniform arbitrary elevation for each GPS-established mapping datum, the methods used for mapping structures and features remained the same as in previous seasons. Mapping in 2004 took place in 16 forested grid sections, resulting in the recording of 39 structures, one *chich* mound and two micro-*cenotes*.

The 2004 mapping methods proved to be nearly as accurate (in the horizontal plane) as the previously-used optical transit method. This was demonstrated when a field crew mapped the southern half of structure 13H-STR-07. The northern half of this structure is in the cleared area of the site, and had been mapped in reference to a datum that had been established using the optical transit. The southern half, located in the forested area of the site, was mapped from a separate datum established with the GPS. When data for the southern half of 13H-STR-07 was entered into the GIS, it aligned almost perfectly with the northern half (Figure 5.8). It is important to note that visibility in the forest (as opposed to the cleared area) may have limited the identification of less obvious features such as *chich* mounds and low structure foundations, however, final comparisons of mapping results between the cleared and uncleared areas do not appear to differ in any significant degree for the number of structures and features recorded.

Mapping during the 2005 field season proceeded with the goal of mapping everything within a 500 m radius of Cenote T'isil. The teams used the GPS mapping method once again, this time using Garmin GPS V units, following the same procedures

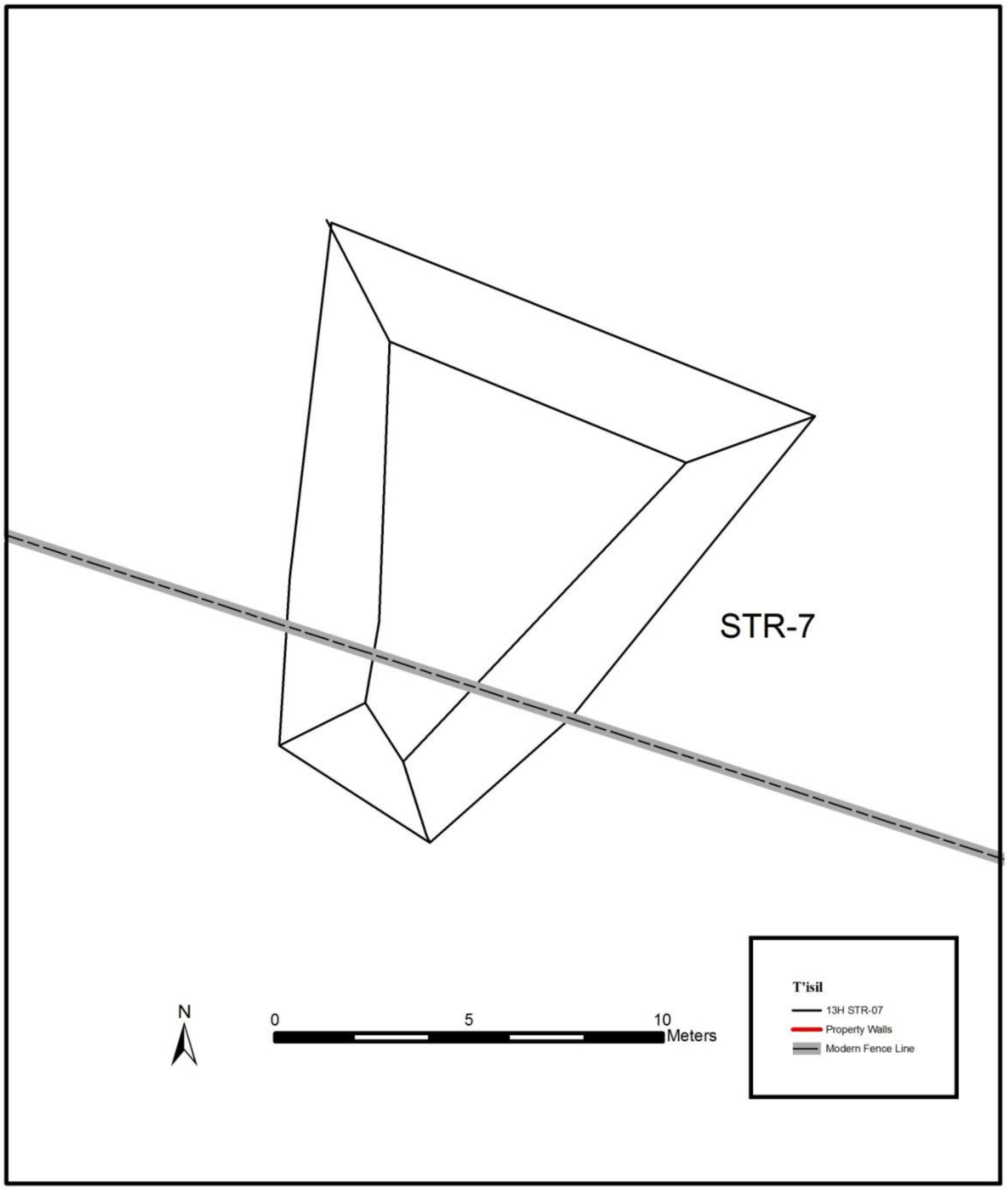


Figure 5.8. Structure 13H STR-07. The north side of the structure was mapped using the transit method, while the southern side was mapped using the GPS method.

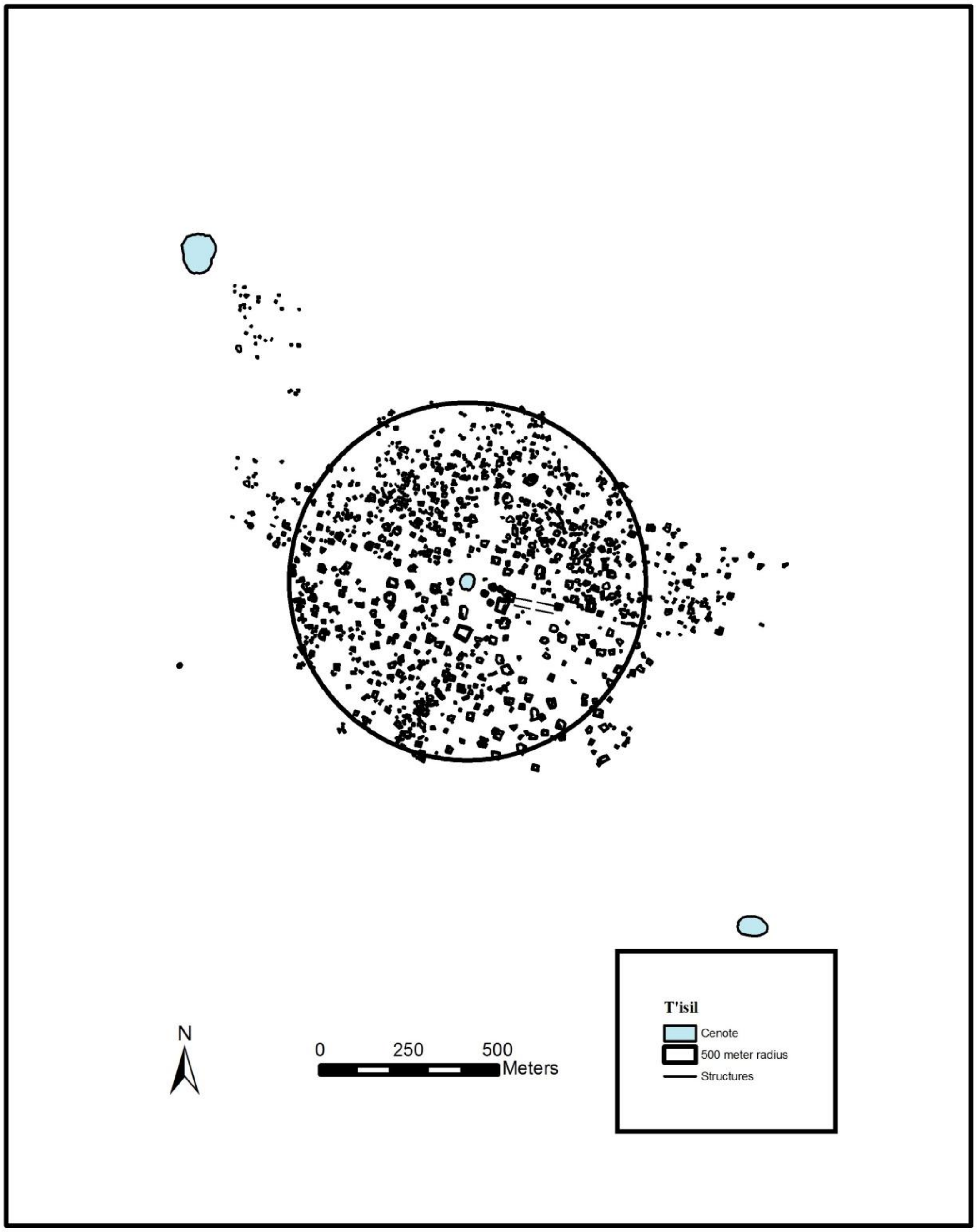


Figure 5.9. The 500 meter radius study area (Outline by circle).

described for 2004. Ultimately, we mapped everything within our target area of the 500 m radius (Figure 5.9). We conducted mapping during the 2005 season in 69 grid sections, resulting in the recording of 509 structures, 60 *chich* mounds, 17 walls, 40 features of undetermined function, and 35 micro-*cenotes*.

Mapping at T'isil, 2007

Our intended goal for mapping during the 2007 season was to extend mapping outward and into the forest from the 500 m radius area (centered on Cenote T'isil) that had been previously mapped, until the remainder of the site map was completed. Upon arrival at the site in 2007, we found that the unmapped southern portion of the site was choked with an almost impenetrable cover of fallen trees and new vegetation that consisted of dense, thorny brush and vines that were the result of hurricane Wilma in October of 2005 and the subsequent forest fires that ravaged the area in 2006 (Figures 5.10). Fortunately, the cleared field that forms an east-west cross-section of the site had acted as a fire break, protecting the northern area. As a result, mapping was confined to the northern section of the site that remained untouched by the fires (Figure 5.11). Mapping conducted during the 2007 field season used the standardized methods developed in 2004 for mapping in the forest (described above). We recorded a total of 74 structures, nine *chich* mounds, nine property walls, three features of undetermined function, and four micro-*cenotes*/caves in 2007.

Between the years of 1999 and 2007, we systematically surveyed and mapped a total of 2.3265 km^2 (232.65 ha) at the ancient Maya site of T'isil (Figure 5.12). Within

Figure 5.10. Damage from Hurricane Wilma.

Figure 5.11. Northern portion of site untouched by fire (Photo by Scott Fedick).

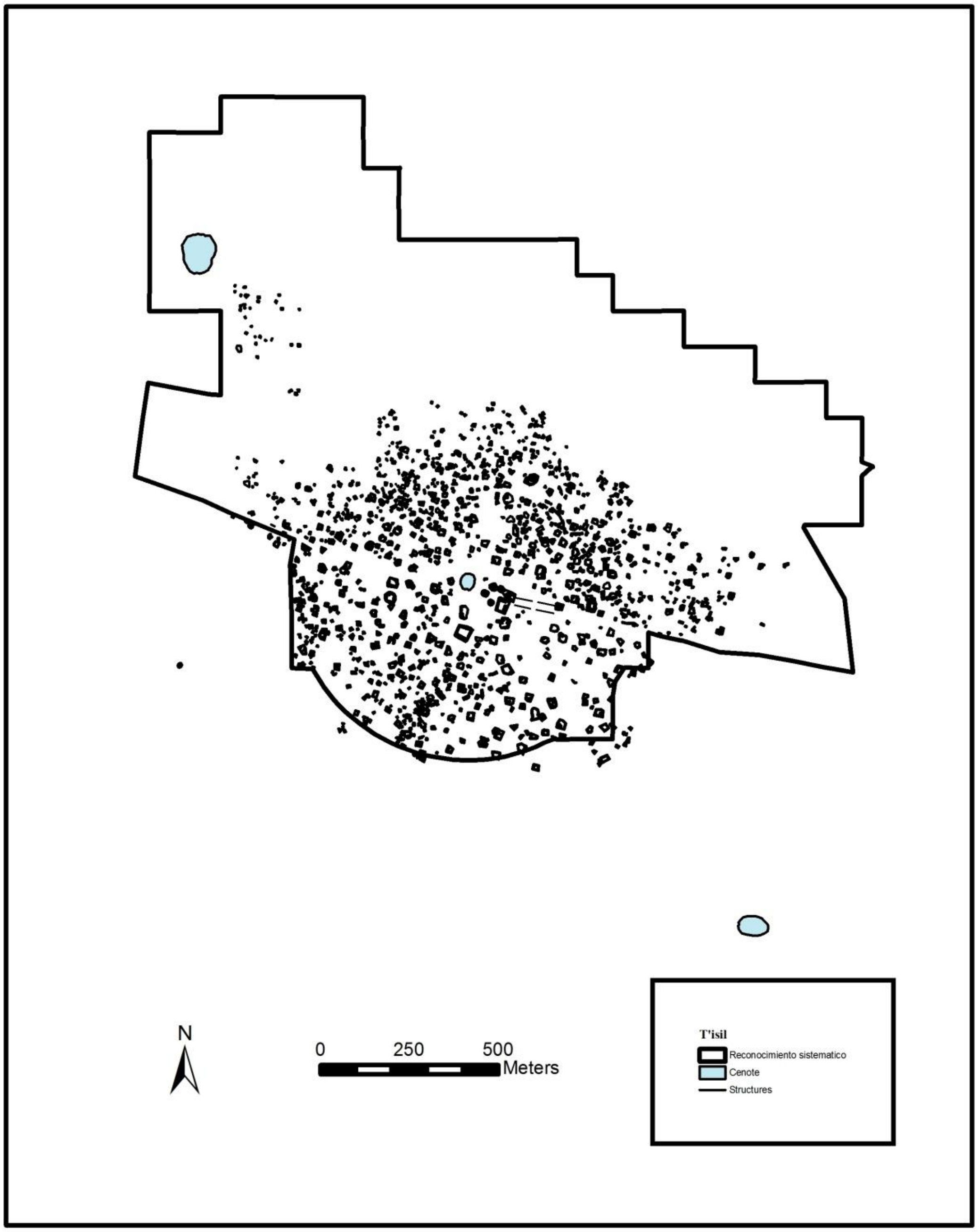


Figure 5.12. Systematically mapped area of T'isil (Outlined by heavy black line).

the systematically surveyed area of T'isil, a total of 1784 features were mapped, consisting of 1270 structures, 301 *chich* mounds, 65 property walls and 53 features of undetermined function, one *sacbe* (roadbed), eight *cenotes*, as well as 86 micro-*cenotes* or caves. Included at the back of this dissertation is a summary of all the features that have been systematically mapped at T'isil (Appendix A), and maps of all 210 systematically surveyed grid sections (Appendix B).

Architecture and Other Features at T'isil

Architecture at T'isil is heavily dominated by residential structures represented by low foundations and platforms constructed of limestone rubble with few dressed stones. A few structures are represented by wall braces of limestone boulders placed directly on bedrock (e.g., structure 13R-STR-1 - see Figure 5.13). We have mapped a few platforms of rather substantial proportions (Figure 5.14), and three pyramidal structures (Figure 5.15 and Figure 5.16). The 1270 structures systematically mapped at T'isil cover a total basal area of 101,495.24 m^2, and a total volume of 66,066.192 m^3. A list of all structures mapped is provided in Appendix A.

The largest structures at the site (in terms of volume) are two platforms, 10L-STR-13 (Figure 5.17) and 11M-STR-6 (Figure 5.18). Platform 10L-STR-13 measures roughly 41 m by 39 m, with a basal area of 1517 m^2, a maximum height of 4.16 m, and a volume of 3209 m^3. Platform 11M-STR-6 measures roughly 38 m by 31 m, with a basal area of 1174 m^2, a maximum height of 3.2 m, and a volume of 2198 m^3.

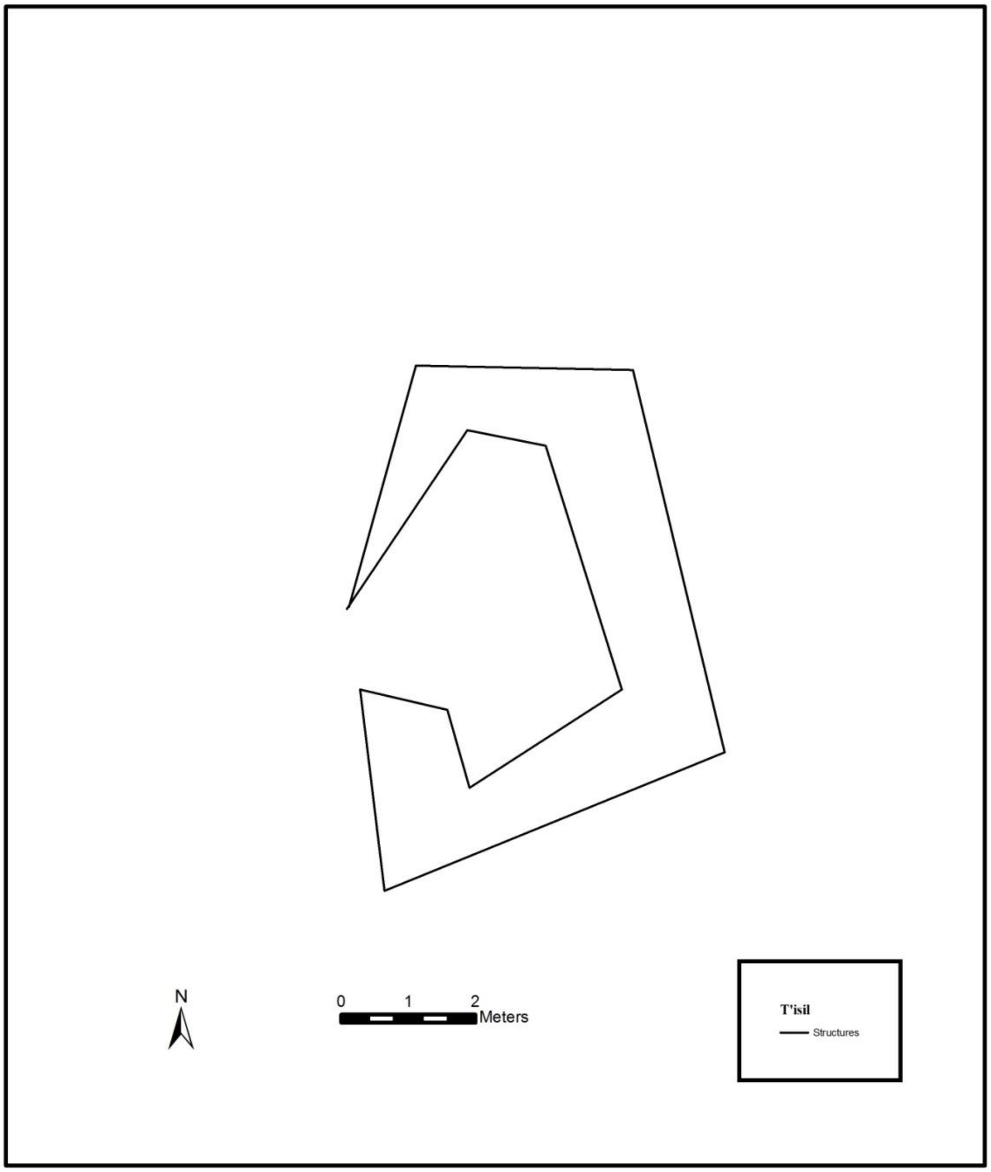


Figure 5.13. Structure 13R-STR-1, limestone boulders placed on bedrock.

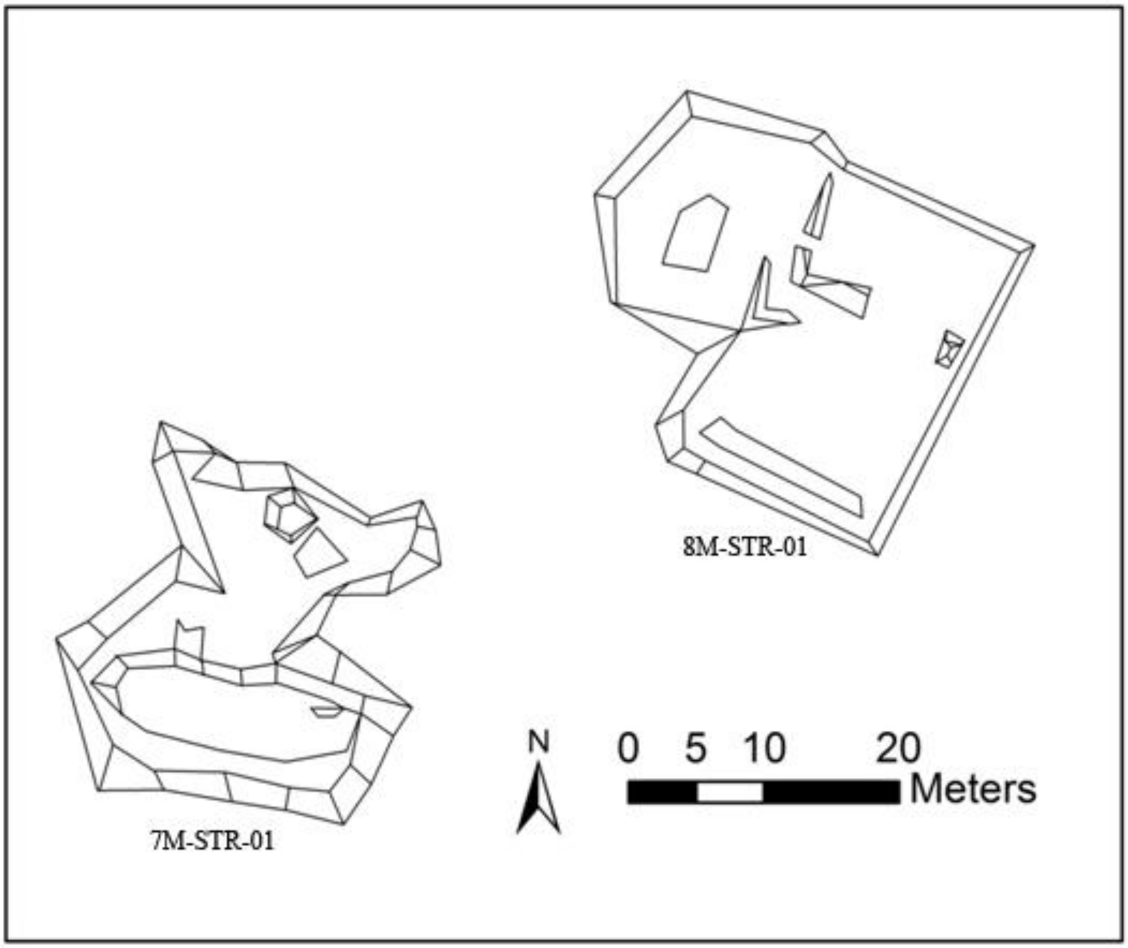


Figure 5.14. Structures STR 7M-01 and STR 8M-01, two of the more substantial platforms at T'isil.

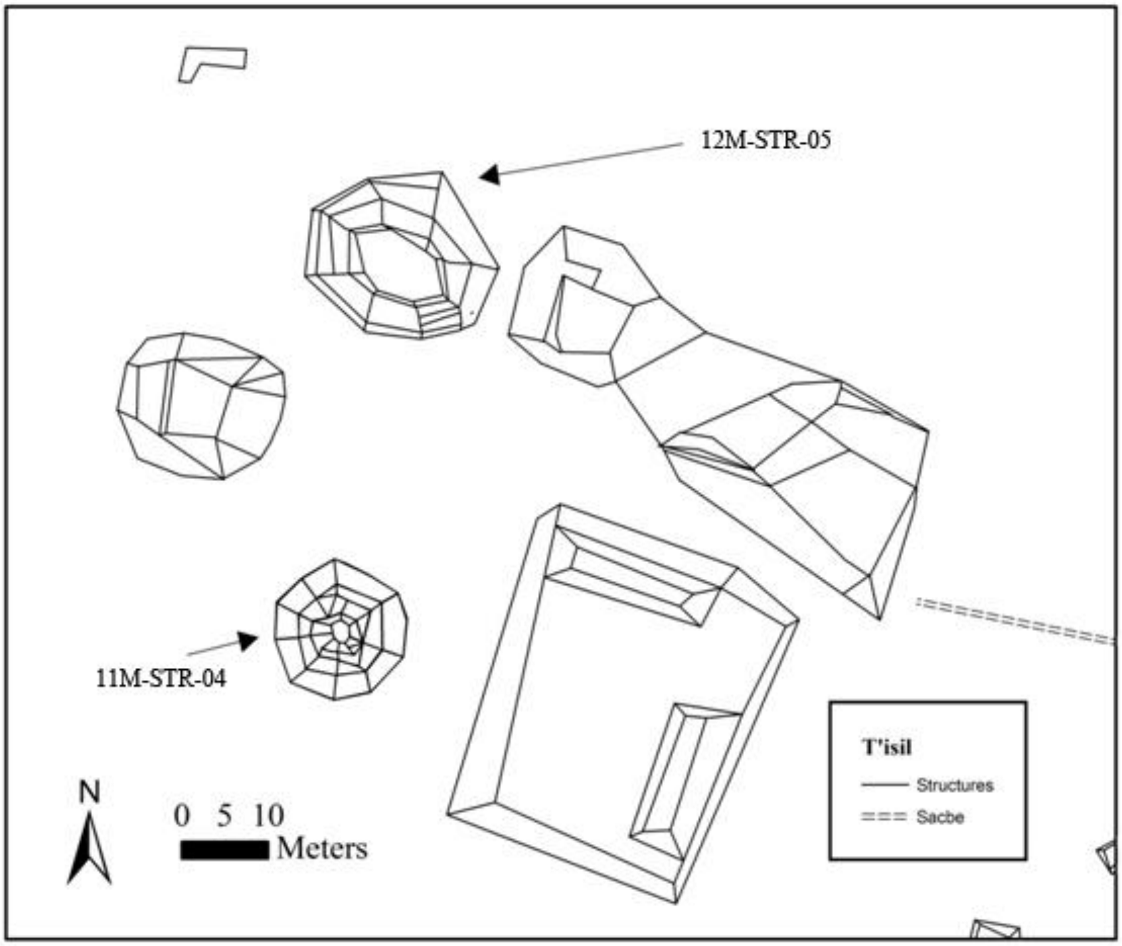


Figure 5.15. Structures 12M-STR-05 and 11M-STR-04, two of three small pyramids at T'isil.

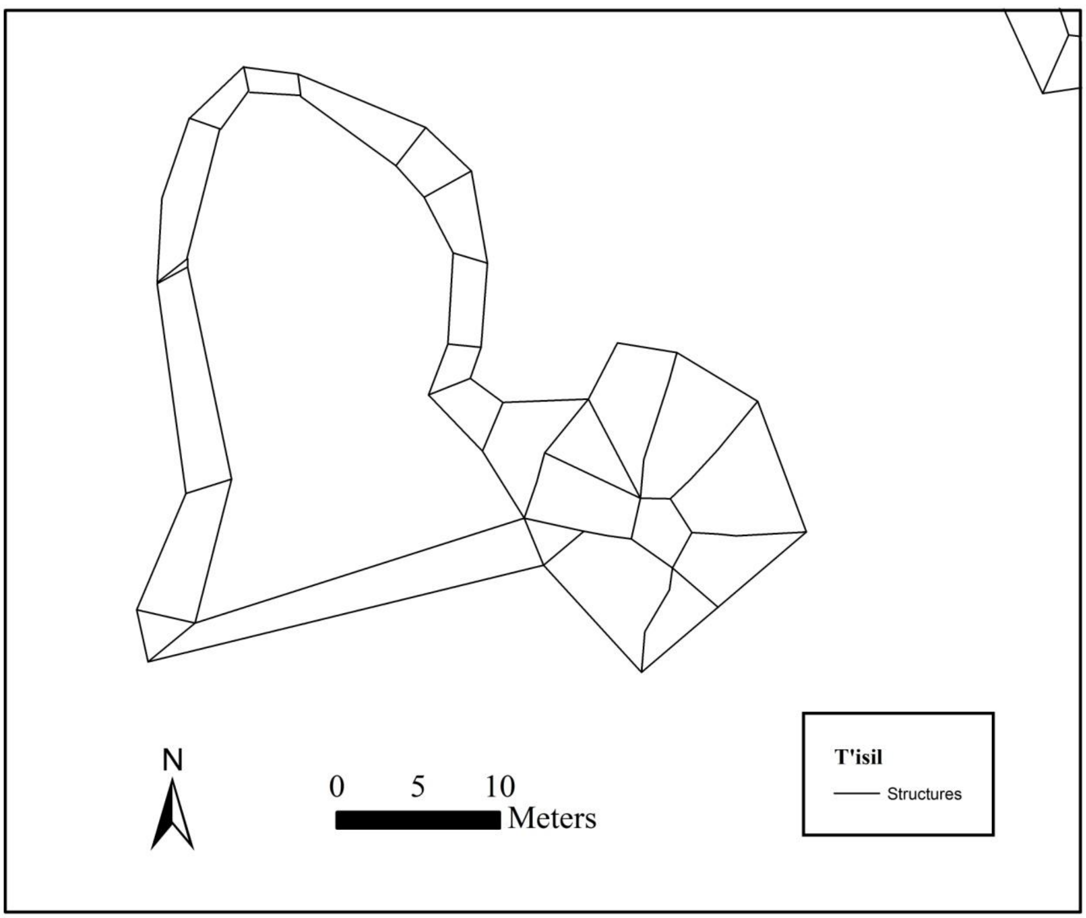


Figure 5.16. Structure 8P-STR-01, a large platform with attached pyramid and the third small pyramid at T'isil.

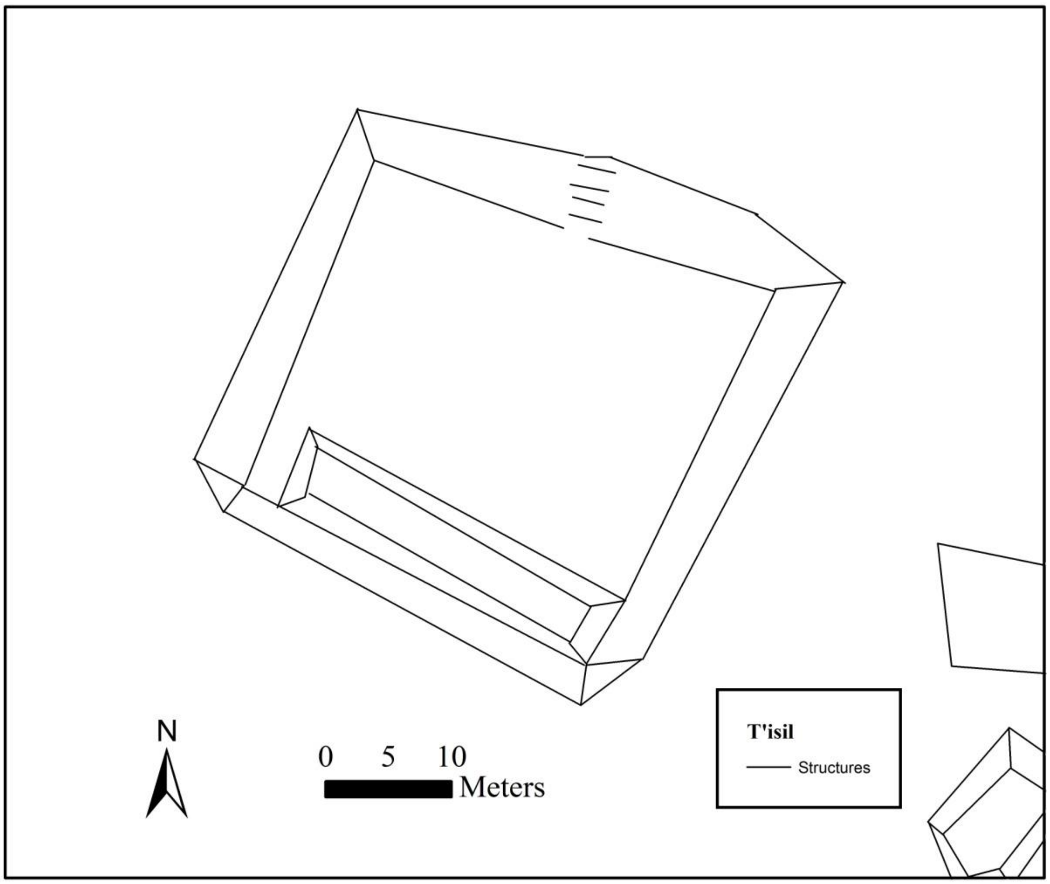


Figure 5.17. Structure 10L-STR-13.

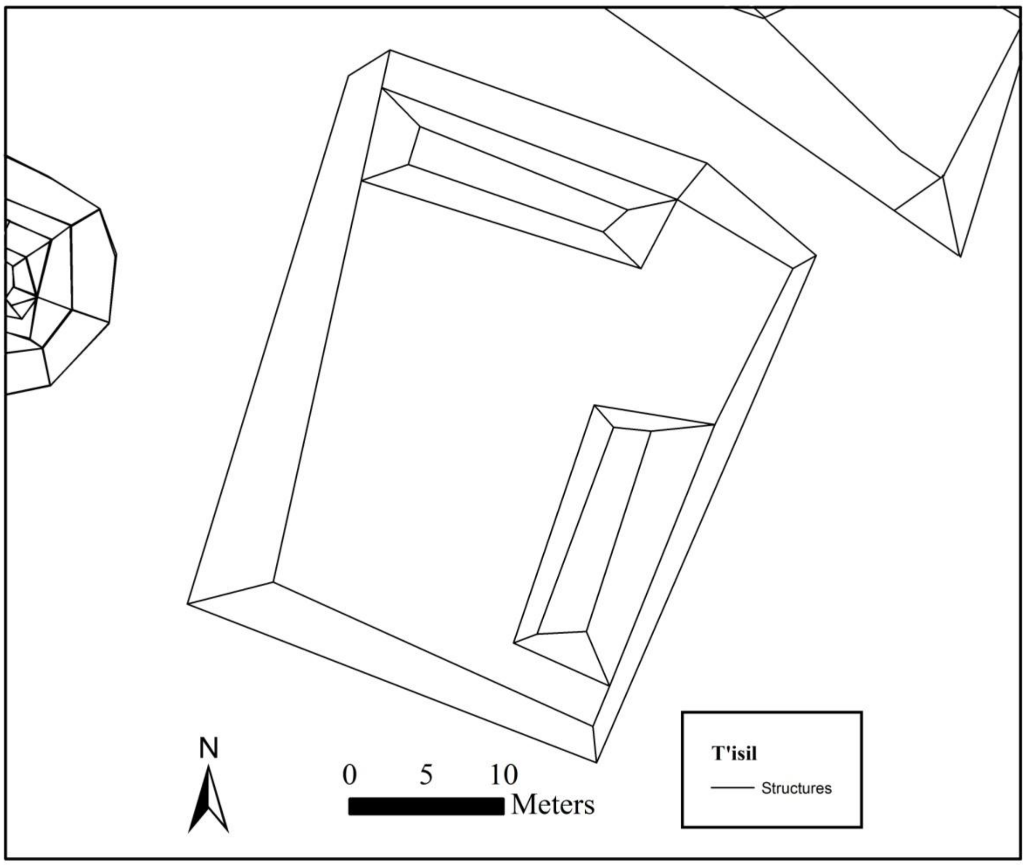


Figure 5.18. Structure 11M-STR-06.

Three pyramidal structures are recorded for the site, 12M-STR-5, 11M-STR-4, and 8P-STR-1. Pyramid 12M-STR-5 (Figure 5.15) has a maximum height of 8.5 m, a basal area of 325 m^2, and 1708 m^3 of volume. Looters dug into the north side of pyramid 12M-STR-5 prior to initiation of mapping at T'isil. Pyramid 11M-STR-4 (Figure 5.15) has a maximum height of 4.8 m, a basal area of 186 m^2, and 309 m^3 of volume. Pyramid 8P-STR-1 (figure 5.16) has a maximum height of 3.3 m, a basal area of 882 m^2, and 1415 m^3 of volume. Pyramid 8P-STR-1 has a looter's pit on the top-center of the structure.

Of particular interest are two structures centered at the northern boundary of the site that may represent a ballcourt (Figure 5.19). These parallel structures (18P-STR-1 and 18P-STR-2, Figure 5.20) are similar in size and orientation to Preclassic ballcourts recently reported for the northwestern Yucatán Peninsula by the Proyecto Costa Maya (Medina 2003; Robles and Andrews 2003).

Chich mounds (CH) are common features at the site, numbering 301 in total. These gravel and cobble mounds are often ringed by larger rocks that serve as retaining walls. By our definition, *chich* mounds are less than 3 m in diameter or 7.07 m^2 in area. While mapping of *chich* mounds in the cleared area of the site is probably complete, the number of mapped *chich* mounds in the forested area of the site may be lower than the actual number present due to ground cover by vegetation.

We systematically mapped 65 dry-laid rock property walls (PW) at T'isil. In general, these walls were probably no more than two or three courses in height, and we interpret them to most likely have functioned as boundary walls between family compounds or *solares*. Some walls extend over the top of structures or platforms (e.g.,

Figure 5.19. Photo of possible ballcourt at T'isil. Crew members are standing on top of the parallel structures.

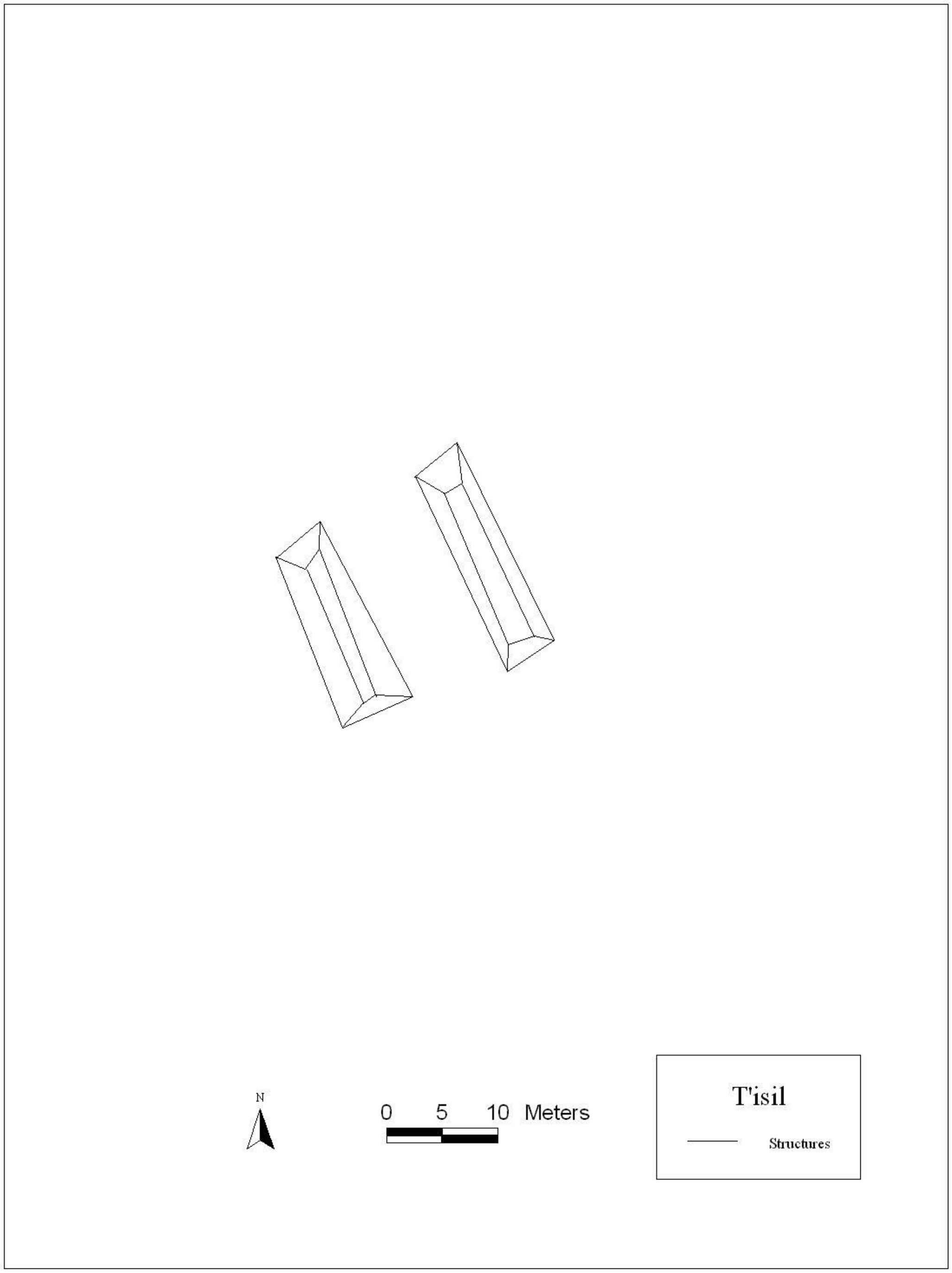


Figure 5.20. Map of possible ballcourt, Structures 18P-STR-1 and 18P-STR-2.

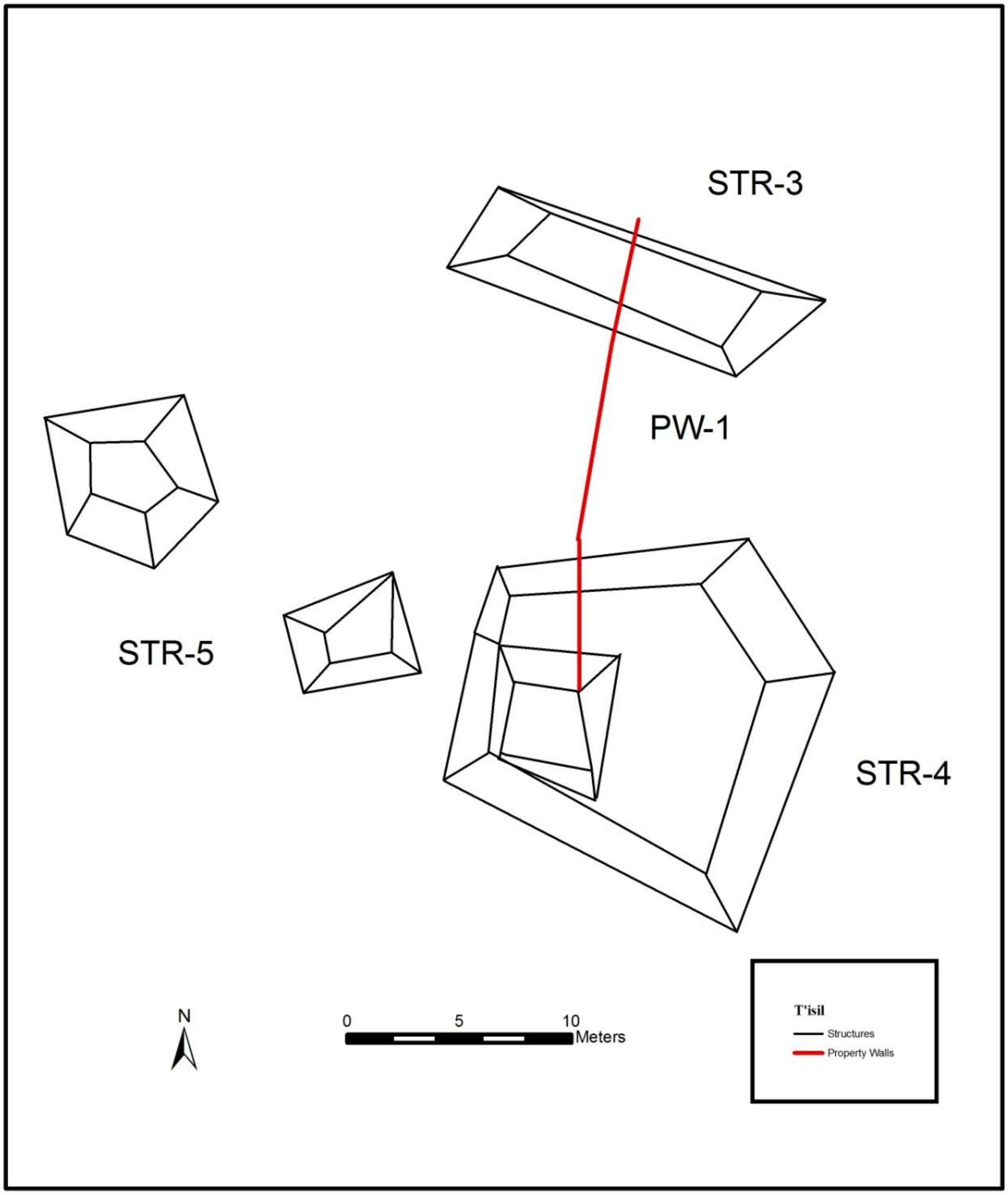


Figure 5.21. Structure 7K-STR-03 and 7K-STR-04 with rock wall running over the top of two structures.

wall 7K PW-01 built over the top of structures 7K STR-03 and 7K STR-04, Figure 5.21), suggesting that they had been constructed after the underlying structure was abandoned. While walls are generally made up of unfaced limestone boulders and cobbles, wall 15N-PW-1 contains many large, faced stones, and appears to have been more carefully laid in a straight line than other walls at the site, including the extension of wall 15N-PW-1 that runs west and then south from the main wall. Without further research and excavation of the rock walls, it is not possible to determine the time of construction but they do appear to be ancient. We mapped a *sacbe* (11N-SB-1 (Figures 5.22 and Figure 5.23), or roadbed, at the site running roughly east from a plaza near the center of the site for approximately 115 m. A segment of the *sacbe* on the west end is particularly well preserved, while the remainder of the length is represented by two segments that are less preserved.

We believe that nearly all architecture and other features at the site date to the main occupation period during the Late Preclassic/Early Classic transition. Postclassic architecture seems to be represented by only a few small wall-braces on top of the largest platform at the site (10L-STR-13), a C-shaped structure on top of the second largest platform (11M-STR-6), a temple added to the top of the largest pyramidal structure (12M-STR-5), and several miniature shrines in the central area of the site (Hoover 2003).

Site Boundaries

In order to determine the boundaries of the site, crew members under the direction of Scott Fedick carried out a series of survey transects, completed during the 2005 field season. Fedick and crew members cut breccia lines through the forested area of the site

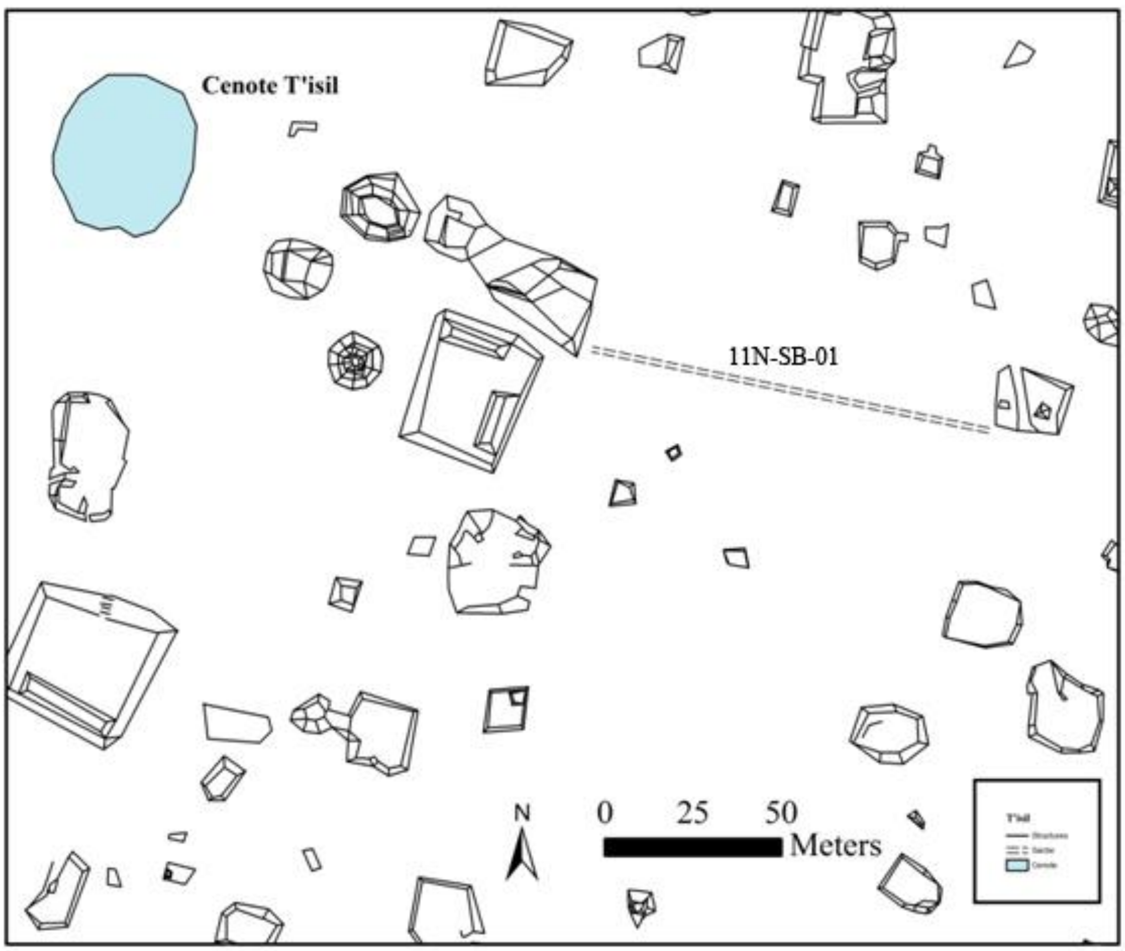


Figure 5.22. Map showing location of *sacbe*, represented by dashed lines.

Figure 5.23. Photograph of *sacbe* segment at T'isil.

of ceramic sherds of all structures and features in the cleared area of the site recovered during a previous surface collection; 2) it had the greatest variety of ceramic types; and following the grid system used for mapping, ending only when they saw no evidence of structures for at least 200 meters in a row. Transects were conducted from north to south along the H, L, Q, S, V and W lines, and from east to west along the 4, 8, 10, 12, 15, 16 and 17 lines (Figure 5.24).

We estimated a new boundary for the settlement area of the site by drawing a line around the outermost structures of the systematically mapped area as well as the outermost structures recorded by the boundary survey in the southern portion of the site where systematic mapping was not completed. This new settlement boundary includes at least 20 m of space between the outermost structures and the boundary line. The newly defined site boundary (Figure 5.25) defines a site area of 2.3744 km2 (237.44 ha). Given the estimated site boundary, a total of 1.7366 km^2 (173.66 ha) of the site has been systematically mapped, leaving an estimated 0.6378 km^2 (63.78 ha), or about 27% of the estimated total site area, that has not yet been mapped (Figure 5.25).

Excavation Methods and Radiocarbon Dates

During the 2003 field season a series of subsurface test excavations were carried out (Fedick 2003). One of the main goals of the subsurface testing was to recover samples of carbon from occupation strata suitable for radiocarbon testing for determining the occupation dates for the site. The structure that yielded the materials selected for

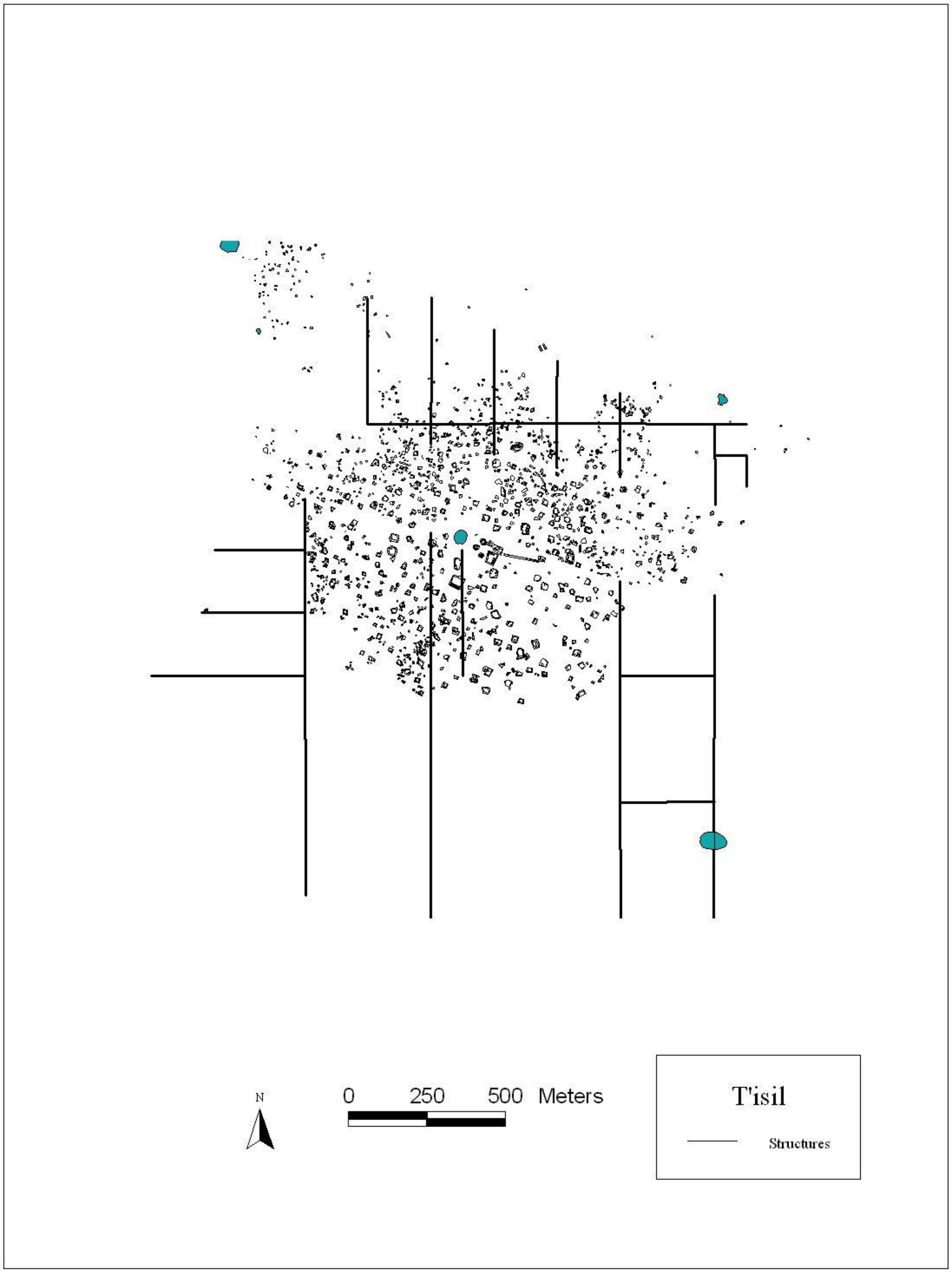


Figure 5.24. Transect survey lines at T'isil.

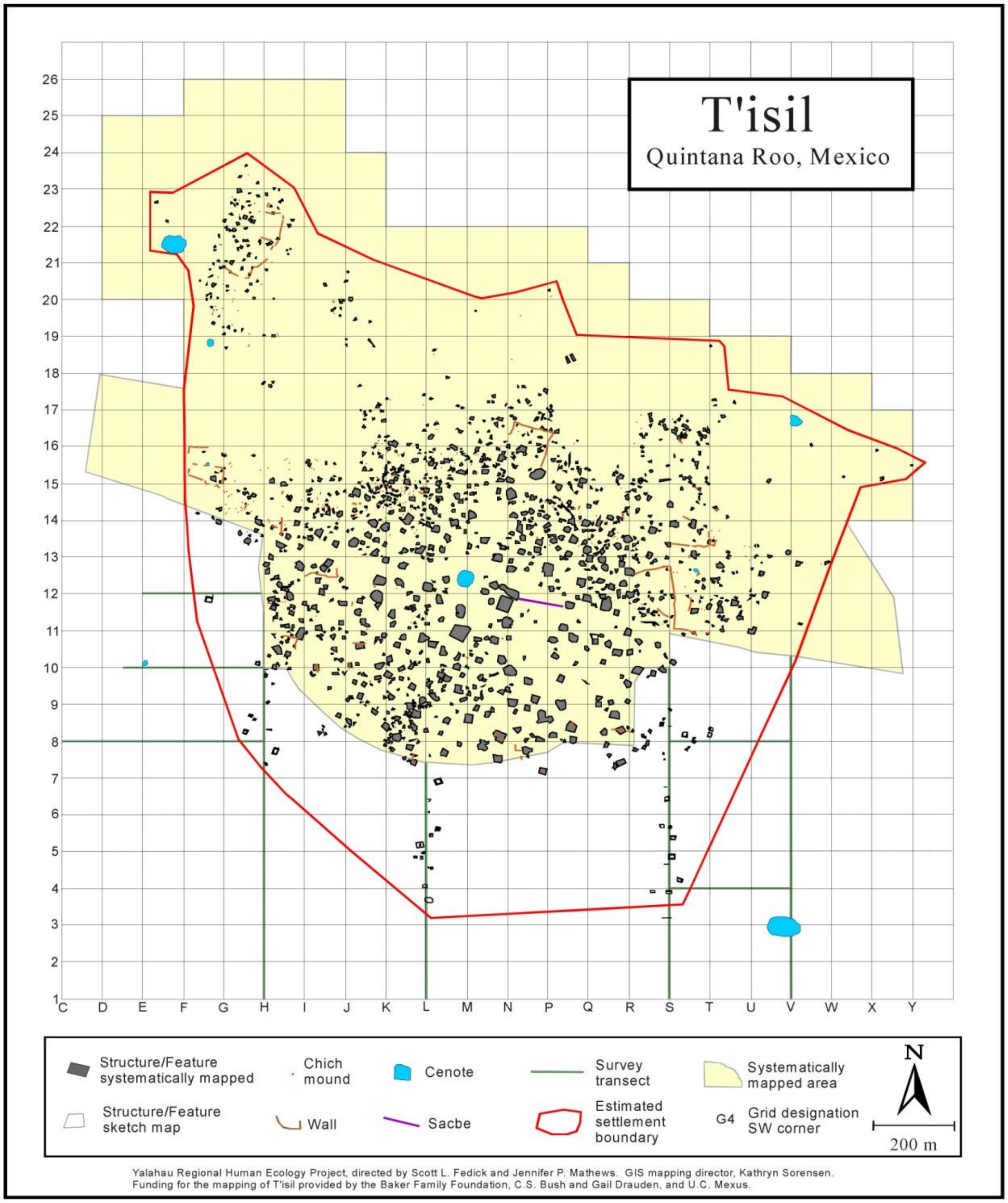


Figure 5.25. Site Boundary defined in 2007.

radiocarbon dating was 13M STR-2, a platform structure whose dimensions are roughly 1.5 m high and 400 m^2. We selected this structure because: 1) it had the greatest number 3) it contained deep soil deposits, which is a rarity at T'isil. A field crew excavated three 1 x 2 m test pits (Figure 5.26) adjacent to structural collapse on the southern side of the structure were in arbitrary 10 cm levels (no stratigraphy was evident). Detailed excavation results are presented in Appendix B.

A total of eighteen faunal specimens recovered from these units were selected for radiocarbon dating. A UCMEXUS dissertation improvement grant awarded to me provided funding for the dating of the specimens by the University of Arizona AMS, producing conventional carbon dates. Calibration was done by Lance Wollwage using the Calib v.5.0.2 software program (Stuvier et al. 2005). The results of the radiocarbon dates and their implications are discussed in Chapter 6.

Statistical Methods and Geographic Information Systems (GIS)

Geographic Information Systems software is a tool that has received much attention from archaeologists because "much if not all of the data archaeologists recover is spatial in nature, or has an important spatial component" (Wheatley and Gillings 2002:3). GIS software is an instrument used to capture, store, manage, analyze and present data linked to a location, making it a useful tool for archaeologists. The software, first developed by the Canadian Department of Forestry and Rural Development in 1964, is used to manage natural resources and develop a strategic and sustainable plan for their

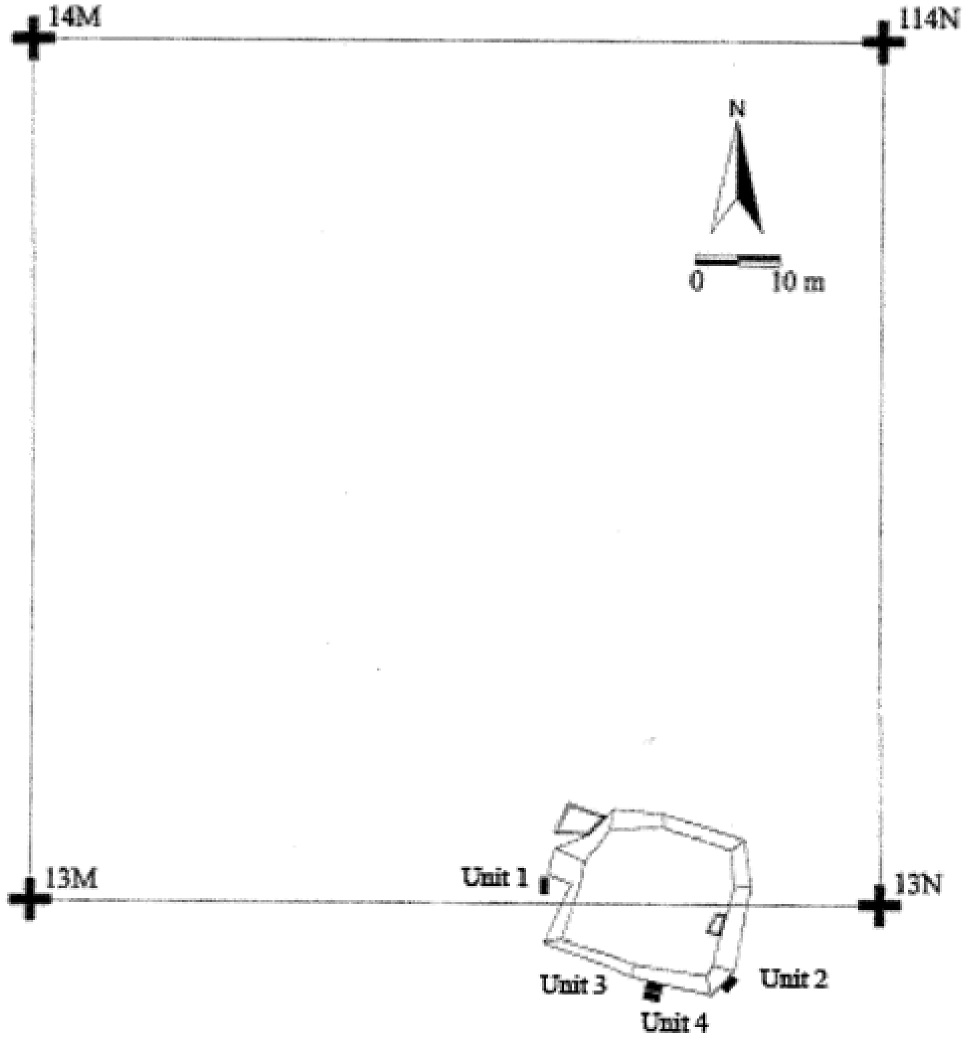


Figure 5.26. Structure 13M STR-02 with location of excavation units.

use (Wheatley and Gillings 2002:14). The Granite Reef archaeological project in the American Southwest was the first to apply GIS in an archaeological context in 1979 (Kvamme 1999). Over the last 30 years, new survey techniques and equipment have dramatically increased the amount of spatial data collected, making GIS an attractive method for the management and analysis of this burgeoning amount of data.

The use of GIS has been extremely important in both the management and analysis of the data collected at T'isil. All of my data has been compiled in to an ArcGIS 9.3 personal geodatabase, including the volume and basal area of every feature and structure mapped at the site. GIS software also became a critical component in our mapping process. Every day mapping data recorded by field crews was entered manually into the database which allowed me to check the data on a daily basis for accuracy. If I encountered a problem with the data, the field crew could return to the field the next day and correct the problem.

The various ways that I used GIS for my analysis and the statistical methods used are discussed below as I have applied them to various aspects of my analysis. Throughout the seasons of 1999-2007, I entered all data collected on standardized mapping forms (Figure 5.2) into a computerized database using Microsoft Access. This database is linked to a GIS (initially ArcView 3.0, then ArcGIS 8.0 beginning with the 2005 field season, and ArcGIS 9.3 for 2007). The GIS generates unique data layers for the 100 meter mapping grid, mapping substations, and all points recorded during the mapping of each individual feature. I then entered the data into Microsoft Access which is linked to the GIS, and joined the points with lines to create the outline forms for the structure or other feature as it appeared in the field note sketch maps. We conducted this on a daily basis, in order to recognize and correct any errors in field recording or data entry. The final GIS version of the T'isil map is referenced to the Universal Transverse Mercator grid.

Volumetrics and Basal Area Calculations

As part of the theoretical orientation discussed in Chapter 4, volumetrics and basal area was used as a means of testing the concentric zonation hypothesis (discussion in Chapter 6). Many archaeologists have used architectural volume as a means of representing labor investment at a site. Using volume is seemingly more appropriate in the Yalahau region because of its short occupational history. Based on ceramic analysis, radiocarbon dates (to be discussed in Chapter 6) and architectural style, we estimate that the majority of architecture at T'isil was constructed during the Late Preclassic and Early Classic periods. Because of the short occupational history, we do not see the overburden of architecture seen in other areas.

In order to calculate the volume of building material used in each structure, I used ArcGIS software. This was accomplished by generating a triangulated irregular network (TIN), which takes all of the points recorded for each structure and creates a three dimensional image. The ArcGIS software's cut and fill tool was then able to take the TIN and calculate the volume for each structure and feature (see Appendix A). Appendix A includes the data for all structures mapped at the site, but only those structures located within the 500 m radius (my study area) are included in the analysis. Because we were unable to complete a map of the entire site, I chose to use a 500 m radius from the center point of Cenote T'isil. I believe that this area fairly represents the architecture at the site and provides a large enough sample size for my analysis.

For the basal area calculations, I created polygons in ArcGIS using the outer, ground-level mapping points which outline the foundation of each structure or feature. I then used the ArcGIS software to calculate the area of each polygon (see Appendix A). This was done using the "Feature to Point" option in ArcToolbox. This tool calculated the distance from a point (in this case the center point of Cenote T'isil) to the closest outer edge of any polygon (the outer edge of mapped structures and features) and the results are also displayed in Appendix A.

Distance Calculations

A crucial component in the testing of the concentric zonation hypothesis was the measurement of the distance of each individual structure and feature from the site center. I calculated this distance using the ArcGIS software and establishing two shapefiles: one consisting of the point designated as the center of Cenote T'isil, and another shapefile consisting of a set of polygons representing the basal areas of the mapped structures and features. I chose the center point of Cenote T'isil because it represents both the geographic center and the cosmological center of the site. ArcGIS has a proximity analysis tool that electronically calculates the distance from the center point to the closest edge of each of the polygons, the results of which I utilized to test the hypothesis. This was done by using the 'Feature to Point' tool in ArcGIS 9.3 ArcToolbox. The method for measuring the distance from the center point of Cenote T'isil to all structures and features within the 500 m radius is outlined below.

To conduct a distance measurement from one feature to another, use the following steps in ArcGIS 9.3. All "tools" are accessed in ArcToolbox.

1. If the polygon shapefile is the near feature, convert polygons to a point file by:
    a. Open 'Feature to Point' in ArcToolbox (Data Management > Features > Feature to Point.
    b. Input Features is basal area.shp
    c. Output Feature Class is the name and location of the new file
    d. Leave 'Inside' with NO check
2. Open 'Near' in ArcToolbox (Analysis Tools > Proximity > Near)
3. Input features is the newly created point file (basal area_pt.shp)
4. Near Features is the *cenote* center point.shp
5. Leave search radius blank
6. Leave location and angle unchecked unless you want the x,y of the locations or the angle from the center to each polygon.
7. Click OK
8. After the process runs, basal area_pt will then have two new fields: NEAR_FID (ID for *cenote* center) and NEAR_DIST (distance from each polygon to the center point in mapping units, in this case as meters

I then correlated the volume and basal area of each structure to its distance from the site center in order to test the Concentric Zone hypothesis (analysis to be discussed in Chapter 6).

Statistical Methods

I used two different statistical methods to test the concentric zone hypothesis -- the Kendall tau rank correlation and linear regression analysis. The Kendall tau rank correlation coefficient is a statistical method used to measure the strength of the relationship between two rankings and to assess the significance of this correspondence. This is the method used by Arnold and Ford (1980) in their statistical examination of the settlement patterns at Tikal. The Kendall tau rank correlation (τ) is carried out on ranked data. For each variable, the values are separately put in order and numbered with the lowest value being number 1, the next lowest value number 2, and so on. If the agreement between the two rankings is the same, the coefficient will have a value of 1. If the two rankings are in total disagreement, where one ranking is the exact reverse of the other, the coefficient will have a value of -1. For values that lie between -1 and 1, an increasing value implies an increasing correlation between rankings. If the rankings are completely independent, the coefficient will have a value of 0.

The Kendall tau coefficient is defined:

$$\tau = \frac{n_c - n_d}{\frac{1}{2}n(n-1)}$$

where n_c is the number of concordant pairs and n_d is the number of discordant pairs in the data set. In the case of Arnold and Ford, the variables that they compared were distance and labor investment. Rankings consisted of the distance of residential units in the study area from the midpoint of the Great Plaza of Tikal (the civic-ceremonial precinct) and the total labor investment for the residential units in the study area (Arnold and Ford 1980:714).

Arnold and Ford used information gathered directly from the Carr and Hazard (1961) Tikal maps, using this information to quantify the architecture (Arnold and Ford 1980:715). The features they employed in their study included the size (basal area), presence or absence of a shrine/oratory, pole-and-thatch vs. masonry structures, presence or absence of plazas, and solitary vs. grouped structures. They used these variables to calculate the labor expenditure (work-days) for each of the 630 residential units identified on the Tikal maps. The results were ranked by distance from the center and by labor investment. A rank of 1 was assigned to the highest labor investment and a rank of 630 to the lowest labor investment. The shortest distance to the center was ranked 1, while the farthest distance was ranked 630. Their tau-B result was 0.03, a very low correlation coefficient, prompting them to conclude that there is no positive correlation between labor investment and distance from the defined center of Tikal (1980:722).

For the T'isil data, the variables I used were distance from Cenote T'isil which is the geographic and ideological center, and a volume/basal area ratio which I feel reflects labor investment. I wasn't able to utilize the same method for ranking labor investment used by Arnold and Ford because of the lack of evidence for group plazas, masonry shrines or masonry structure at the site, but I do believe that using the volume/basal area ratio is a valid way to determine labor investment. Instead of using only the volume calculations or only the basal area calculations, I decided to use a ratio of volume to basal area. I decided to use this ratio because it seemed like a more accurate reflection of labor investment. In many cases there are features and structures that consist solely of a very low layer of limestone rubble that covered a relatively large basal area. Using only basal area calculations would not be an accurate indication of the labor investment in this case. For example, there were a number of architectural features that consisted of relatively large basal areas that were nothing more than limestone rubble piled a few centimeters high. Had I used only basal area, this would have not reflected the difference in labor investment between that type of structure and one that was 1.5 m high. I used the volume to basal area ratio because "...from an energetic perspective, it was "cheaper" to extend out than to build up" (Abrams:70 1994:70).

I ranked the structures and features at T'isil first by their distance from Cenote T'isil, and also by their volume/basal area ratio. If the concentric zone model is present at the site of T'isil, then we should see a Kendall tau rank correlation of 1, and if there is no relationship between distance and volume the coefficient will have a value of 0.

The other statistical method I used for the concentric zone analysis was simple linear regression. Linear regression is a technique in which a straight line is fitted to a set of data points to measure the effect of a single independent variable. One can use linear regression to analyze the relationship between two variables (a dependent and an independent variable) in order to determine whether or not there is a relationship between them. It does not imply that one variable causes the other, but that there is some kind of a significant relationship between them. In this case the dependent variable (Y) would be the volume/basal area ratio of each structure or feature, and the independent variable (X) would be distance of each structure or feature from Cenote T'isil. If there is a relationship between X and Y, the data can be plotted and a "best-fit" line can be drawn straight through the data. The slope of the line is based on the equation $Y = a + bX$, where X is the independent variable and Y is the dependent variable.

I believe that linear regression is the more logical statistical tool to use for testing the concentric zone model than the Kendall tau method. I base this statement on the fact that the Kendall tau analysis involves a straight one-to-one analysis. In other words, the only way there would be any correlation between rank and volume is if the largest structure was also the closest to the cenote, the second largest was second closest, etc., and the smallest was the farthest away. The closeness of clustered structures is lost in this type of analysis. Linear regression would be able to pick up patterning of things getting smaller as distance increases. The results of this analysis are discussed in Chapter 6.

Quadripartite Model Analysis

The concept of quadripartition, as discussed in Chapter 4, permeates all levels of space as evidenced in both ancient and modern Maya communities. From the scale of the universe all the way down to altar and caches, the four quarters is a key concept in how the Maya structured their space. One area of research that I pursued for this dissertation was to try to answer the question of whether or not there is evidence that the site of T'isil had a visible quadripartite spatial component in its overall layout. A visual inspection of the T'isil survey map seemed to indicate that there might be a partitioning of the site by means of open space (space with no visible architecture), so I decided to see if I could approach the problem from a more statistical viewpoint using GIS software.

Most spatial analysis studies tend to evaluate objects and characteristics associated with a discrete loci within a defined space. For example, where is the largest architecture within a 500 meter radius from the central plaza located? However, what might be a more interesting question that is often overlooked are the void spaces between the architecture, and other attributes (such as built roads, walls, etc.) under study, because they are quite often difficult to characterize. "Instead of discarding this 'Swiss Cheese' component of the solution space, spatial analysts may find it worthwhile to look for meaning in the space without attributes, for patterns within the void" (Heidelberg 2010:1).

The Openness Operator is a tool that was developed by Kurt Heidelberg in consultation with me for use with GIS software and is intended to identify the "openness" of spaces on the map. This tool relies on raster, rather than vector data. There are two formats used by GIS software to store and retrieve geographic data: raster and vector. Vector data consists of points, lines and polygons. Polygon data is used to represent areas and are displayed using thematic mapping symbology, such as patterns or color gradation. Line data represents linear features like roads. The survey map of T'isil is an example of a vector map, where the architecture and *cenotes* are represented by polygons and other features such as the location of *chich* mounds or micro-*cenotes* are represented by points.

However, the quadripartite analysis here is based on a raster dataset. Raster data are cell-based spatial datasets. Raster data are divided into cell or pixels such as what you see in a digital image. Raster data is formed by assigning each cell with the value of the feature that dominates the cell and row and column numbers are used to identify the location of each cell within the array.

The Openness Operator is a tool intended to aid the user in identifying the "Openness" of any particular location in unoccupied space, that is, how much it contributes toward making any large, open area within the solution space. There are many applications for this tool, but the example used below is based on a typical archaeological problem where a plan representation of a site map is a grid map (*M*) with one meter resolution, where the presence of any part of a structure in any cell is denoted by a true value (*t*) and absence of any structural component is denoted with a false value(*f*).

The method for analyzing open space, as outlined by Kurt Heidelberg (2010) is described below.

The Openness Operator creates a new grid, The Openness Grid (*O*), based on the following algorithm:

<u>For each cell *M(i,j)*</u> that is false (unoccupied):

First, measure the distance *d1* from *M(i,j)* to the closest occupied cell on a bearing of 0 degrees from *M(i,j)*. Correspondingly, measure the distance *d2* from *M(i,j)* to the closest occupied cell on a bearing of 180 degrees from $M(i,j)$. Add the two values $d1 + d2 = d$. Note that d represents the distance between the two closest structures on a N-S axis which runs through $M(i,j)$. Assign $O(i,j) = d$.

Second, at regular intervals within 180 degrees, increase the bearing and perform the same operation. For example, if the regular interval is to be 2 degrees, measure the distance $d1$ from $M(i,j)$ to the closest occupied cell on a bearing of 2 degrees from $M(i,j)$. Correspondingly, measure the distance $d2$ from $M(i,j)$ to the closest occupied cell on a bearing of 182 degrees from $M(i,j)$. A new value of $d = d1 + d2$ is calculated. The next iteration will make measurements at 4 degrees and 184 degrees, then 6 and 186, and so on. Each time a new d value is calculated, it is compared to the existing value for that cell $O(i,j)$. If the new d is smaller than the existing value, then $O(i,j)$ becomes the smaller value.

Lastly, the resulting value of any cell in *O* holds the value of the closest two opposing structures in any straight line that passes through that cell. Effectively this is a measurement of the greatest flow constraint put on the cell based on structure locations; the greatest "bottleneck," so to speak. As a whole, the grid can be viewed as a choropleth map where groupings of cell values are classified in graduated rankings using whatever criteria the user chooses.

According to Heidelberg, most conventional analyses of open space tend to be based on proximity of the open space to individual objects, the premise being that the farther away a cell is from any object the more "open" it is. The problem with this approach is that it defines spaces simply by their distance from single objects and it doesn't look at the relationship of space to multiple other objects or other spaces. In other words, a cell in the middle of a courtyard might have a higher value because it is located at the farthest location from architecture or other features. A cell located adjacent to the architecture that encloses the courtyard would have a lower value. Conventional analysis of open space would not look at these cells as being equally important. However, both of these cells are equally important because they make up the open space of the courtyard. The value of Heidelberg's Openness Operator to my research is that it allowed me to look at where the most open spaces of T'isil are located and what that openness can tell us about how the site was organized in terms of access and organization. Because the site is so densely packed with architecture, it is difficult to really see where the most open areas are located. This tool displays the open areas of the site, revealing patterns that were not easily evident with a visual inspection.

I used ArcInfo 9.3 and classified the raster grouping values in 10 geometrical interval classes in order to visually display the areas that are most open using this algorithm. I chose a geometric classification scheme because this method is best for visualizing continuous data that is not distributed normally, or where there are excessive duplicate values (e.g. 30% of the features have the same value). I selected 10 intervals because it shows a reasonable amount of detail without showing so much detail that generalizations cannot be made about the void spaces. Results of this analysis are presented in Chapter 6.

City Plan Template Model

Finally, I analyze the hypothesis put forth by Ashmore and Sabloff (2002) regarding the spatial layout of Classic Period Maya civic centers. One of the research questions posited in this dissertation questions is whether some of these ideational urban planning principles are present at a non-elite, Preclassic/Classic transition period site such as T'isil. Since there are no clearly defined methods for analyzing city plans, I had to rely on visual examination of the T'isil map and compare its site layout to some of the Classic period sites discussed in the Ashmore and Sabloff article. Although the authors were looking at the placement of different architectural elements (such as plazas, ballcourts, etc) and using their locations to suggest political affiliation, I thought it would be interesting to look at whether these architectural elements exist and where they may be located at a non-elite Preclassic/Classic transition period site, not to look at political affiliation, but instead to see if the physical location of any of these elements is in any way similar to their location at the larger and later elite Maya centers.

Using the characteristics of the spatial template described by Ashmore (1991:200) I examined the GIS-generated map of T'isil to see if I could identify any of these site-planning principles (discussed in detail in chapter 4). The template proposed by Ashmore includes the following principles: (1) an emphatic north-south axis seen in site organization; (2) formal and functional complementarity or dualism between north and south; (3) elements added on east and west, forming a triangle with the north, with frequent suppression of the south; (4) the presence of a ballcourt marking the transition between north and south; and (5) use of causeways to emphasize connections among these elements, underscoring a unity of the whole layout. A discussion of my results is presented in Chapter 6.

Conclusion

Since the emergence of the "New Archaeology" in the 1960s, emphasis on quantitative thinking and the scientific method pushed archaeologists to look for new ways to think about space. Archaeologists looked toward other academic fields, most notable geography, for additional tools for spatial analysis (Aldenderfer and Maschner 1996:*v*).   Over the past 30 years, the use of Geographic Information Systems (GIS) technology has increased in the field of archaeological research, as archaeologists realized the potential of GIS as a spatial analyst tool. The fact that "Much if not all of the data archaeologists recover is spatial in nature, or has an important spatial component" (Wheatley and Gittings 2002:3), coupled with advances in computer technology, geospatial software programs, and locational devices such as GPS, allows archaeologists to explore the spatial relationships in human settlement systems in ways that would have once been difficult or impossible to do. GIS facilitates the storage, management and display of large quantities of archaeological data in ways that the maps and map overlays of previous generations of archaeologists would never have conceived. GIS can reveal patterns, but it cannot interpret those patterns, so it becomes important to incorporate this technology with theories about the spatial organization of culture, which this dissertation attempts to achieve.

CHAPTER 6: ANALYSIS AND CONCLUSIONS

The primary focus of this dissertation is an examination of the spatial layout of T'isil in order to determine the principles that guided the organization of a small, non-elite community that was occupied primarily during the Late Preclassic/Early Classic transition. With that in mind, I applied the data collected from many field seasons at T'isil to three models of spatial organization to see if any of the models fit.

This chapter begins with a discussion of the results of a radiocarbon analysis of materials recovered from T'isil in order to situate the site chronologically. I then go on to discuss the Quadripartite Model, the Concentric Zone Model, and the City Plan Template Model. With each of these models I discuss the data collected and how well the data fits with the three models. This is followed by an overview and general description of the spatial layout of the site. I conclude the chapter with a discussion of the significance of my research and a discussion of future research projects at T'isil.

Radiocarbon Dating Results

Few absolute dates are available in the northern Maya lowlands, and even fewer in the Yalahau region. Because the Yalahau region has no glyphic or iconographic evidence, archaeologists in the area have had to rely on ceramic chronology and architectural style to determine the occupation periods (Mathews 1998:158). Glover's dissertation research, a regional settlement pattern survey of the Yalahau, looked at the ceramics and architecture of sites within his study area, leading him to conclude that the main occupation of the settlement in the area spans the Late Preclassic and Early Classic periods. Amador's (2005) ceramic analysis of the same sites also supports this occupational span. Because of a lack of radiocarbon dates, their conclusions relied on architectural style and cross-dating of ceramics, both of which are problematic in determining reliable dates for the occupational period.

A regional chronology continues to be a significant problem because in the Maya lowlands changes in ceramic styles have been used as chronological markers with few absolute dates to substantiate the chronology (Glover 2006:635; Glover and Stanton 2010:64). Ceramic chronologies in the northern Maya lowlands are based on peninsula-wide cross-dating and this approach has many problems because "[a]lthough broad regional distinctions in ceramic distributions certainly have some validity, they often mask local variation both in the duration and distribution of ceramic types" (Bey et al 1999:118). Cross-dating has been the basis for the presumed occupation of the Yalahau region and is based on already established collections from neighboring regions of the northern Maya lowlands (Amador 2005; Andrews 1988, 1989; Ball and Andrews 1975; Bey et al. 1999; Kepecs 1998, Rissolo 2001). The problem with cross-dating is that it assumes that identification of a certain ceramic group found in the Yalahau region corresponds temporally to its chronological placement in adjoining areas (Amador 2005:9).

The few dates that we do have suggest that the Yalahau region was occupied primarily in the Late Preclassic to the Early Classic periods. Mathews (1998:169; 2001) recovered AMS radiocarbon dates from charcoal inclusions in Megalithic architectural mortar at El Naranjal, dating to the Late Preclassic and Early Classic. Ceramic analysis at the site of El Naranjal (Boucher and Dzul 1998) further supports the belief that the site was occupied from the Late Preclassic to the Late Postclassic, with the primary occupation during the Late Preclassic. These dates seems consistent with ceramic analyses from T'isil and other sites in the Yucatán Peninsula (Ardren 1997; Dunning 1992; Roys and Shook 1966; Taube 1995; Webster 1977), but the dearth of absolute dates makes the ceramic chronology tenuous. Jorge Ceja Acosta carried out the initial ceramic analysis at T'isil in the 1999, 2000, and 2001 field seasons (Ceja 2002; Fedick 2000, 2001). . However, a new ceramic analyst, José Manuel Ochoa Rodríguez, joined the Yalahau project in 2002, replacing Ceja. While studies conducted by Ceja and Ochoa made similar type-variety identifications, they made different chronological assignments for many of the ceramic groups (Fedick 2003). Ceja assigned many ceramic groups to the Late Preclassic, while Ochoa (2004) assigned them to the Early Classic. Both ceramicists agree that there is a problem separating Late Preclassic and Early Classic ceramic groups in northern Quintana Roo (Fedick 2003).

It is for this reason that the recovery of suitable materials for radiocarbon dating from T'isil was so important. In the following section I provide the details of the excavations at structure 13M-STR-2 where faunal specimens used for radiocarbon dating were recovered. I follow this with discussion of the results of the AMS radiocarbon dates and their impact on our understanding of the chronology of both the site and the Yalahau region.

Excavation Results

During the 2002 field season, surface collections at T'isil were completed of all structures within the cleared area of the site. Additionally, surface collections were also carried out on the four structures at the center of the site within the forested area adjacent to Cenote T'isil (Fedick 2004). This included the two pyramidal structures (11M-STR-4 and 12M-STR-05) and the two large platforms (10L-STR-13 and 11M-STR-06). The project then initiated an excavation program with the goal of comparing the similarity between the types and varieties obtained during the surface collection with those recovered from excavation units (Fedick 2004). Ten units were selected for excavation during 2002-2003 (11T-STR-17, 12N-STR-07, 12U-STR-10, 13J-STR-12, 13S-STR-06, 14F-STR-02, 14G-STR-01, 14K-STR-11, 14N-STR-05, and 13M-STR-02). I am only discussing the excavations at 13M STR-02 because they yielded a significant amount of bone that was used as samples for the radiocarbon dates discussed below.

Three test pit excavations were conducted at structure 13M-STR-2. Unit 13M-STR-2-U-1 and 13M-STR-2-U-2 and did not produce faunal materials suitable for radiocarbon analysis. However, Unit 13M-STR-2-U-3 and Unit 13M-STR-2-U-4 were very productive and a good deal of ceramic artifacts and faunal specimens were recovered. Unit 13M-STR-2-U-3 was located outside the structural collapse on the south side of the structure see (Figure 6.1). We chose this structure for excavation because it had the largest number of ceramic sherds, and the greatest number of types and varieties of ceramics gathered in a previous large-scale surface collection conducted in the cleared area of the site (Fedick 2004). Eight 10 cm arbitrary levels were excavated down to fully exposed bedrock. There was no evidence of natural stratigraphy and the soils were dark and organic. This unit contained a large number of sherds, animal bones, animal teeth, and fragments of obsidian blades. A profile of the excavation unit is presented in Figure 6.2.   Analysis of the ceramics recovered indicates that the lower level (8) was dominated by Middle Preclassic/Late Preclassic (Chunhinta and Dzudzuquil) groups, while ceramics from the Late Postclassic (Payil and Matilla) were restricted to levels 1-4 (Fedick 2004).

Unit 13M-STR-2-U-4 was an extension of Unit 3 and was selected because Unit 3 produced such a high density of artifacts. Six arbitrary levels of 10 cm were excavated down to exposed bedrock. Unit 4 contained a partially-buried *metate* as well as a high density of ceramic sherds, small fresh-water shells, animal bones, and obsidian blade fragments. The soils were dark and organic with a high density of small and medium-sized limestone rocks. There was no evidence of natural stratigraphy. The distribution of ceramic groups show Late Postclassic (Payil and Matilla) gradually declining in frequency with increasing depth, and groups of Middle Preclassic/Late Preclassic (Chunhinta and Dzudzuquil) ceramics increasing at lower levels. A profile of the unit is shown in Figure 6.3.

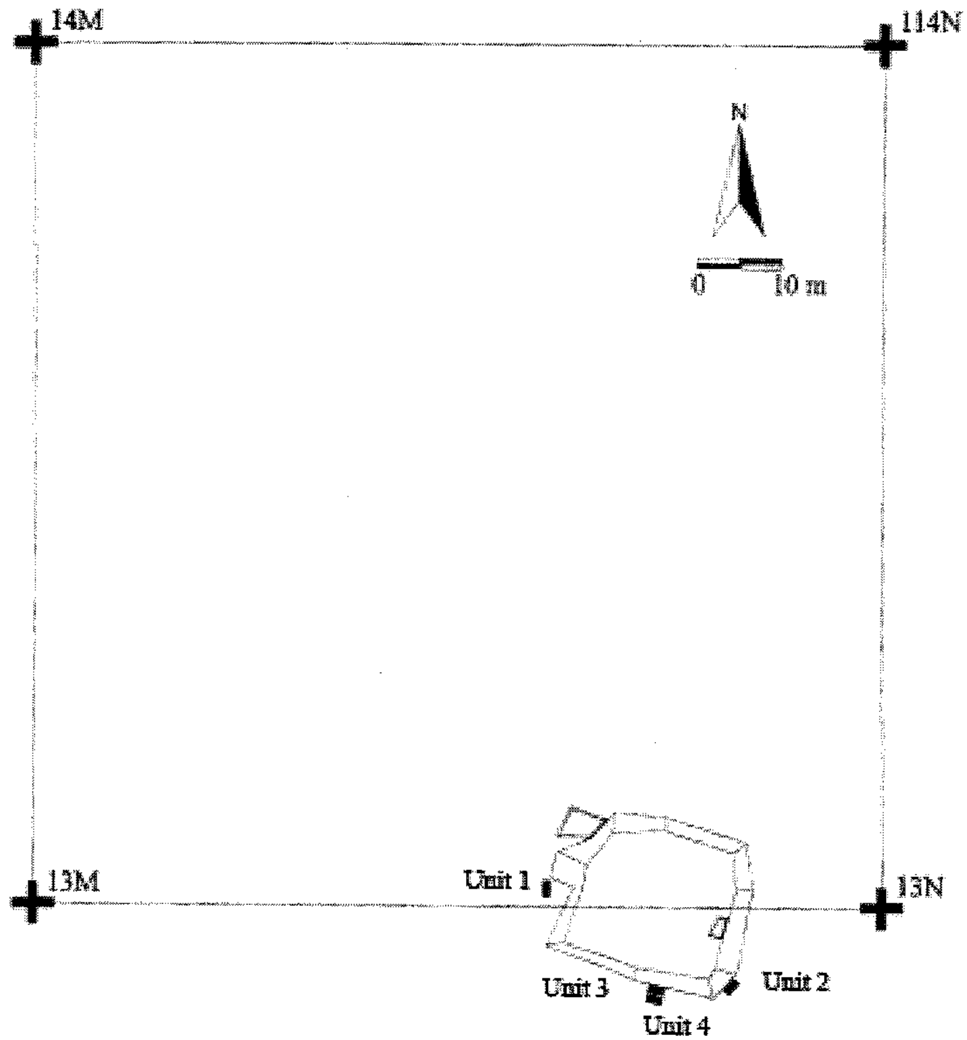


Figure 6.1. Structure 13M STR-02 with location of excavation units from which faunal materials were recovered.

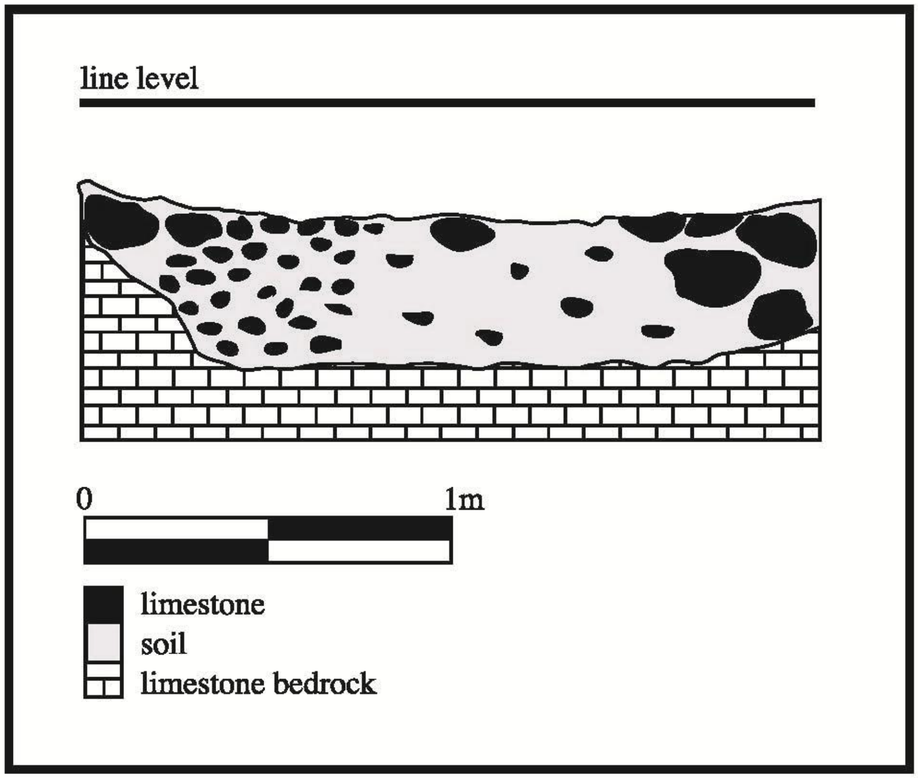


Figure 6.2. Structure 13M-STR-2, Unit 3, east wall profile.

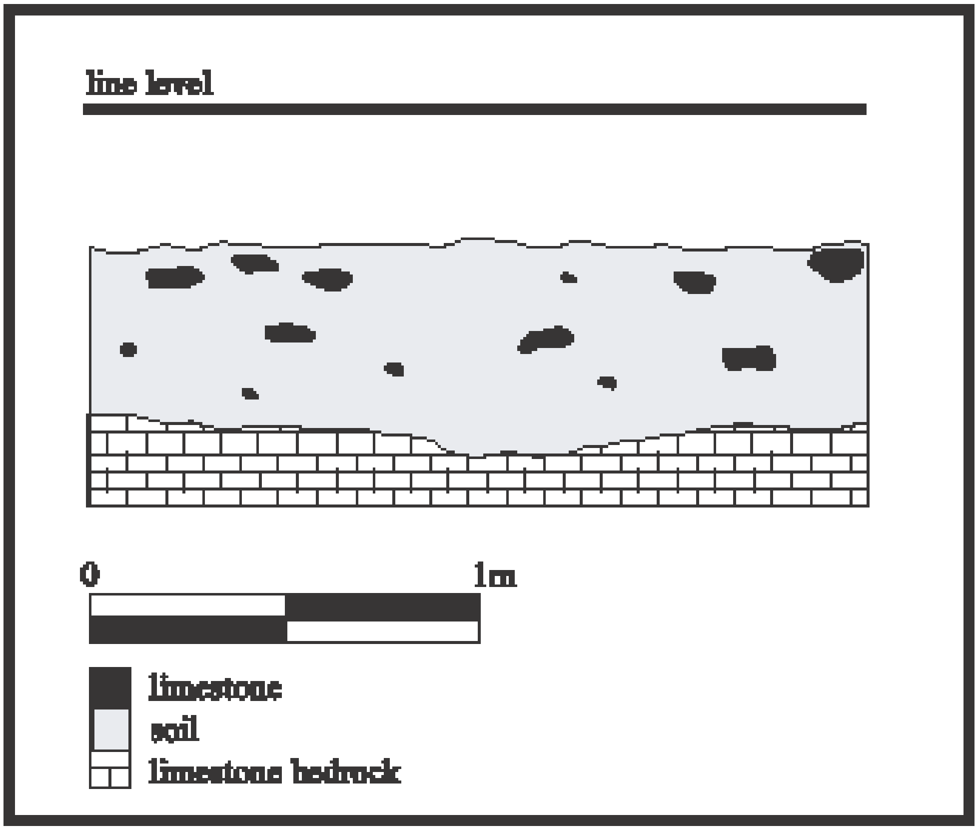


Figure 6.3. Structure 13M-STR-2, Unit 4, east wall profile.

A total of 2,557 faunal specimens were recovered from the excavations at 13M STR-02 (Goossens 2005:38). The faunal assemblage contains a wide variety of identified animals (listed below in Table 6.1) as well as a number of unidentified specimens (Goossens 2005:46).

Radiocarbon Analysis

A total of 21 samples submitted for processing to the University of Arizona AMS laboratory, yielded a total of 18 samples suitable for AMS dating. Three samples were deemed unsuitable for dating because they showed evidence of burning. The resulting dates appear to be clustered into four distinct groups (see Figure 6.4 and Table 6.2). The first, and oldest group, consists of five calibrated dates from the Late Preclassic/Early Classic transition. These samples (AA83658, 44 B.C.-A.D. 85; AA75230, 3 B.C.-A.D. 219; AA75231, 41 B.C.-A.D.179; AA75236, A.D. 224- 412; AA75238, A.D. 134-354) were recovered from Units 3 and 4 - levels four through seven. The next grouping consists of two samples (AA75224, A.D. 893-1043; AA75235, A.D. 995-1159) dating to the Terminal Classic period (approximately A.D. 900-1200) which were recovered from level three of Units 3 and 4. Five nearly identical dates (approximately A.D. 1238-1325) were obtained from materials (AA75227, A.D. 1238-1398; AA75233, A.D. 1274-1330; AA75234, A.D. 1288-1405; AA75237, A.D. 1263-1325; AA83656, A.D. 1263-1325) recovered from levels two, four and five of Units 3 and indicating a Late Postclassic occupation (A.D. 1250-1521). The youngest group (AA75221, A.D. 1442-1529; AA75222, A.D. 1445-1637; AA75223, A.D. 1437-1528;

Taxon
Fish
Cichlidae
Haemulidae
cf. *Lutjanus sp.*
Osteichthyes
Galeocerdo cuvier
Turtles
Clemmys sp.
Emydidae
Kinosternidae
Testudines
Snakes, Lizards, and Crocodiles
Boa constrictor
Colubridae
Viperidae
Iguanidae
Crocodylus acutus
Birds
Small Birds
Medium Birds
Large Birds
Mammals
Dasypus novemcinctus
Canis familaris
Felidae
Mustela frenata
Nasua narica
Mazama americana
Odocoileus virginianus
Cervidae
Tayassu tajacu
Artiodactyl
Orthogeomys hispidus
Agouti paca
Dasyprocta punctata
Rodentia
Sylvilagus floridanus

Table 6.1. List of identified animal species from excavation at 13M-STR-02.

AA # Sample ID	Suite	Material	$d^{13}C$	F	^{14}C age BP	2σ Calibrated Age Ranges
AA75221 1 U3, L1	1 of 18	bone	-23.1	0.953 +- 0.0051	384 +- 43	AD 1442-1529 (58%)/ AD 1543-1634 (42%)
AA75222 2 U3, L2	2 of 18	bone	-20.4	0.954 +- 0.0059	372 +- 49	AD 1445-1637 (100%)
AA75223 3 U3, L3	3 of 18	bone	-21.0	0.952 +- 0.0050	387 +- 42	AD 1437-1528 (64%) / AD 1545-1545 (.2%) / AD 1551-1634 (35.8%)
AA75224 4 U3, L3	4 of 18	bone	-14.8	0.878 +- 0.0048	1,042 +- 43	AD 893-1043 (98%) / AD 1105-1118 (1.8%) / AD 1144-1146 (.2%)
AA75225 5 U3, L4	5 of 18	bone	-12.1	0.954 +- 0.0054	372 +- 41	AD 1445-1637 (100%)
AA75227 7 U3, L 4	7 of 18	bone	-23.8	0.923 +- 0.0048	642 +- 41	AD 1282-1398 (100%)
AA75230 10 U3, L7	10 of 18	bone	-22.1	0.787 +- 0.0044	1,920 +- 45	28-37 BC (1.6%) / 10-24 BC (2.4%) / 3 BC- AD 219 (96%)
AA75231 11 U3, L7	11 of 18	bone	-21.5	0.786 +- 0.0044	1,931 +- 45	41 BC-179 AD (96%) / AD 188-213 (4%)
AA75232 12 U4, L1	12 of 18	bone	-23.4	0.958 +- 0.0048	338 +- 40	AD 1462-1642 (100%)
AA75233 13 U4, L1	13 of 18	bone	-21.8	0.920 +- 0.0047	662 +- 41	AD 1274-1330 (50%) / 1339-1397 (50%)
AA75234 14 U4, L2	14 of 18	bone	-22.1	0.925 +- 0.0047	624 +- 41	AD 1288-1405 (100%)
AA75235 15 U4,L3	15 of 18	bone	-23.0	0.886 +- 0.0046	971 +- 41	AD 995-1159 (100%)
AA75236 16 U 4, L4	16 of 18	bone	-21.0	0.806 +- 0.0044	1,732 +- 44	AD 224-412 (100%)
AA75237 17 U4, L5	17 of 18	bone	-19.0	0.918 +- 0.0047	680 +- 41	AD 1263-1325 (59%) / AD 1344-1394 (41%)
AA75238 18 U4, L6	18 of 18	bone	-23.6	0.802 +- 0.0044	1,766 +- 44	AD 134-354 (97%) / AD 367-380 (3%)
AA83656 22 U4, L5	1 of 3	bone	-20.0	0.9192 +- 0.0048	677 +- 42	AD 1263-1325 (59%) / AD 1344-1394 (41%)
AA83657 21 U4, L5	2 of 3	bone	-21.9	0.9536 +- 0.0032	382 +- 27	AD 1445-1524 (65%) / AD 1558-1631 (35%)
AA83658 19 U3, L5	3 of 3	bone	-22.3	0.7822 +- 0.0030	1,973 +- 31	44 BC- AD 85 (99.2%) / AD109-114 (.8%)

Table 6.2. Results of AMS dating of faunal materials from the site of T'isil.

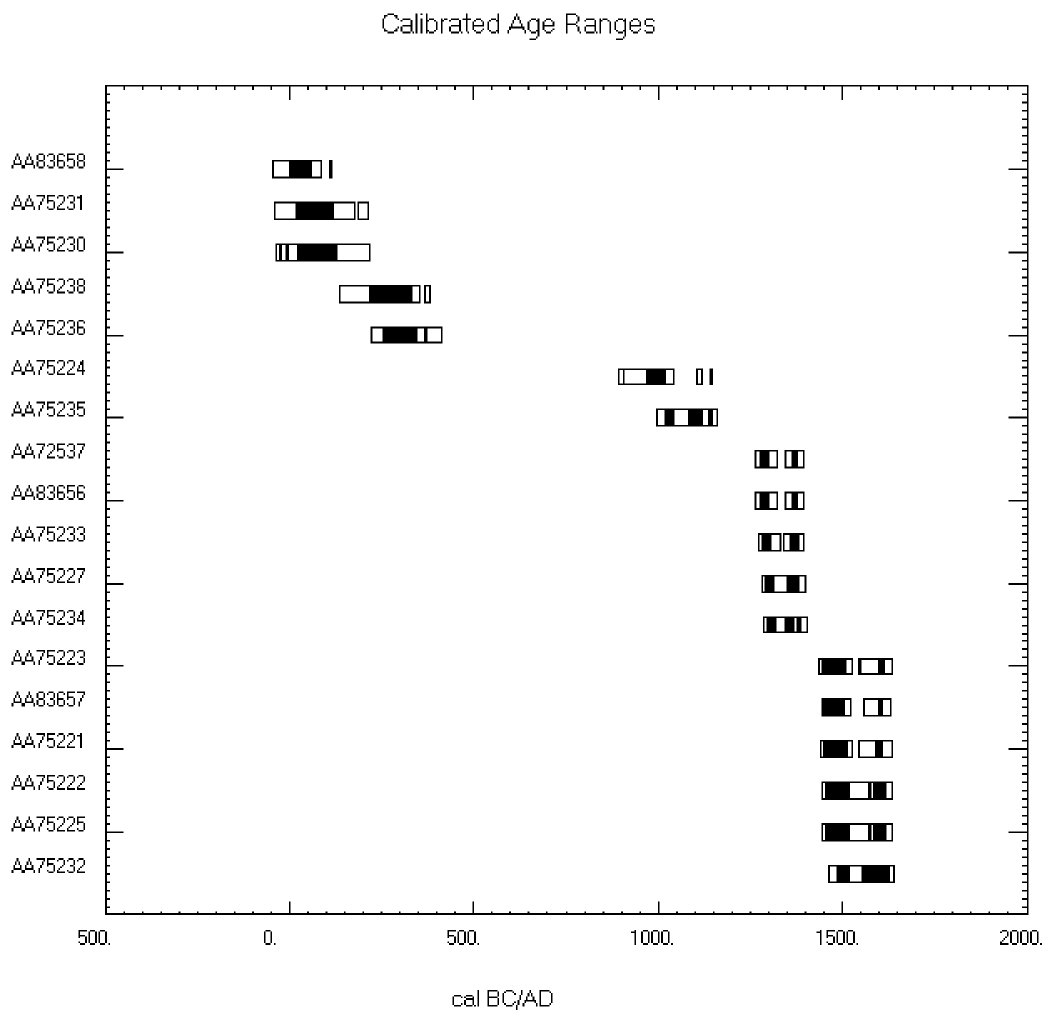


Figure 6.4. Calibrated Radiocarbon Dates from T'isil.

AA75225, A.D. 1445-1637; AA75232, A.D. 1462-1642; AA83657, A.D. 1445-1524) recovered from Units 3 and 4, level one through five, consists of six statistically indistinguishable results ($p < 0.05$), indicating a time span dating to the time of contact and colonization (A.D. 1520-1620). Dates were calibrated using the CALIB 5.0 Radiocarbon Calibration Program (Stuvier and Reimer 1995).

Implications for Settlement Analysis

Ceramic analyses indicate the primary occupation of T'isil occurred during the Late Preclassic and into the early part of the Early Classic period with a subsequent Postclassic reoccupation and radiocarbon dates supports this assessment. What is most interesting here is that the radiocarbon dates are more restricted in time than expected based on the ceramic analysis. The oldest group of dates fall squarely within the Late Preclassic (oldest date beginning around 44 B.C.) and then extending into the Early Classic period (with the youngest date range ending around A.D. 412). These dates do not resolve the ceramic classification problem, but they do tighten the timeline significantly. Because of the lack of stratigraphy in the Yalahau region, ceramic cross-dating will continue to be used, but these radiocarbon dates could be a start toward a more refined chronology at the site and in the Yalahau region. More radiocarbon dates are necessary to resolve this issue and ideally, datable carbon material obtained from sealed deposits would go a long way to settling the debate.

I will now present the analysis of the spatial planning models that I outlined in Chapter four, focusing on a comparison of the data collected to that expected by the models.

Quadripartite Model

Introduction

One of the models that have been applied to sites in the Maya region is the Quadripartite model and part of my dissertation research is to ascertain whether there is a quadripartite component in the layout of T'isil. At many Maya sites there is a constructed system of thoroughfares (*sacbe*) leading from the center in cardinal directions (Bey et al. 1997; Freidel and Sabloff 1984; Tourtellot 1988, Navarette et al. 1979). Although we found a segment of *sacbe* at the site, most of the thoroughfares at T'isil were likely informal pathways throughout the site. What I was looking for was the presence of open spaces that might represent such pathways or thoroughfares that could have divided the site into four quarters. I wanted to use a more objective and statistical approach to this question, so in collaboration with Kurt Heidelberg (2010), I used the Openness Operator tool with GIS software to identify the openness of spaces on the map. As discussed in Chapter 4, the density of architecture at T'isil makes it difficult to see where contiguous open spaces are located and the Openness Operator can reveal patterns that may not be easily discernable through an unassisted visual inspection of the paper map.

Quadripartite Analysis

Initial site investigation of the paper map indicates that there is some partitioning by means of open space (space that has no visible architecture), dividing the northern and southern halves of the site (Figure 6.5). The only known *sacbe* at the site (approximately 110 m in length) is located in this open space. The site is further delineated by the presence of a wall of cut limestone blocks (approximately 100 m in length) that have been carefully placed runs perpendicular to the *sacbe* and appears to divide the northeastern and northwestern quarters of the site. An extension to this wall, running west (for about 100 m) and then south (for 34 m) from the northernmost point of the dressed block part, is made up of undressed, stacked slabs of limestone and looks like it was built at a later time. Lined up to the north of the dressed stone wall are two parallel structures that could possibly be a ballcourt. The wall and the possible ballcourt appear to mark a division between the northeastern and northwestern parts of the site. I was unable to see anything in the southern half of the site that might indicate a partitioning of the space.

If the site was indeed partitioned by means of open space, then the Openness Operator tool would be able to graphically display this division. A graphic representation of the open spaces at T'isil was produced using the Openness Operator tool (Figure 6.6). In the image, Cenote T'isil is at the center and the outline of the basal areas of each structure superimposed on the image produced by the Openness Indicator. The darker areas represent the more open space while the lighter color indicates less open space. As expected from the visual examination of the map, you

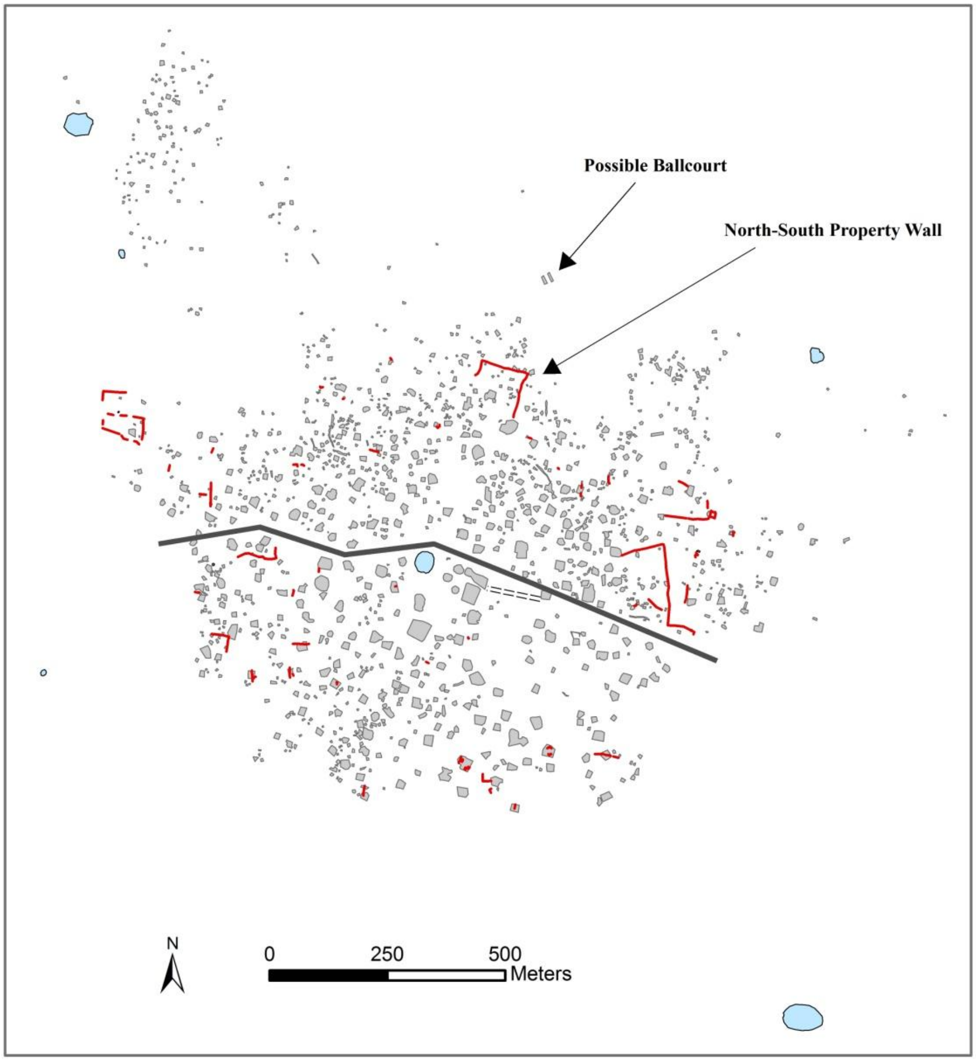


Figure 6.5. Map of T'isil showing north-south division identified through visual examination, indicated by black line.

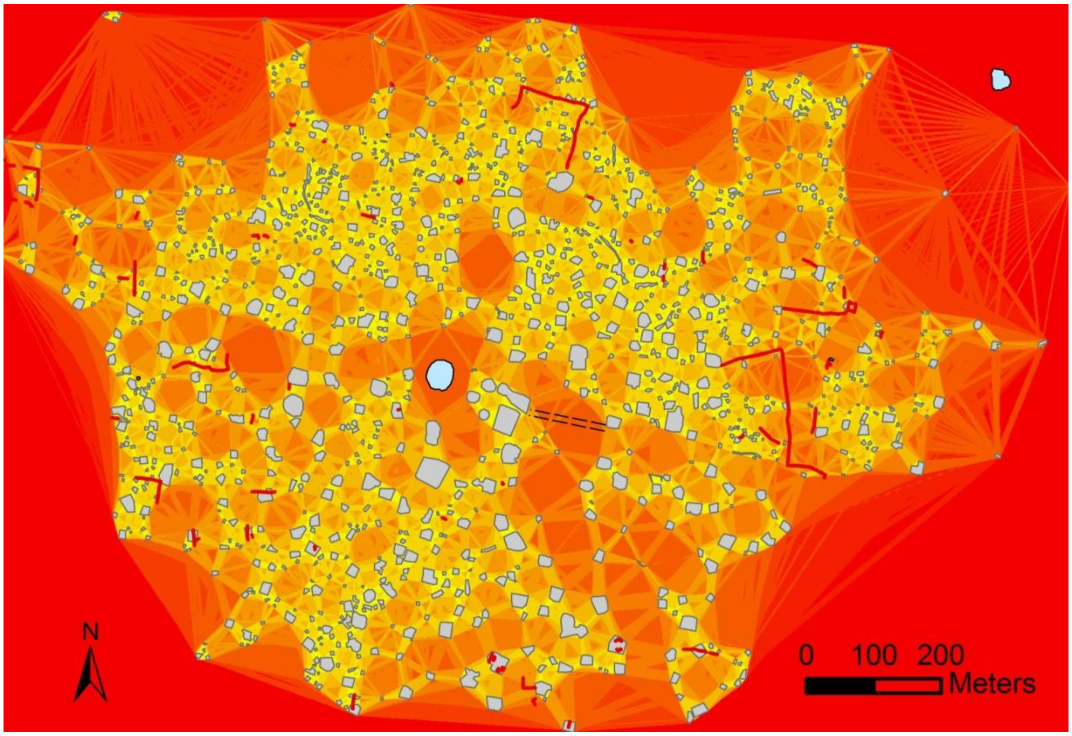


Figure 6.6. Openness Operator map, used to highlight degrees of openness between constructed features within the study area.

can see an open area that runs east to west intersecting Cenote T'isil and the only identified *sacbe* segment runs through this east/west corridor.

Although the site shows a clearly-defined north-south delineation, the Openness Operator did not present a clear quadripartite divisioning. There is a defined open space that runs east-west through the center of the site (Figure 6.7) most likely a thoroughfare of some kind that provided entrée to the site as well as access to the civic center and Cenote T'isil. This seems to be deliberately open space, especially when contrasted with the dense architecture found throughout the rest of the site. There does not appear to be any clearly defined open space running north-south, which we would have expected to see if the quadripartite model were defined by means of open space. However, the graphic reveals some other interesting patterns, discussed below.

Other Patterns Revealed by the Openness Operator

There are a number of areas that could indicate the presence of patio residences (Figure 6.8), defined by Ashmore as "several structures sharing a single central ambient space (a patio)" (1981:49). Ashmore points out that the problem with identifying these groups of structures as patio residences lies in the fact that without further research (for example, excavations or the identification of associated features such as hearths or burials) there is no way to distinguish them as being residential rather than special-function buildings. Figure 6.8 indicates the location of possible patio groups but a more detailed examination of the architecture along with an excavation strategy would be necessary to determine whether or not these are actually patio groups.

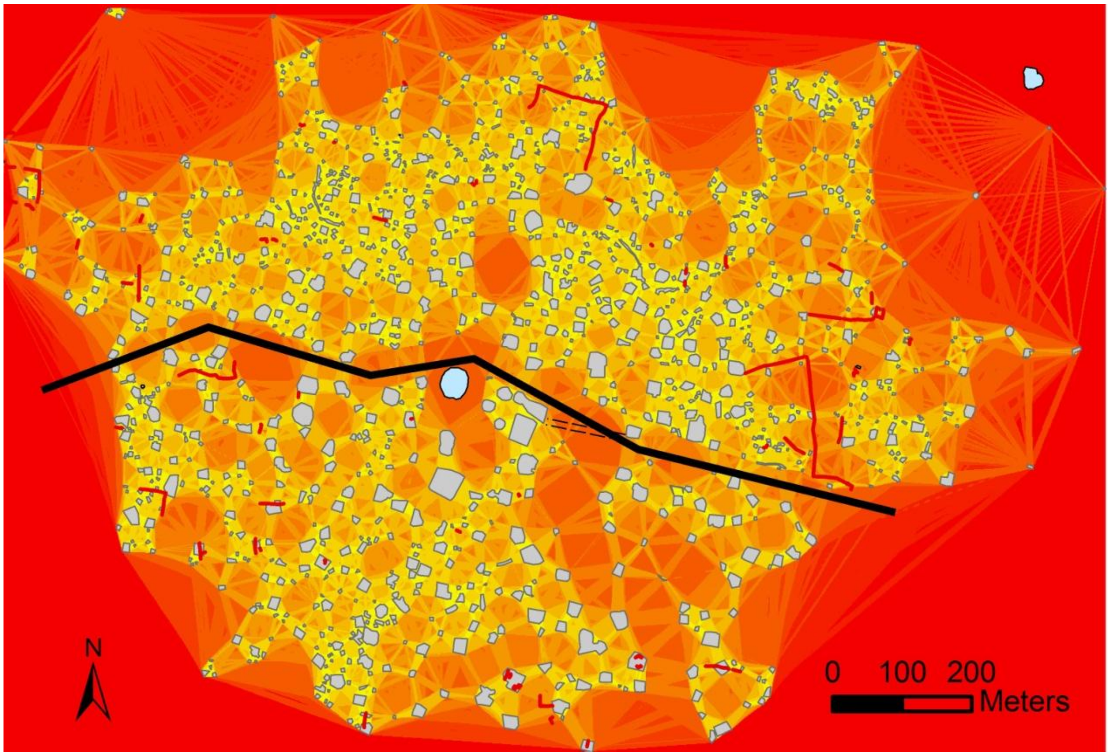


Figure 6.7. Openness Operator map, with east-west open space indicated by black line.

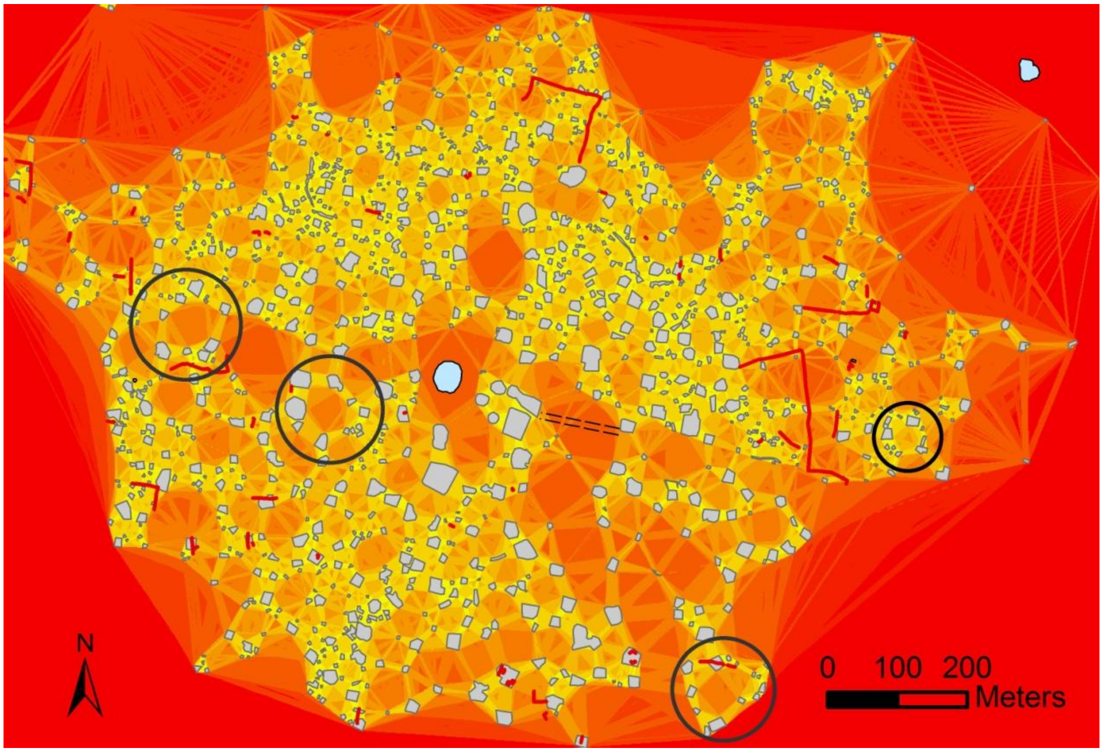


Figure 6.8. Openness Operator indicating potential patio groups highlighted by circles.

One of the open spaces that really stands out is the area surrounding Cenote T'isil (Figure 6.9). Access seems to be open, with clear spaces around the entire outer edge of the *cenote*. Also clearly visible in the image is the restricted space of a plaza in what appears to be the civic plaza where the two pyramids are located.

One of the most interesting aspects of the Openness map was the large open space located between two large, low platforms (11M-STR-03 and 11L-STR-14) located just south of Cenote T'isil (Figure 6.10). It is plausible to think that this open space was an area of public assembly, possibly a marketplace or an area where public gatherings might have occurred. The proximity of this space to Cenote T'isil, the civic plaza area, and the *sacbe* seems to indicate that this was an area of importance. Inomata (2006:810) notes that theatrical performance most likely occurred in plazas such as this, which he describes as "large open spaces surrounded by temples and other symbolically charged buildings" found at the core of every Classic Maya city. Inomata (2006:814) also describes low structures without roofs or walls that might have served as open stages and were likely used for ritual dance at smaller sites like Aguateca. This description matches the characteristics of structures 11M-STR-03 and 11L-STR-04 at T'isil.

One of the problems with using maps and tools like the Openness Operator is that it could lead to misinterpretation. For example, there appears to be many large open areas in the southeast corner of the map (Figure 6.11). Someone who looks at this map with no knowledge of the site's topography would likely remark on the unusually

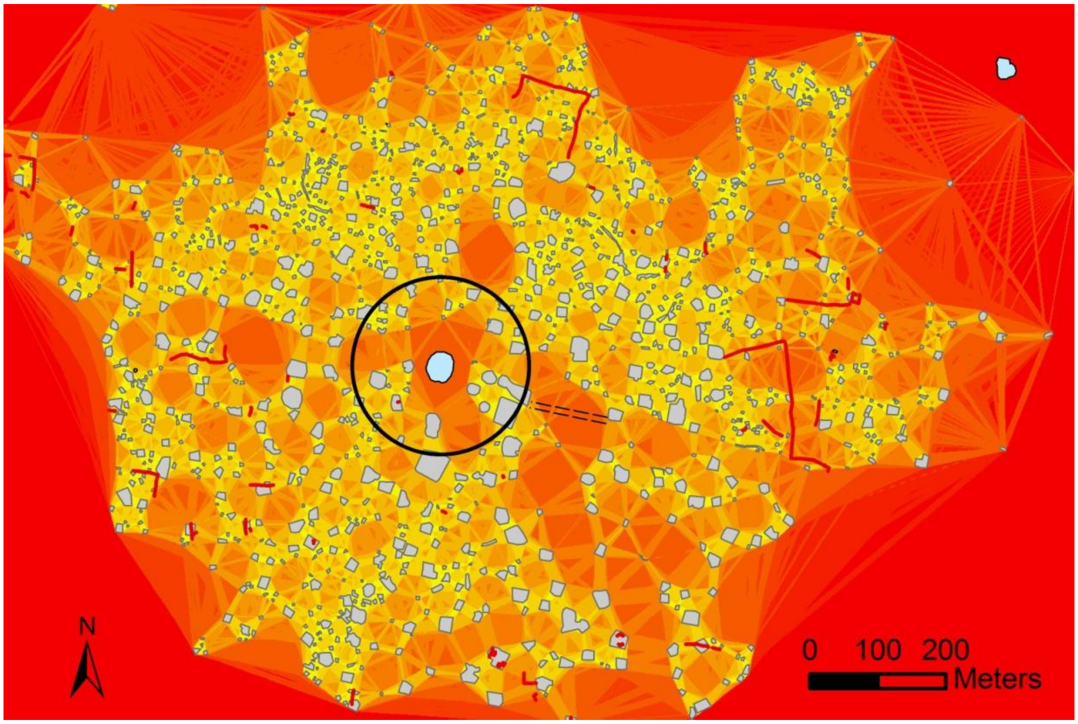


Figure 6.9. Openness Operator map showing open space around Cenote T'isil highlighted by circle.

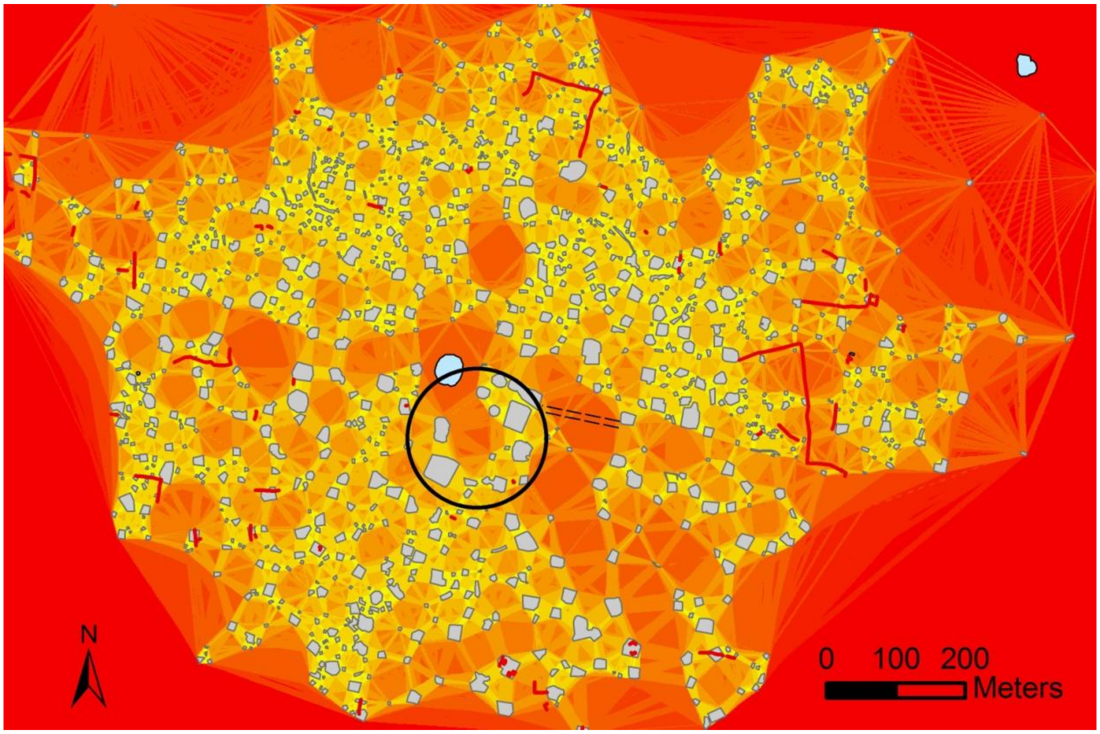


Figure 6.10. Openness Operator map, indicating possible public gathering area.

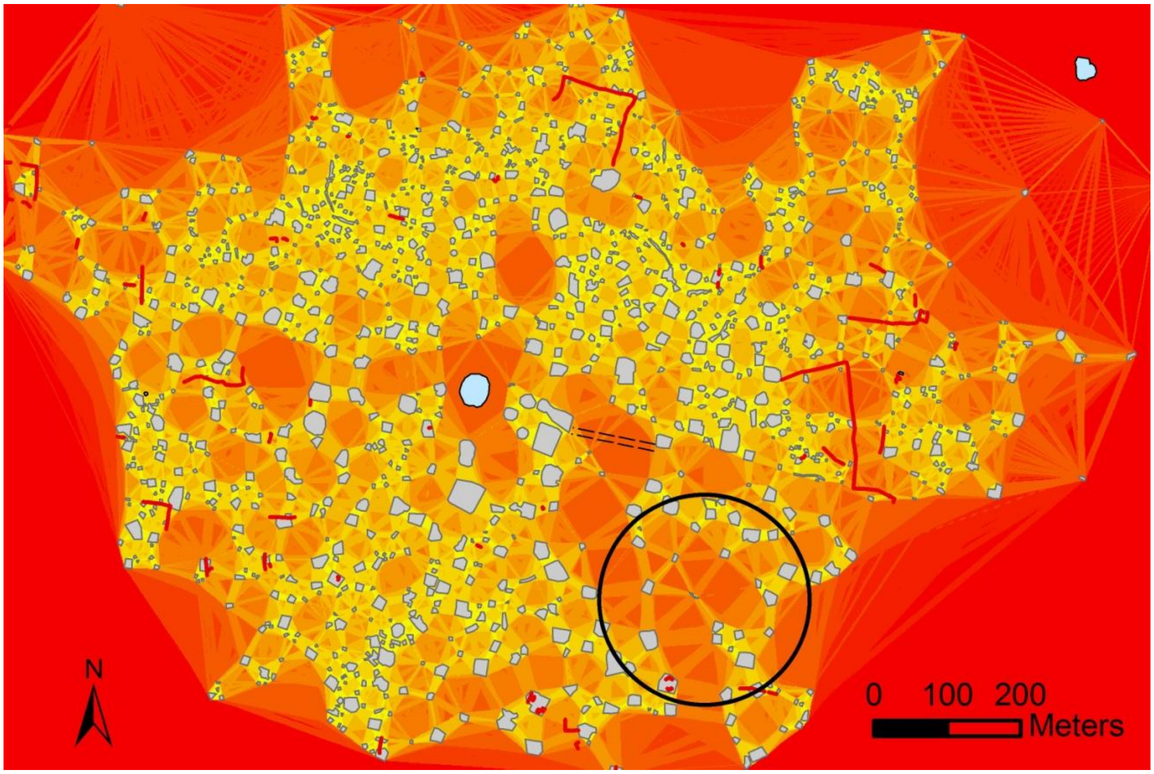


Figure 6.11. Openness Operator, open spaces in southeast corner where topography is very uneven.

numerous open spaces in this area. However, this area of the site is covered by large, broken slabs of limestone that are lying at various angles making this area unsuitable for building or even walking.

Another pattern that stands out is a rectangular open space that runs more or less east/west and is approximately 300 m in length located at the southern periphery of the study area (Figure 6.12). What is most remarkable is that this open space ends at the only pyramid not located in the civic plaza adjacent to Cenote T'isil. This pyramid-platform may well be an example of what Tourtellot (1988:377) refers to as a 'chief's establishment' which are often associated with open areas that may have been used for public ceremonies or rituals.   This east-west open space could also be a type of thoroughfare, providing access to the pyramid.

Conclusion

Although the Openness Operator did not confirm a four-part division, a visual examination of the map does provide evidence of quadripartition. The east-west thoroughfare divides the site into northern and southern halves. A wall of cut limestone blocks that have been carefully placed runs perpendicular to the *sacbe* and appears to divide the northeastern and northwestern quarters of the site and the placement of the possible ballcourt located midpoint between the two northern *cenotes* seems to further emphasize this division. Although I have not identified anything that might indicate a division in the southern half of the site, it does not mean that such a division does not exist. For example, if the site were divided into endogamous wards, as suggested by Coe

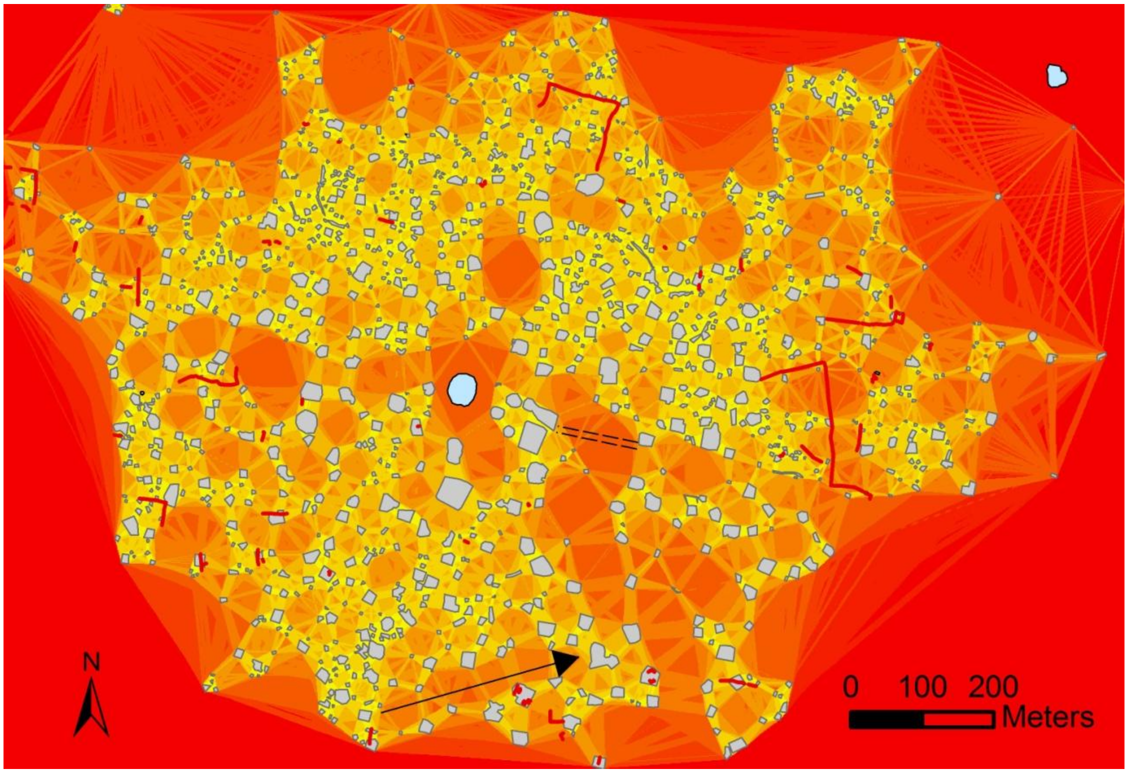


Figure 6.12. Openness Operator map showing open space leading to 8P STR-02 (arrow points to the pyramid/platform).

(1965:106), we might expect to see differences in other aspects of the archaeological record. There are alternate avenues of investigation that could be pursued and which might yield clues which would support this line of thinking. For example, a ceramic analysis could be used. Community-specific pottery designs and forms have been documented in the Maya region in ritual deposits, such as caches and burials (Bartlett and McAnany 2000:117), creating a "genealogy of place" linking ancestors and their descendants to specific locations (McAnany 1995:100). Although ceramics have been found to express community identity, I am not aware of any studies in the Maya region that looked at ceramic variation that would indicate differences within a community and I think this line of investigation might be rewarding. For example, petrographic analysis of ceramic pastes might reveal differences that could suggest 'family recipes' that could possibly differentiate areas of the site (Stark et al. 2000). Ceramic types and varieties, as well as decorative elements might also be analyzed to see if any locational patterns are revealed. I believe that some creative and innovative ways of looking at community structure could prove very informative.

Concentric Zone Model

The Concentric Zone model predicts that at Maya sites we should expect to find a central *cenote* or cave surrounded by the most impressive architecture, marking temples of worship and the residences of the elite (Coe 1965:106). This pattern may reflect the unequal distribution of social power, with architecture acting as the symbolic form of communication, expressing the relative importance of the individual. I used two statistical methods, Kendall tau and Linear Regression to determine if the Concentric Zone model is evident at the site of T'isil.

Kendall tau

As discussed in Chapter 5, the Kendall tau rank correlation coefficient is a statistical method used to measure the strength of the relationship between two rankings and to assess the significance of this correspondence. This is the method used by Arnold and Ford (1980) in their statistical examination of the settlement patterns at Tikal. A complete agreement of the rankings of distance from Cenote T'isil and the volume/basal area ratio (see Chapter 5 for a discussion of why this ratio was used) would result in a coefficient value of 1, and if the rankings were completely independent, the coefficient would have a value of 0.

The study area consists of all structures and features within a 500 m radius calculated from the center point of Cenote T'isil. I measured distance from the center point of Cenote T'isil for all structures and features in the study area using GIS software and the results are listed in Appendix A, along with the volume/basal area ratio for each. I then ranked the structures and features from 1 to 930, according to their distance from the center point (1 being the closest and 930 being the farthest away). I then ranked each structure and feature a second time based on its volume-to-basal area ratio, from 1 to 930 (1 having the largest volume-to-basal area ratio and 930 having the smallest).

Having calculated the distance and the volume/basal area figures for the 930 structures and features in the study area, I compared the two. If the assumption that high-status or elite individuals lived close to Cenote T'isil and the lower status individuals lived on the periphery, there should be a strong correlation between distance and labor investment (represented by the volume/basal area ratio). I tested this assumption using Kendall's tau-B statistical rank order method and if there is a positive and perfect correlation or relationship the tau-B value will be + 1.00. If there is no correlation or relationship (the null hypothesis), the tau-B value should approach zero.

The computer-generated calculation (Wessa 2008) of the tau-B coefficient produced the results seen below in Table 6.3. The tau-B result of 0.104 is a very low coefficient and this result indicates that there is no relationship between distance from Cenote T'isil and labor investment or status.

Kendall tau Rank Correlation - All Structures and Features within 500 m radius	
Kendall tau	0.104691125452518
2-sided p-value	1.78813934326172e-06
Score	45225
Var(Score)	89516896
Denominator	431985.03125

Table 6.3: Kendall tau Rank Correlation of All Structures and Features within a 500 meter radius of Cenote T'isil

However, to compare the results from T'isil to the study done by Arnold and Ford (1980) of residential architecture at Tikal, it was necessary to run the test again, this time using only residential architecture. T'isil has very little architecture that could be considered non-residential. Of the 930 structures and features that were mapped, only three can be positively identified as non-residential. These are the three pyramids, Structures 12M-STR-05, 11M-STR-04, and 8P STR-01 (see Figure 5.15). The results listed below in Table 6.4 still show a very low coefficient of 0.107 (rounded) again indicating no relationship between the distance from Cenote T'isil and labor investment/status.

Kendall tau Rank Correlation	
Kendall tau	0.107583627104759
2-sided p-value	9.39139226829866e-07
Score	46175
Var(Score)	88653848
Denominator	429201

Table 6.4 Kendall tau Rank Correlation of All Structures and Features Except Pyramids within a 500 meter radius of Cenote T'isil

Both results using the Kendall tau ranking correlation appear to support Arnold and Ford's (1980) conclusion of no concentric patterning. Arnold and Ford's computer calculation of *tau*-B = 0.03 led them to conclude that the two rank orders show such a low correlation that the null hypothesis cannot be rejected and there is no correlation between labor investment (status) and distance from the defined midpoint at Tikal (Arnold and Ford 1980:722).

Linear Regression

One of the limitations of the Kendall tau method is that it uses a ranking system that dilutes real spatial dimensions. The Kendall tau method simply ranks architecture from largest to smallest, or from closest to farthest. But what if, for example, you have

50 structures and 40 of them were within 25 to 30 m from the Cenote? With the Kendall tau method, they would all receive a ranking, and even though there are only a few meters difference in the distance for those 40 structures the ranking difference would make them statistically seem very different. Therefore, I decided to employ an alternative statistical approach, Linear Regression Analysis, to see if I might get different results. I used linear regression because this method allowed me to use actual measurements (such as the actual distance of each structure or feature, and the actual volume/basal area ratio rather than ranks. This method would more likely to pick up clusters of structures that are close in distance and/or basal/volume ratio.

As discussed in Chapter 5, linear regression is a technique in which a straight line is fitted to a set of data points to measure the relationship between the points. According to Griffiths (2009:640) positive linear correlation is indicated when low X-values correspond to low Y-values and high X-values correspond to high Y-values. If the values of both X and Y form a random pattern, then there is no correlation. The correlation coefficient, r, is a number between -1 and 1 that describes the scatter of data away from the line of best fit. If $r = 1$, there is a positive linear correlation. If $r = 0$, there is no correlation. (Griffiths 2009:640). And if $r = -1$, then there is an inverse correlation, in this case it would indicate that the closer you get to Cenote T'isil, the smaller the architecture (or labor investment). In this case the Y-variable would be the volume/basal area ratio of each structure or feature, and the X-variable would be distance of each structure or feature from Cenote T'isil.

I entered the X (distance from Cenote T'isil) and Y (volume/basal area ratio) values, into the program used to calculate the linear regression, again omitting the pyramids (Wessa, P. 2010). The resulting value of -0.032627 (Table 6.5) indicates no apparent correlation between the two variables. I plotted the points and the resulting scatterplot is displayed in Figure 6.13. The more often points fall along a straight line the stronger the linear relationship. The generated scatterplot indicates that there is not a strong relationship between the two variables.

Conclusions

Based on the results of both the Kendall tau and linear regression analyses, there does not appear to be a pattern of concentric zonation in terms of the status of the residents of T'isil. In this case, the null hypothesis cannot be rejected. Because all of the correlation coefficients are very low, I can only conclude that the relationship between distance to Cenote T'isil and the volume/basal area ratio is random. These findings support the conclusions reached by Arnold and Ford's (1980) statistical examination of

Simple Linear Regression	
rho - Least Squares	-0.032627

Table 6.5: Results of Linear Regression Analysis

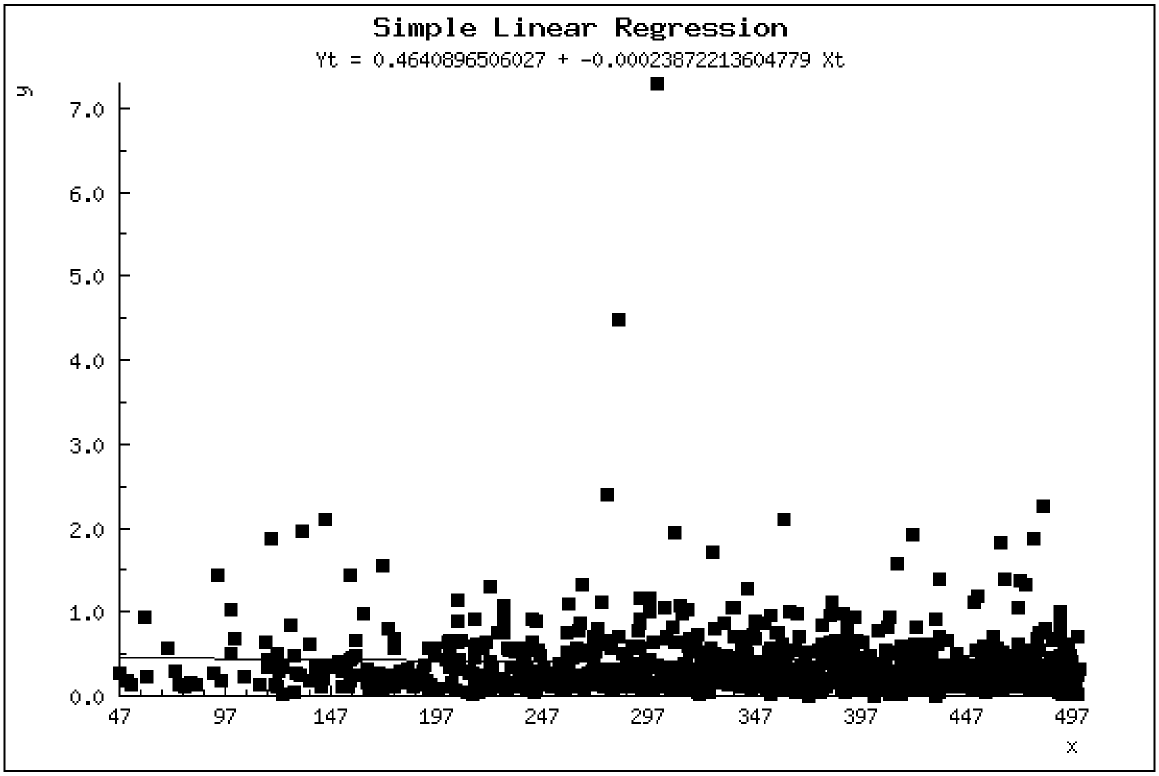


Figure 6.13: Scatterplot of Distance and Volume/Basal rankings

Tikal, which found no positive correlation between labor investment and distance from the defined midpoint of the site.

Even though the site does not appear to conform to the Concentric Zone model, it is interesting to note that of the 10 largest structures by volume at the site five are located within about 150 m of Cenote T'isil (10L-STR-13, 11M-STR-06, 12M-STR-05, 12M-STR-06, 11M-STR-03) (Figure 6.14). The settlement pattern at T'isil may not conform to the Concentric Zone model, but the fact that some of the largest architecture at the site, including the two pyramids, are found so close to Cenote T'isil indicates that this area of the site has some significance.

Arnold and Ford (1980:722-724) discuss alternative explanations for the lack of correlation and the apparent randomness at Tikal. One hypothesis suggests that the elite may have chosen to build their residences upon higher elevations (Becker 1973:401). Statistical results show that this hypothesis could not be supported at Tikal (Arnold and Ford 1980:724). This hypothesis could not be applied to T'isil either because of the lack of any substantial elevation change at the site.

Haviland (1968:112) suggests that the randomness might be explained by the fact that servants may have lived adjacent to the elite, which would certainly be manifested in a more random pattern. Arnold and Ford (1980:724), using a nearest neighbor statistical analysis, found no evidence to support this suggestion. A nearest neighbor approach examines the distances between each point and the point closest to it, and then compares these distances to see if there is a random pattern to their locations. If servants lived in smaller houses adjacent to the elite they served, there would be a discernable pattern to

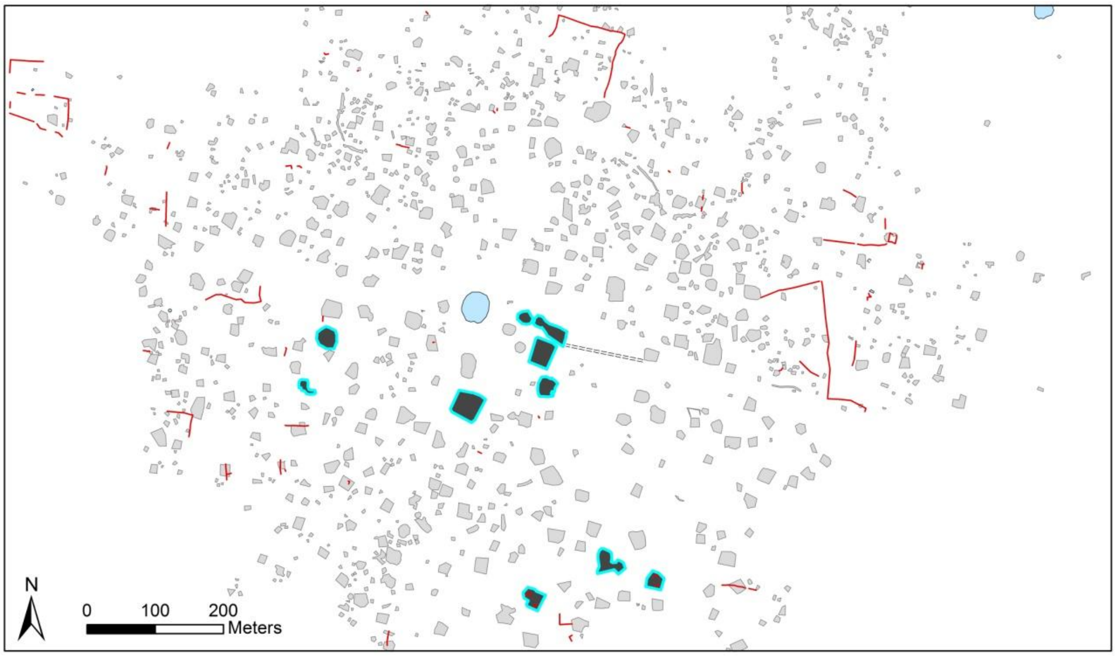


Figure 6.14. Location of 10 largest (by volume) structures at T'isil.

this distribution. This could possibly be the case at T'isil, but further research would be required to make this determination. Nearest neighbor analysis, combined with excavation could provide data to support or negate this hypothesis.

Bullard (1960:370) suggested that settlement may have been contingent upon the availability of water supply and level, well-drained house lots. Arnold and Ford (1980:724) observed that the majority of reservoirs at Tikal were part of the civic-ceremonial precinct and were therefore approximately the same distance to residences as the Great Plaza. There have been no wells located thus far at T'isil. Cenote T'isil is only seasonally-inundated and cannot be considered as a reliable water source for the community. There are five fresh-water *cenotes* at T'isil, but these are located on the periphery of the site, quite a distance from the ceremonial and geographic center, so this does not appear to be a determining factor in the application of the Concentric Zone model.

Arnold and Ford (1980:724) posit another possible explanation, suggesting that perhaps all of the high status inhabitants of the site lived within the study area, while the lower status lived outside of the study area, but further analysis would be necessary to make that determination. This hypothesis does not seem to apply at T'isil. The northern half of the site has been fully mapped, and structures definitely decrease in size toward the northern periphery.   However, this does not appear to be the case in the southern portion of the site. Transect surveys indicate that larger architecture extends all the way to the southern boundary (Figure 6.15) (Fedick 2006). My sense is that there is considerably larger

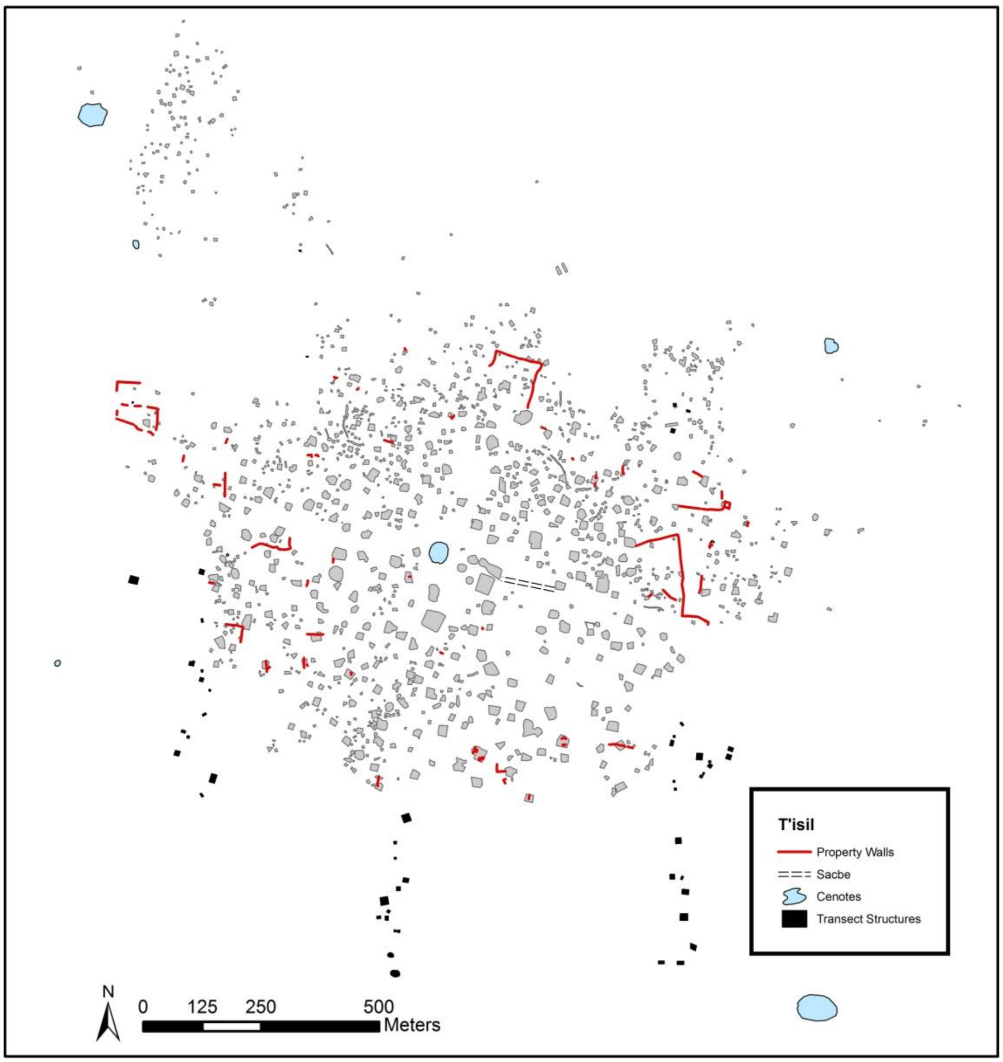


Figure 6.15. Southern boundary transect structures not formally mapped.

architecture in the southern half of the site than in the north, but that cannot be confirmed until completion of the mapping process. In any case, distance to Cenote T'isil does not seem to correlate to labor investment.

One suggestion made by Arnold and Ford (1980:724) that seems most plausible is that Tikal may have been settled rapidly during the Late Classic period. Rapid growth could result in a more organic settlement pattern, where structures were built when and where they were needed, rather than following a rigid pattern. This could very well be the case with T'isil, since evidence suggests a relatively short occupation period during the Late Preclassic.

Arnold and Ford made a valid point when they questioned the applicability of the Concentric Zone model at Tikal. Many scholars have accepted that the concentric zonation model applies to various sites in the Maya region, and it is entirely possible that many sites do indeed fit this pattern. Rigorous quantitative analysis of labor investment is one possible method that can be used to clarify this issue. However, labor investment may not be the only way to evaluate status. Independent verification through the a broad coverage collection and analysis of artifacts and ecofacts could provide a total-site approach that would paint a clearer picture of the settlement patterns of the ancient Maya (Smyth et al. 1995:342). An artifact analysis approach might reveal status differentiation that may not correlate with labor investment. If, as Arnold and Ford suggest, settlement patterning is not arranged the way it has commonly been accepted in the past, it is possible that many of the other assumptions of Maya social organization should be re-examined.

City Plan Template Model

Introduction

This analysis focused on whether some of the ideational urban planning principles present at many Classic period Maya sites are found at T'isil, a small non-elite site occupied primarily during the Preclassic period. This analysis relied on a visual examination of the T'isil map to see if any of the elements outlined by Ashmore (1991:200) are present. Ashmore outlined a particular spatial template that has been identified at various Maya centers from the Late Preclassic to the Late Classic which are based on orientation to cardinal directions.

These elements include:

1. Site organized around a marked north-south axis
2. Formal or functional dualism between north and south.
3. Elements located to the east and west to form a triangle with the north, and frequent "suppression of marking the southern position."
4. Presence of a ballcourt marking transition between north and south
5. Frequent use of causeways to emphasize connections among the cited elements, thereby underscoring the symbolic unity of the entire layout.

City Plan Template Analysis

The first element that I looked for at T'isil was the presence or absence of a marked north-south axis which is present in the layout of many Classic period architectural assemblages. Since T'isil lacks the major architectural groups that are present in Classic period civic centers, it is safe to say that a marked north-south axis is not present. The only architecture at T'isil that could be safely considered civic architecture are the two pyramids (12M-STR-05 and 11M-STR-04) located adjacent to the east side of Cenote T'isil. These two pyramids mark a north-south axis and are located within 20 m of each other in a small plaza (Figure 6.16) which differs from the east-west orientation of pyramidal structures at Classic period sites such as the twin pyramid group 4E-4 at Tikal or Str. E-VII Sub and Str. E1 at Uaxactun (Coggins 1980). The second and third components identified by Ashmore (1991:200) are formal or functional dualism between north and south, and east-west elements forming a triangle with the north. Again, the lack of monumental architecture at the site precludes a discussion about these elements at T'isil.

The fourth component of the model is the presence of a ballcourt marking the transition between north and south. Although T'isil does have a possible ballcourt, it is located on the northern periphery of the site (Figure 6.17) (Fedick 2009). The location of this ballcourt is unusual because it is not located anywhere near the civic architecture and the closest domestic architecture is approximately 85 m away. Ballcourts in the northwest area of the state of Yucatán are commonly found near the architectural centers of the sites, and are relatively small when compared to the better-known ball courts of the later Classic period sites (Robles and Andrews 2003; Medina 2003; Robles and Ceballos 2003).

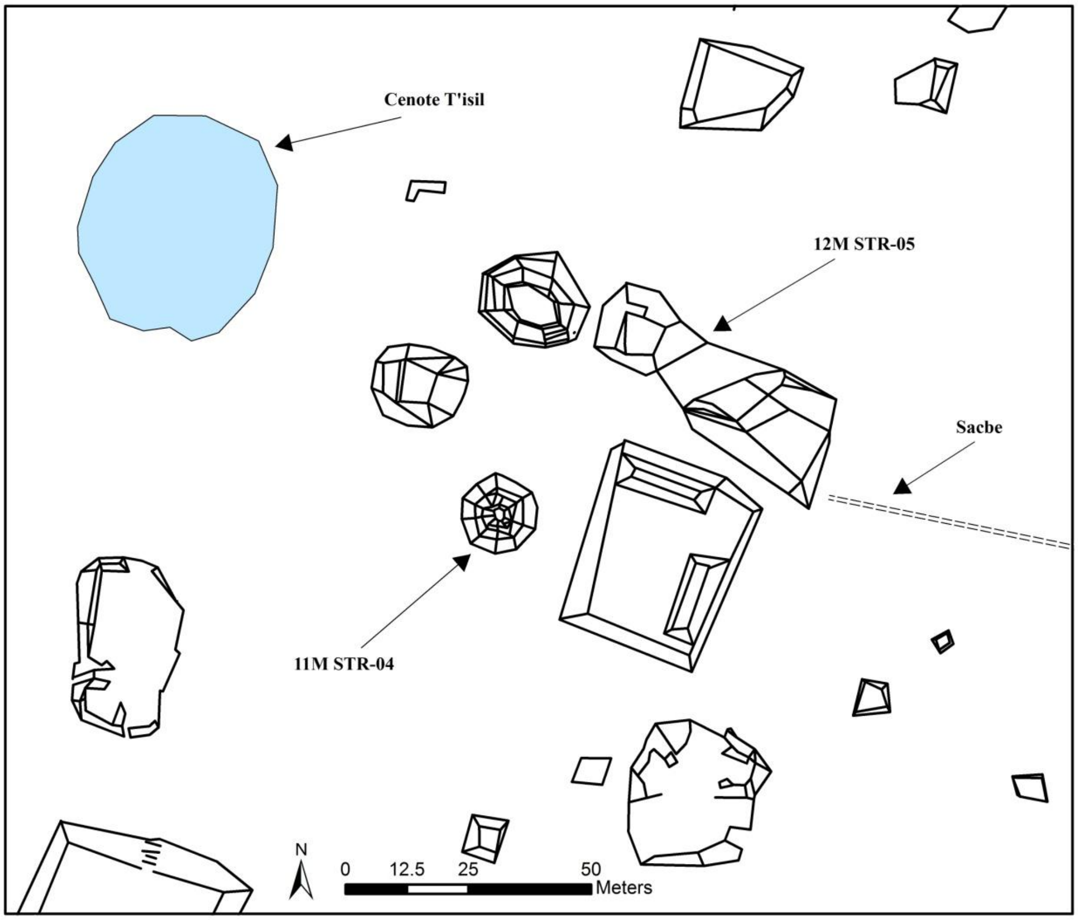


Figure 6.16: Pyramids in central plaza

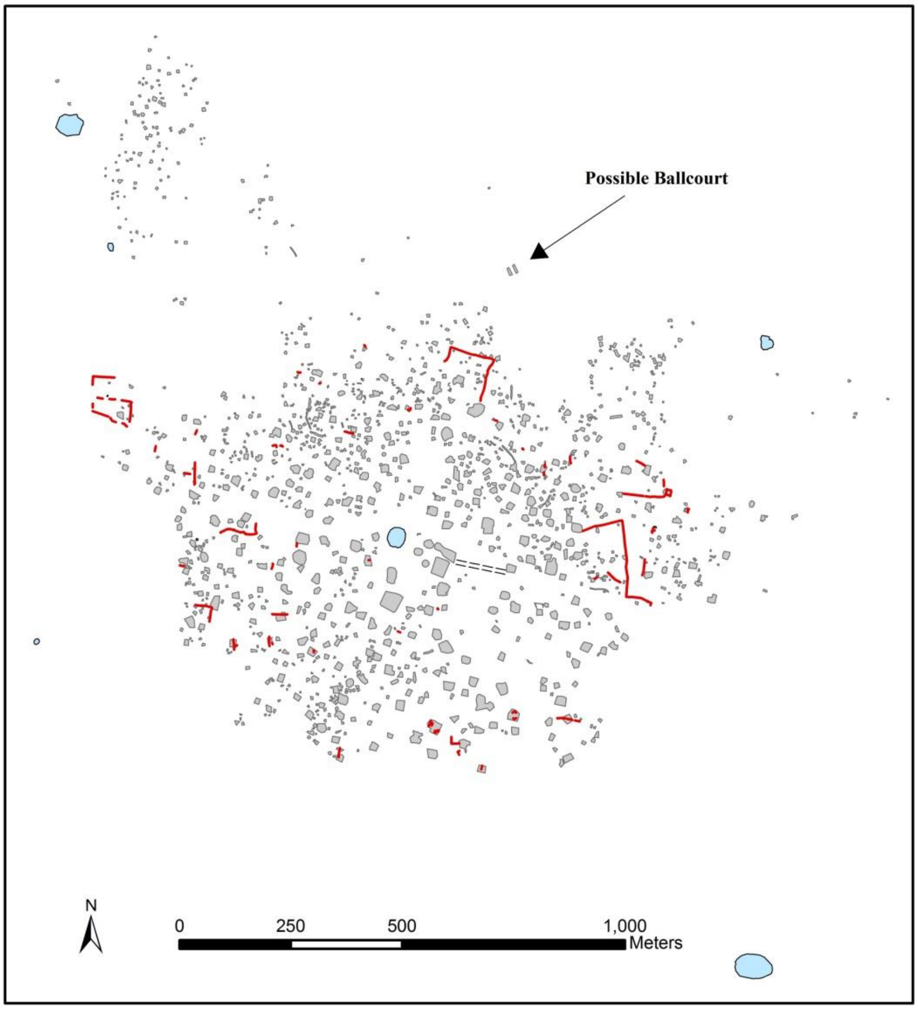


Figure 6.17: Possible Ballcourt at T'isil

The final element in this model is the presence of a causeway connecting the previously discussed components. The only *sacbe* identified at T'isil leads from the eastern outskirts of the site to a plaza area containing the two small pyramids, located adjacent to the eastern side of Cenote T'isil (see Figure 6.16). Although the *sacbe* does appear to terminate at the plaza located adjacent to Cenote T'isil, there is no evidence that it connects this plaza to any of the other elements as outlined by Ashmore (1991:200).

Conclusion

According to Ringle (1999:186), the construction of monumental architecture appears during the Middle-to-Late Preclassic transition, and it is during the Late Preclassic that we see the expression of architectural features and symbology that is appropriated in the Classic period by the elite to legitimize their position of power. Some of these elements, such as ballcourts, *sacbeob*, and pyramids, are present at T'isil and testing of these various models discussed above demonstrate that they were not utilized in the same way that we see at Classic period sites. The small pyramids at T'isil are the only features that could be considered at monumental, and even though there is variation in the size and volume of residential architecture, none of the platforms are as large or elaborate as the residences of the Classic period elite. T'isil probably had some degree of social differentiation, but remained more or less egalitarian in nature, similar to what we might now call a "blue collar" neighborhood, whose population probably relied on agriculture to make a living. The Preclassic was a period where the roots of the elements outlined in the City Plan Template model originated, but they were used in a very different way than they were in later periods of Maya history.

Overview of T'isil

Based on the research and analysis presented in this dissertation, I would now like to summarize my findings and provide an overview of T'isil using the data collected during many years of field research at the site. Although the mapping process is not yet complete, a majority of the site has been mapped, which allows me to present a relatively complete overview of the spatial layout of the site. However, due to future non-archaeological development, the mapping of T'isil may never be completed.

T'isil is a small community that appears to have had a limited Middle Preclassic population, but all evidence points to the peak of settlement occurring during the Late Preclassic and possibly into the Early Classic, with a limited re-occupation during the Postclassic. I hypothesize that the site was initially occupied because of its proximity to the wetlands, the anomalous rainfall amounts found in the Yalahau region, an amazing amount of biodiversity and perhaps the presence of natural features which may have been used as community boundary markers (discussion to follow).

Ceramic and radiocarbon dating evidence supports the idea that T'isil's main occupation period was the Late Preclassic/Early Classic with a seemingly abrupt abandonment. But why did the inhabitants of the site leave? At around the same time T'isil and other sites in the Yalahau were becoming depopulated, the site of Cobá, located approximately 80 km to the southwest of T'isil, was becoming a powerful regional entity.

Cobá was initially established during the Early Preclassic, growing into a city during the Early Classic, and was occupied until the Late Postclassic (Folan et al. 1983:212). The rise of Cobá coincides with the depopulation of T'isil, perhaps suggesting a migration from the Yalahau area to Cobá (Fedick and Taube 1995:10; Glover 2006:741). Abandonment of T'isil at this time may also be the result of fluctuating water levels that would have impacted use of the wetlands, making it unsuitable for agricultural purposes (Wollwage 2008).

The geographical and focal point of the site is Cenote T'isil. The civic architecture of T'isil consists of two small pyramids which are located adjacent to the eastern edge of Cenote T'isil. The pyramids, along with two large platforms and one other structure of indeterminate use, are centered on a plaza. A *sacbe* runs from this civic center toward the eastern side of the site. There is no evidence of any other *sacbe* segments at the site.

One of the larger platforms that ring the plastered courtyard is 11M-STR-06. This rectangular platform is one of the largest platforms at the site, measuring 37 x 34 m with a height of approximately 2 m (Figure 6.18). To the south of 11M-STR-06 is another structure that is rounded in shape, measuring approximately 25 x 30 m. This structure is made up of a ring of rubble less than .5 m in height, the interior of which is ground level. To the west of these two structures is what I refer to as the "mirror image" pair of platforms. This pair of platforms are very similar in dimension to the previously mentioned structures, but in this case the larger platform, 10L-STR-13 (42 x 40 m, approximately 2 m high), is located to the south of the lower platform, 11L-STR-14 (36 x

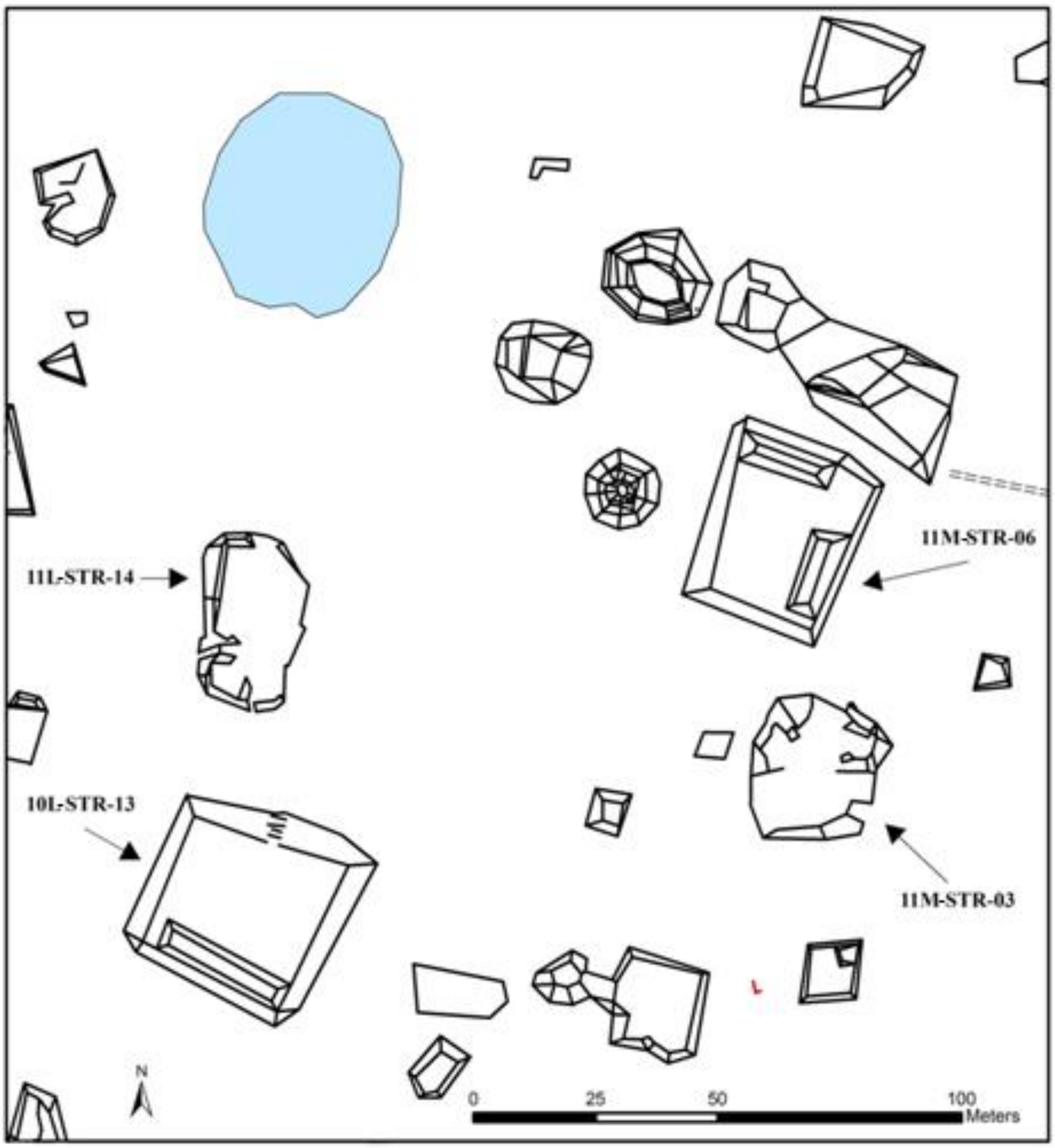


Figure 6.18. Mirror image pairs of structures.

21 m, less than .5 m high). The two larger platforms appear to be residential, but more research would be necessary to confirm this. The two lower platforms do not appear residential, and again more research would be necessary to support this conclusion. According to Ringle (1999:198), small Preclassic pyramids are often located in association with open areas or platforms used for dances or other public ceremonies, which may certainly be the case with the mirror image structures. Ringle believes that this pattern may indicate a Preclassic origin to the importance of centralized performance and display, and the mirror image complex could be ceremonial space.

Although there are a few larger structures, the size of architecture in the northern portion of the site appears to decrease in size as you move north. However, the southern half of the site is very different. The architecture in the southern mapped portion of the site is consistently much larger than what appears in the northern part of the site. Transect surveys seem to indicate that the architecture remains consistently large all the way to the southern boundary of the site (Fedick 2006). Also located in the southern half of the site is the third small pyramid at T'isil, 8P-STR-01. Ringle (1999:195) refers to these smaller pyramids as local or minor temples and notes that during the Late Preclassic period they are usually found singly or in association with domestic groups often scattered through Maya sites. This pyramid is different from the other two because it is attached to a large residential platform This fits with the pattern observed by Ringle who suggests this may indicate a more centralized and hierarchically-organized residential pattern. All of the architecture surrounding this pyramid/platform is relatively large in size. Tourtellot believes that the local temples acted as organizational nodes for "local corporate social groups each with its own idiosyncratic service center, or 'chief's establishment'" (1988:377)

There also appears to be a number of platform groups that could possibly be characterized as extended family compounds. Interspersed throughout these compounds are many *chich* mounds made up of cobbles and gravel that may indicate the former location of cultivated trees (Fedick and Morrison 2004; Kepecs and Boucher 1996).

North of Cenote T'isil is the remains of what I hypothesize might be a ballcourt (Fedick 2009). This possible ballcourt is unusual because it is located at the northern periphery of the site, not in the center of the community as is usually the case in the Maya region. It is fairly isolated, as the nearest architecture is approximately 90 m away. This pair of parallel structures (18P-STR-01 and 18P-STR-02) stand out because there is no other comparable architecture at the site (see Figure 6.17). The western structure (18P STR-01) is 18 m long, 6.5 m wide and 1.02 m high. The eastern structure (18P-STR-02) is 19.25 m long, 4.6 m wide, and .71 m high. The area between the two structures is 8.5 m wide. The orientation of these structures is approximately 338°, which is only slightly outside of the range of orientations noted for ballcourts in the northwestern Yucatán (Medina 2003:64).

Since the start of our mapping at T'isil, we have been interested in looking at the internal structure of the community to see if there was evidence to suggest that the quadripartite model might be expressed at the site. We did not really expect to find any features physically marking the corners of a quadripartite settlement. What we were looking for was more along the lines of four-part divisions in the settlement distribution or quadruple sets of distinctive structures within the community. We have assumed since the beginning of work that Cenote T'isil was at or near the geographic center of the ancient community, which we have confirmed. Cenote T'isil is a seasonally flooded *cenote*, about 45 m X 40 m in diameter, and with a 3 m drop from the surrounding ground surface to the bottom of the sinkhole (Figure 6.19). The largest ancient structures at the site are clustered relatively close to Cenote T'isil.

From early reconnaissance at the site, we had known of three other *cenotes*. Located 890 m northwest of Cenote T'isil, a deep water *cenote*, referred to by the landowners as the Swimming Cenote, has modern improvements constructed around it to facilitate swimming and leisure activities. It is 17.9 m X 13 m in diameter, with a drop of about 4 m from the ground surface to the water, which is about 12 m deep (Figure 6.20).

A short distance northwest of the Swimming Cenote, and 1130 m northwest of Cenote T'isil, is a large, seasonally flooded *cenote* referred to by the landowners at the Battlefield Cenote, because of the numerous historic/modern semi-circular rock-wall features that surround the *cenote* and appear to be defensive features. The Battlefield Cenote (Figure 6.21) is 62 m X 50 m in diameter, with a drop of 3 m from the surrounding ground surface to the interior floor. The Battlefield Cenote is filled with a deep deposit of organic-rich soil and has a distinctive vegetation association dominated by annona trees (*Annona glabra* L.).

Figure 6.19. Cenote T'isil (Photo by Scott Fedick).

Figure 6.20. Swimming Cenote at T'isil (Photo by Jeffrey Glover).

Figure 6.21. Battlefield Cenote at T'isil (Photo by Scott Fedick).

Another large, seasonally flooded *cenote* is situated 1200 m southeast of Cenote T'isil, and was identified during general reconnaissance of the Rancho Santa Maria property. The *cenote* is 84 m X 55 m in diameter, and drops about 3 m from ground surface to the interior floor. We refer to this *cenote* simply as the Southeast Cenote.

As mapping at T'isil progressed in 2005, we noticed some interesting attributes concerning the boundary of the site. Settlement density at T'isil seemed to drop off sharply, as opposed to most other lowland Maya sites, where boundaries are diffuse and difficult to define (Fedick 2006; Fedick and Sorensen 2006). Additionally reconnaissance and formal mapping indicated that ancient settlement extended to near, but not beyond, both the Battlefield Cenote in the northwest, and the Southeast Cenote (Fedick 2006b; Sorensen and Fedick 2006). Within the systematically mapped area of the site, an interesting feature was also mapped in 2005. This feature (designated as 10D-CN-1) appears to be a human-excavated pit located outside of the southwest margin of ancient settlement (Figure 6.22). The pit is 11.56 m X 13.81 m in diameter, and reaches a maximum depth of 4 m. The pit does reach below the rainy-season water table, and numerous modern bottles and cans scattered around the opening seem to indicate that it has been used as a water source in recent times. Around the opening of the pit is a semi-circle of rubble, probably remaining from the excavation of the pit (Figure 6.23). The mouth and walls of the pit (Figure 6.24) do not exhibit the eroded bedrock that is typical of natural sinkholes or miniature *cenotes*, dozens of which have been observed and mapped in the vicinity. The pit also does not conform to the appearance of constructed

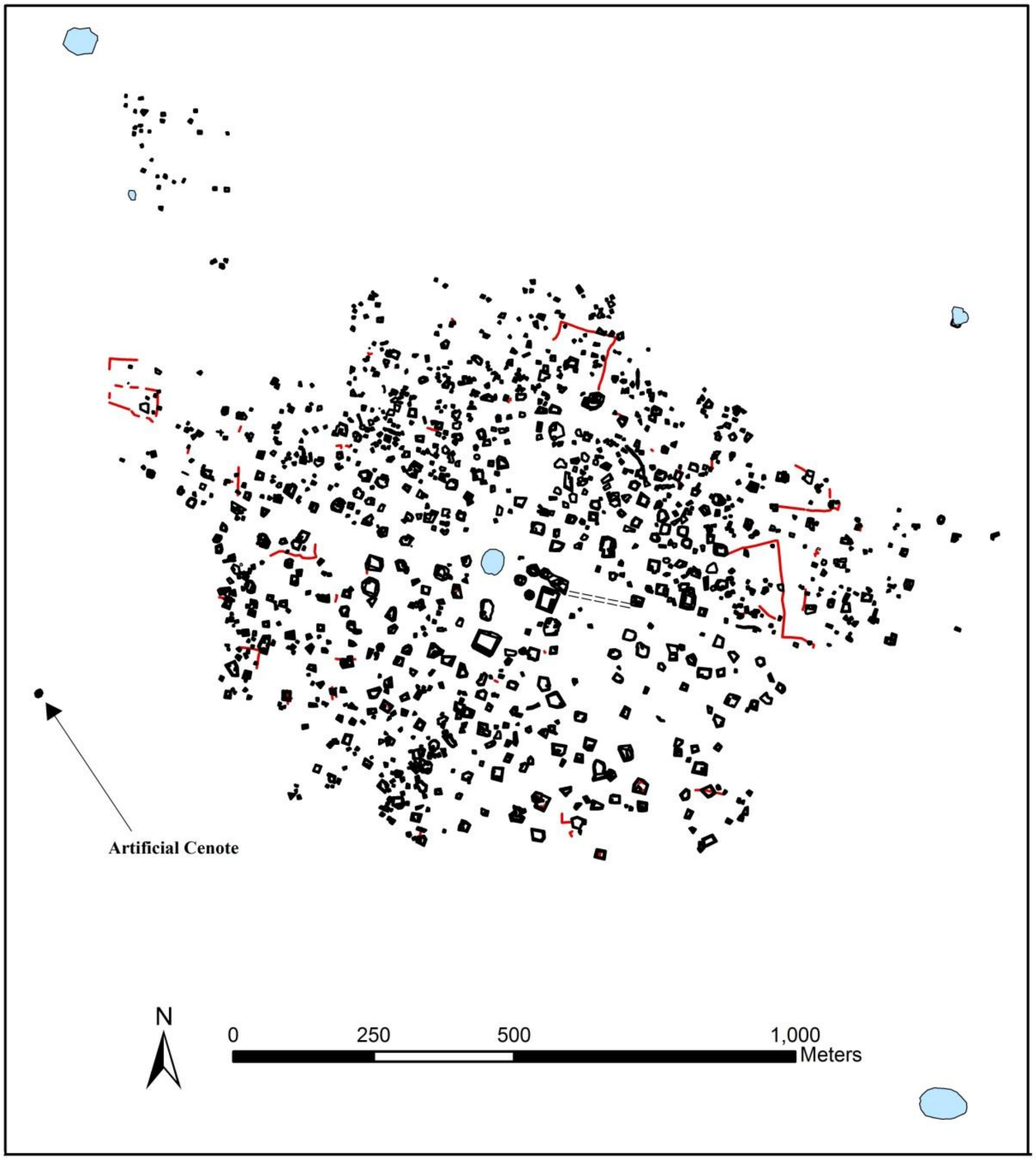


Figure 6.22. Location of artificial cenote.

Figure 6.23. Artificial *cenote* at T'isil.

Figure 6.24. Interior of artificial cenote.

ancient wells, which are also common in the region (Winzler and Fedick 1995). The location of the pit away from any major architecture, and the high ratio of depth to circumference, suggests that the pit does not represent an ancient quarry. For lack of a better functional designation, we refer to the pit as an artificial *cenote*.

After entering the data from the 2005 season into the computerized mapping program, we noted an interesting pattern. Not only did Cenote T'isil fall almost exactly at the midpoint between the Battlefield Cenote and the Southeast Cenote, but the extent of ancient settlement appeared to be bounded by these natural *cenotes* to the northwest and southeast, as well as by the artificial *cenote* in the southwest. Ancient settlement at T'isil may have conformed to a conceptual quincunx with *cenotes*, both natural and constructed, defining the boundaries. Construction of an artificial *cenote* as a landmark in a sacred landscape would not be unexpected or unique. There are numerous examples from the Maya area and elsewhere in Mesoamerica, for example, Dianzú near Monte Alban (Markman and Markman 1990:83), Acatzingo Viejo near Puebla (Aguilar et al. 2005) of artificial caves being constructed and incorporated into sacred landscapes (Brady and Rissolo 2006; Prufer and Kindon 2005). Did another *cenote*, either natural or artificial, mark the northeast corner of a quincunx at T'isil? Extending a line from the artificial *cenote* through Cenote T'isil and out to the northeast might predict the location of such a boundary marker (Figure 6.25). We had not yet systematically mapped the extent of settlement in the northeast.

The 2007 field season did complete mapping in the north of T'isil, with systematic mapping extending well beyond the limits of settlement. On June 8, 2007 a

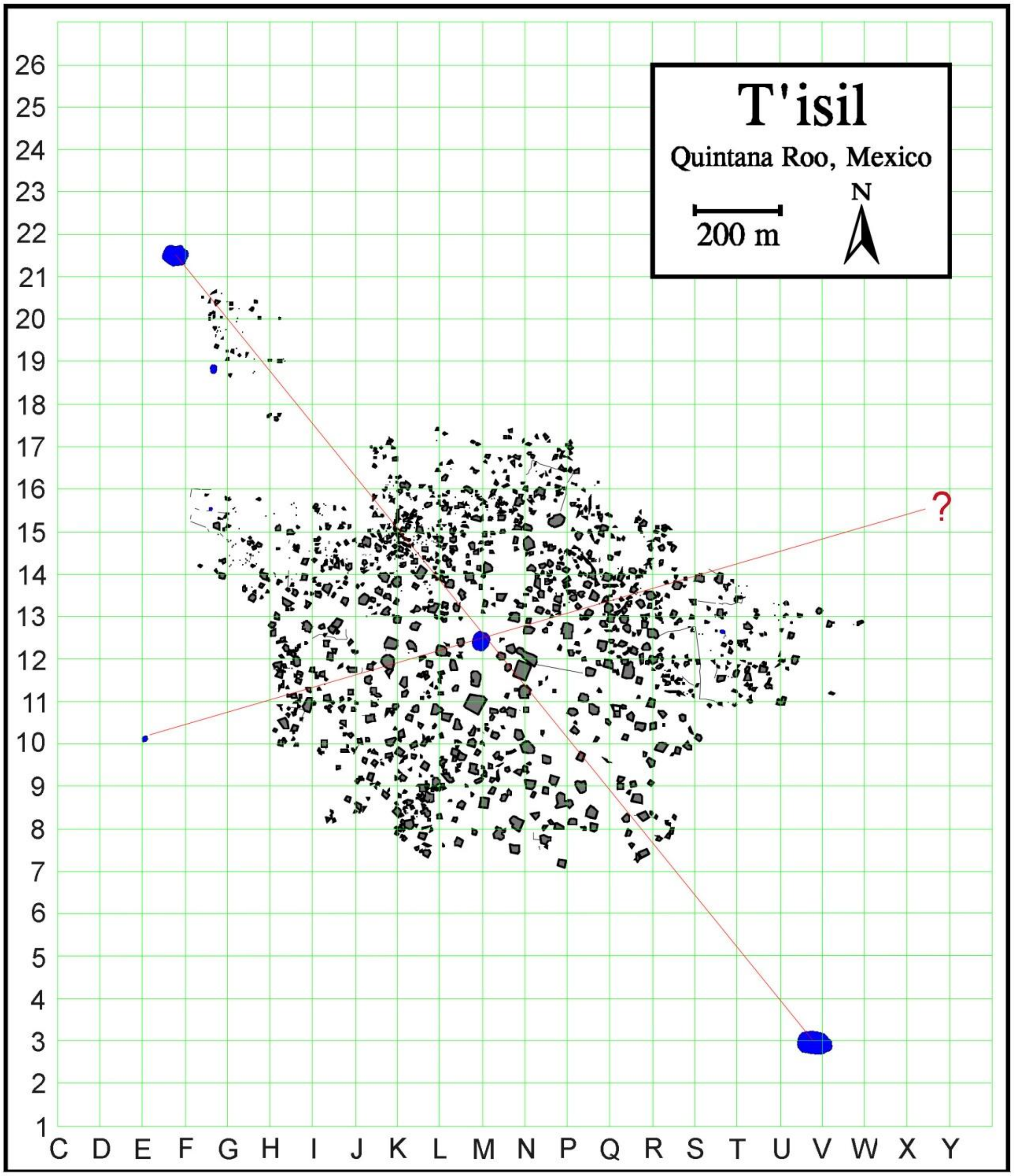


Figure 6.25. Map of T’isil at the end of the 2005 field season. A line runs between the Battlefield Cenote and the Southeast Cenote. A second line is projected from the Artificial Cenote, through Cenote T’isil, and out to the northeast.

survey crew reported finding a *cenote* in the northeast area (Figure 6.26). This *cenote* is 33 m X 27 m in diameter, with a depth from ground surface to the seasonally flooded floor of about three meters (Figure 6.27). The northeast *cenote* is located 903 m from Cenote T'isil. When plotted on the map, this new *cenote* fell almost exactly along the line extended from the artificial *cenote* through Cenote T'isil, and to the northeast. This new *cenote* completed a quincunx (Figure 6.28), and is likely to have been used by the ancient Maya to determine the location for the artificial *cenote*, in a process opposite of what we had used to predict the location of the northeast *cenote*. It may not be possible to conclusively say that the pattern of settlement and *cenotes* at T'isil represents an intentional effort by the Maya to plan their community in conformance with a cosmological template (see Smith 2005). It does, however, seem to be a plausible hypothesis, particularly considering the excavation of an artificial landscape feature that appears to complete the pattern. The mid-point placement of the possible ballcourt along the line between the two northern *cenotes* also helps bolster the idea that the inhabitants of T'isil were intentionally conforming to a preconceived spatial template.

Overall, T'isil is a small and very dense site whose primary occupation was during the Late Preclassic/Early Classic period. The site is almost exclusively residential, with only a handful of structures that could be considered public architecture indicating that T'isil was a largely egalitarian society with limited differences in rank.

Figure 6.26. Field crew finds missing cenote (Photo by Scott Fedick).

Figure 6.27. View of Northeastern Cenote (Photo by Scott Fedick).

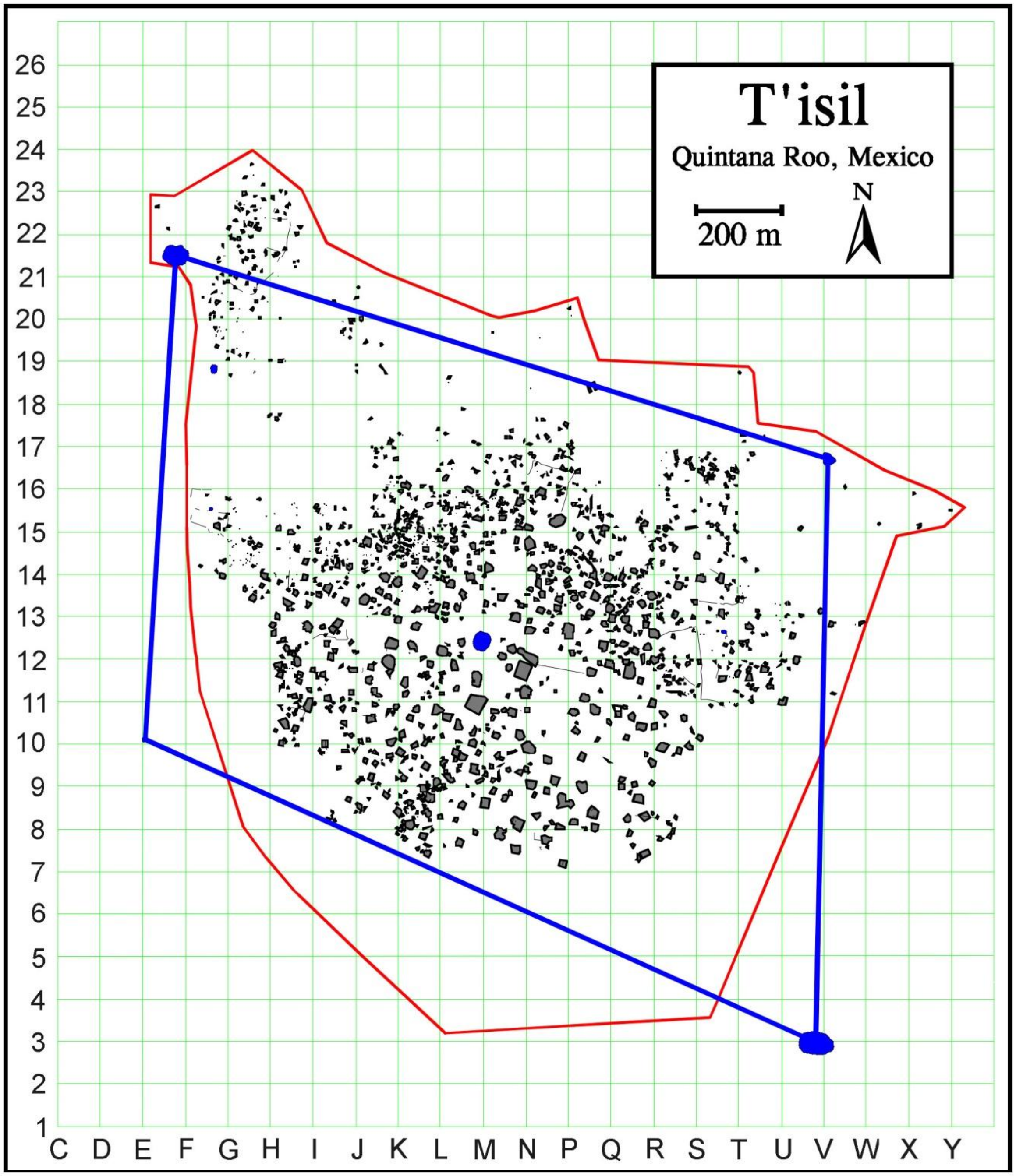


Figure 6.28. Completed quincunx pattern at T'isil.

Concluding Remarks

This final section discusses the contribution this dissertation makes to our understanding of the spatial layout of a Preclassic/Early Classic period Maya community. Additionally, I outline some potential research projects that would further clarify our understanding of settlement in a small, non-elite Preclassic period site and perhaps just as important, further research at T'isil would contribute to a deeper insight into the settlement history of the Yalahau region as well.

This study focused on the spatial layout of a small, non-elite site called T'isil. The goal of my research was to provide a chronology of the site, and to explore models of community structure using settlement pattern data to provide insight into Maya social organization and community structure during the Preclassic/Classic period transition. I was able to accomplish two important goals. First, I was able to establish a chronology for the site through radiocarbon dating analysis, where previously dates had been based on tenuous ceramic cross-dating. Results of the radiocarbon dating put the primary occupation of T'isil securely in the Late Preclassic/Early Classic transition period. It is hoped that the dates provided from this site will help shed more light on the settlement chronology of the Yalahau region. Second, I applied three models of community structure used elsewhere in the Maya region to see if any of these models could be applied to the layout at T'isil. Although the data I used for testing these models doesn't fit either the Concentric Zone model or the City Plan Template model, this does not definitively exclude the possibility that these models could be applied at T'isil, and further research would be necessary to make this determination. However, there does seem to be evidence that the Quadripartite model can be applied at the site, providing evidence that concepts of spatial planning do indeed have roots in the Preclassic period.

At this point, I would like to outline a few of the future projects that could further illuminate our understanding of the settlement patterns in the Yalahau region. When mapping began at T'isil, the primary objective was to find out what we could about Maya social organization and community structure during the Preclassic/Classic period transition. It was our intention to complete the map and then go back and carry out a series of excavations that would answer some of the questions raised by our observations.

There are a number of projects that could contribute to a larger understanding of the site. Most important is the need for more dates from T'isil and from across the region to provide a sound chronology on which to contextualize future research projects. It would be useful to collect more dates from various locations at T'isil through a comprehensive excavation strategy, and use them to further refine our understanding of the initial settlement and growth patterns at the site. For example, excavations at what I call the "mirror image" platforms would help provide evidence of when they were constructed and how they were used, and excavations at the parallel structures thought to be a possible ballcourt could clarify their use.

A second equally-important future goal would be completion of the T'isil map. Since our final field season in 2007, the site has been purchased by developers who plan on constructing a resort style community, complete with golf course, at this location. A complete map of T'isil would be a significant contribution toward an understanding of a Preclassic community layout, particularly if this development takes place. There are very few sites of this size, age, and density that have been fully mapped and it would be a shame if the map was not completed due to development.

These proposed research projects are just a few ideas, but they would provide a broader understanding of the settlement at the site and in the region. I hope that my research will prove to be helpful to others who work in the Yalahau as we strive to better understand this rich and unique area of the Maya lowlands.

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APPENDIX A - FEATURES MAPPED

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
07J	7J STR-01						114.85	6.505
07K	7K STR-01						157.39	5.840
07K	7K STR-02						220.83	108.815
07K	7K STR-03						64.12	34.759
07K	7K STR-04						205.62	71.984
07K	7K STR-05						22.40	7.013
07K	7K STR-06						41.74	15.091
07K	7K STR-07						46.34	23.977
07K				7K PW-01				
07L	7L STR-01						106.37	40.253
07L	7L STR-02						271.24	142.377
07L	7L STR-03						15.18	6.444
07M	7M STR-01						504.12	602.168
07M	7M STR-02						400.51	153.486
07N	7N STR-01						363.67	240.198
07N	7N STR-02						17.08	2.719
07N	7N STR-03						251.78	178.942
07N				7N PW-01				
07N				7N PW-02				
07Q	7Q STR-01						114.22	44.389
07Q	7Q STR-02						302.24	111.393
07Q	7Q STR-03						144.97	40.428
07Q	7Q STR-04						53.02	20.192
07R	7R STR-01						57.39	16.613

Section	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
07R	7R STR-02						62.25	21.335
08I	8I STR-01						125.02	45.355
08I	8I STR-02						29.92	16.175
08I	8I STR-03						13.33	4.474
08I	8I STR-04						57.05	23.052
08I	8I STR-05						11.37	2.449
08J	8J STR-01						95.61	32.520
08J	8J STR-02						14.44	5.999
08J	8J STR-04						237.29	83.425
08J	8J STR-06						10.00	1.805
08J	8J STR-07						16.13	4.680
08J	8J STR-08						8.75	1.304
08J	8J STR-09						163.63	86.529
08J	8J STR-10						19.30	4.985
08J	8J STR-11						32.82	8.831
08J	8J STR-12						9.96	1.567
08J	8J STR-13						144.20	99.478
08J		8J CH-01					4.89	0.988
08J		8J CH-02					6.11	0.738
08K	8K STR-01						27.48	7.541
08K	8K STR-02						432.07	489.343
08K	8K STR-03						89.33	21.228
08K	8K STR-04						204.94	74.658
08K	8K STR-05						21.77	2.579
08K	8K STR-06						37.49	2.388
08K	8K STR-07						349.64	97.822
08K	8K STR-08						20.56	2.817

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
08K	8K STR-10						24.47	2.819
08K	8K STR-11						8.57	0.865
08K	8K STR-12						8.80	1.107
08K	8K STR-13						27.13	6.483
08K	8K STR-14						280.33	111.493
08K	8K STR-15						40.91	4.252
08K	8K STR-16						35.46	9.093
08K	8K STR-17						32.92	12.385
08K	8K STR-18						12.94	1.800
08K	8K STR-19						13.37	1.290
08K	8K STR-20						132.09	69.559
08K	8K STR-21						154.33	128.428
08K	8K STR-22						33.28	7.015
08K	8K STR-23						20.24	1.722
08K	8K STR-24						62.87	12.270
08K	8K STR-25						20.08	2.680
08K	8K STR-26						18.25	3.842
08K	8K STR-27						20.33	1.727
08K	8K STR-28						51.04	15.204
08K	8K STR-29						9.24	1.927
08K	8K STR-30						10.03	1.287
08K	8K STR-31						8.83	2.000
08K		8K CH-01						
08K		8K CH-02					7.02	0.448
08L	8L STR-01						219.80	148.827
08L	8L STR-02						397.78	213.285
08L	8L STR-03						37.95	5.447

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
08L	8L STR-04						72.95	26.044
08L	8L STR-05						15.60	1.388
08L					8L CV-01			
08L					8L CV-02			
08L					8L CV-03			
08L					8L CV-04			
08L					8L CV-05			
08L					8L CV-06			
08L					8L CV-07			
08M	8M STR-01						674.12	942.164
08M	8M STR-02						100.69	213.285
08M	8M STR-03						151.59	32.175
08M	8M STR-04						138.51	51.037
08N	8N STR-01						185.36	94.541
08N	8N STR-02						58.11	23.433
08N	8N STR-03						238.67	146.471
08N	8N STR-04						78.45	18.183
08N	8N STR-05						69.61	24.503
08N	8N STR-06						167.02	81.326
08P	8P STR-01						881.86	1415.260
08P	8P STR-02						519.71	819.970
08P	8P STR-03						235.01	315.875
08P	8P STR-04						8.85	1.462
08P	8P STR-05						25.14	8.567
08P	8P STR-06						244.75	174.396
08P	8P STR-07						513.96	968.837

Section	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
08Q	8Q STR-01						31.59	15.146
08Q	8Q STR-02						447.86	217.682
08Q	8Q STR-03						34.46	20.316
08Q	8Q STR-04						212.75	302.445
08Q	8Q STR-05						312.16	152.471
08Q				8Q PW-01				
08R	8R STR-01						92.72	50.271
08R	8R STR-02						19.58	4.610
08R	8R STR-03						26.10	8.602
08R	8R STR-04						45.45	71.945
08R	8R STR-05						21.55	3.254
09I	9I STR-01						12.65	2.399
09I	9I STR-02						10.98	2.245
09I	9I STR-03						15.81	2.036
09I	9I STR-04						68.06	15.990
09I	9I STR-05						56.37	19.973
09I	9I STR-06						13.77	3.477
09I	9I STR-07						8.11	0.577
09I	9I STR-08						16.12	3.606
09I				9I PW-01				
09I				9I PW-02				
09I					9I CV-01			
09J	9J STR-01						43.91	5.877
09J	9J STR-02						16.18	2.834
09J	9J STR-03						115.94	82.872
09J	9J STR-05						77.24	40.234
09J	9J STR-06						84.60	51.920

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
09J	9J STR-07						19.90	4.787
09J	9J STR-08						223.08	113.246
09J	9J STR-09						16.54	4.759
09J	9J STR-10						24.08	6.968
09J	9J STR-11						11.96	1.102
09J	9J STR-12						86.70	42.376
09J	9J STR-13						27.91	5.141
09J	9J STR-14						14.38	1.676
09J	9J STR-15						62.80	23.748
09J		9J CH-01						
09J		9J CH-02						
09K	9K STR-01						256.31	130.273
09K	9K STR-02						229.27	124.578
09K	9K STR-03						11.97	2.382
09K	9K STR-04						14.35	3.793
09K	9K STR-05						8.60	4.003
09K	9K STR-06						51.16	27.701
09K	9K STR-07						175.84	125.871
09K	9K STR-08						11.01	2.072
09K	9K STR-09						19.01	3.938
09K	9K STR-10						92.35	28.880
09K	9K STR-12						274.93	200.792
09K	9K STR-13						38.84	20.710
09K	9K STR-14						15.19	5.096
09K		9K CH-01					5.06	0.894
09K				9K PW-01				
09L	9L STR-01						237.67	314.299

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
09L	9L STR-02						200.28	202.983
09L	9L STR-03						98.45	107.803
09L	9L STR-04						58.00	34.819
09L	9L STR-05						39.95	16.526
09L	9L STR-06						11.76	2.550
09L	9L STR-07						24.10	7.419
09L	9L STR-08						50.14	10.405
09L	9L STR-09						22.91	3.191
09L	9L STR-10						385.96	250.045
09L	9L STR-11						97.20	21.488
09L	9L STR-12						121.05	53.680
09L	9L STR-13						43.20	11.130
09L	9L STR-14						263.31	164.093
09L	9L STR-15						87.76	20.646
09L	9L STR-16						267.63	457.895
09L	9L STR-17						27.61	7.824
09L	9L STR-18						27.22	14.480
09M	9M STR-01						154.23	47.506
09M	9M STR-02						41.65	9.696
09M	9M STR-03						129.24	29.078
09M	9M STR-04						81.78	23.423
09M	9M STR-05						7.54	3.072
09M	9M STR-06						68.60	40.559
09M	9M STR-07						119.33	25.179
09M	9M STR-08						69.84	49.556
09M	9M STR-09						84.94	32.064
09N	9N STR-01						411.59	201.649

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
09N	9N STR-02						126.63	70.954
09N	9N STR-03						340.75	335.501
09N	9N STR-04						21.48	7.488
09N	9N STR-05						290.36	195.910
09P	9P STR-01						212.23	161.954
09P	9P STR-02						23.07	13.049
09Q	9Q STR-01						72.01	24.053
09Q	9Q STR-02						158.70	217.682
09Q	9Q STR-03						91.17	149.056
09Q	9Q STR-04						273.14	274.647
09Q	9Q STR-05						149.22	53.402
09Q	9Q STR-06						124.75	87.142
09Q					9Q CV-01			
09R	9R STR-01						194.35	115.984
09R	9R STR-02						19.11	3.221
09R	9R STR-03						220.72	146.380
10D					10D CN-01			
10H	10H STR-01						123.64	48.257
10H	10H STR-02						11.24	2.502
10H	10H STR-03						7.27	0.689
10H	10H STR-04						21.55	4.187
10H	10H STR-05						150.11	83.662
10H	10H STR-06						10.05	2.319
10H	10H STR-07						36.23	12.525
10H	10H STR-08						384.55	276.376
10H	10H STR-09						47.43	107.993
10H	10H STR-10						14.14	1.247

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
10H	10H STR-11						14.94	4.134
10H	10H STR-12						469.68	435.424
10H	10H STR-13						20.14	4.424
10H	10H STR-14						30.51	10.492
10H	10H STR-15						24.95	5.327
10H	10H STR-16						8.96	0.177
10H	10H STR-17						13.79	4.439
10H	10H STR-18						34.41	14.398
10H				10H PW-01				
10I	10I STR-01						59.56	24.164
10I	10I STR-02						73.83	26.685
10I	10I STR-04						16.21	3.755
10I	10I STR-05						9.37	2.318
10I	10I STR-06						126.20	65.895
10I	10I STR-08						117.89	72.293
10I	10I STR-09						232.28	193.981
10I	10I STR-10						31.18	13.298
10I	10I STR-11						10.29	2.172
10I	10I STR-12						53.26	28.458
10I	10I STR-13						14.49	8.540
10I	10I STR-14						11.75	2.414
10I		10I CH-01					5.59	1.021
10I		10I CH-02					5.47	2.448
10I					10I CV-01			
10J	10J STR-01						96.62	25.133
10J	10J STR-02						54.34	43.808
10J	10J STR-03						14.37	2.156

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
10J	10J STR-04						293.28	113.001
10J	10J STR-05						61.81	22.758
10J	10J STR-06						79.45	30.398
10J	10J STR-07						321.08	336.258
10J	10J STR-08						118.77	14.135
10J	10J STR-09						88.91	49.852
10J	10J STR-10						24.78	9.189
10J				10J PW-01				
10J				10J PW-02				
10J				10J PW-03				
10K	10K STR-01						426.56	60.418
10K	10K STR-02						207.35	120.894
10K	10K STR-03						42.10	5.138
10K	10K STR-04				`		28.17	4.070
10K	10K STR-05						15.61	3.960
10K	10K STR-06						11.43	1.198
10K	10K STR-07						126.21	88.980
10K	10K STR-08						135.70	35.892
10K	10K STR-09						84.82	26.367
10K	10K STR-10						15.28	2.436
10K	10K STR-11						202.08	180.363
10K	10K STR-12						202.06	41.507
10K	10K STR-13						34.92	13.023
10L	10L STR-01						300.81	172.424
10L	10L STR-02						299.20	156.376
10L	10L STR-03						184.24	11.243
10L	10L STR-04						229.34	101.500

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
10L	10L STR-05						19.49	5.060
10L	10L STR-06						54.81	12.487
10L	10L STR-09						13.73	1.601
10L	10L STR-13						1517.10	3209.352
10L			10L FEAT-07				19.15	2.441
10L			10L FEAT-08				22.66	1.860
10L					10L CV-01			
10M	10M STR-01						132.43	48.202
10M	10M STR-02						412.46	239.155
10M	10M STR-03						470.40	270.939
10M	10M STR-04						8.36	1.112
10M	10M STR-06						93.20	27.768
10M	10M STR-07						149.97	13.604
10M	10M STR-08						207.82	85.100
10M	10M STR-10						16.75	5.439
10M	10M STR-11						34.81	5.613
10M	10M STR-12						16.09	18.413
10M				10M PW-01				
10M				10M PW-02				
10M					10M CV-01			
10M					10M CV-02			
10N	10N STR-01						631.96	259.164
10N	10N STR-02						53.24	20.200
10P	10P STR-01						113.08	38.705
10P	10P STR-02						428.23	832.545
10P	10P STR-03						275.77	166.281

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
10P	10P STR-04						10.76	1.614
10P	10P STR-05						180.31	191.772
10P	10P STR-06						59.21	21.424
10Q	10Q STR-01						237.18	222.343
10Q	10Q STR-02						69.24	23.167
10Q	10Q STR-03						360.26	181.078
10Q	10Q STR-04						198.00	173.396
10Q	10Q STR-05						123.04	30.941
10R	10R STR-01						184.49	131.321
10R	10R STR-02						180.83	109.952
10R	10R STR-03						390.79	336.156
10R	10R STR-04						157.86	89.049
10R	10R STR-05						69.26	47.607
10R	10R STR-06						15.18	2.915
10S	10S STR-01						23.56	4.000
10S	10S STR-02						38.10	12.308
10S	10S STR-04						177.56	49.543
10S		10S CH-01						
10S		10S CH-02						
10S		10S CH-03						
10S			10S FEAT-03				10.06	1.066
10T		10T CH-01						
10T		10T CH-02						
11H	11H STR-01						114.13	54.649
11H	11H STR-02						38.69	9.907
11H	11H STR-03						11.96	2.364
11H	11H STR-04						35.81	6.731

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11H	11H STR-05						13.22	3.378
11H	11H STR-06						96.02	41.192
11H	11H STR-07						243.09	129.645
11H	11H STR-08						13.27	3.004
11H	11H STR-10						10.46	2.355
11H	11H STR-11						20.34	6.594
11H	11H STR-12						55.17	29.623
11H	11H STR-14						10.63	2.799
11H	11H STR-15						8.70	1.048
11H	11H STR-16						17.59	3.116
11H	11H STR-17						18.20	2.728
11H	11H STR-18						119.05	79.735
11H	11H STR-19						159.32	81.641
11H	11H STR-20						110.86	51.211
11H	11H STR-21						25.86	9.882
11H	11H STR-22						42.90	18.553
11H		11H CH-01						
11H		11H CH-02						
11H		11H CH-03					5.10	0.427
11H				11H PW-01				
11I	11I STR-01						13.49	3.002
11I	11I STR-02						55.20	15.070
11I	11I STR-03						216.71	178.732
11I	11I STR-04						30.55	9.523
11I	11I STR-05						115.55	34.921
11I	11I STR-06						193.90	190.898
11I	11I STR-07						24.01	9.647

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11I	11I STR-08						19.79	1.843
11I	11I STR-09						22.79	5.825
11I	11I STR-10						135.11	54.472
11I	11I STR-11						99.71	34.321
11I	11I STR-12						7.26	1.156
11I		11I CH-01						
11J	11J STR-01						755.56	848.092
11J	11J STR-03						223.51	148.046
11J	11J STR-05						201.15	178.049
11J	11J STR-06						128.11	96.385
11J		11J CH-01						
11J		11J CH-02					5.37	0.656
11J				11J PW-01				
11J					11J CV-01			
11K	11K STR-01						23.36	8.297
11K	11K STR-02						27.62	7.060
11K	11K STR-03						49.01	20.737
11K	11K STR-04						20.50	6.301
11K	11K STR-05						53.14	18.588
11K	11K STR-06						43.02	10.990
11K	11K STR-07						19.19	5.660
11K	11K STR-08						52.91	17.099
11K	11K STR-09						20.81	2.404
11K	11K STR-10						23.09	1.728
11K	11K STR-11						170.41	81.936
11K	11K STR-12						159.89	146.250
11K	11K STR-13						290.22	156.808

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11K		11K CH-01						
11L	11L STR-01						48.60	5.672
11L	11L STR-03						306.71	608.302
11L	11L STR-04						17.21	0.416
11L	11L STR-05						71.20	31.976
11L	11L STR-08						115.82	35.208
11L	11L STR-14						650.98	377.077
11L			11L FEAT-01					
11M	11M STR-01						59.61	20.609
11M	11M STR-02						30.97	8.923
11M	11M STR-03						650.63	935.387
11M	11M STR-04						186.33	308.500
11M	11M STR-06						1174.25	2198.332
11N	11N STR-01						41.88	10.454
11N	11N STR-02						11.29	1.924
11N	11N STR-03						29.34	12.991
11P	11P STR-01						343.61	241.182
11P	11P STR-02						327.12	182.097
11P	11P STR-03						98.14	30.008
11P	11P STR-04						325.03	209.186
11P	11P STR-05						40.58	12.318
11Q	11Q STR-02						163.67	86.889
11Q	11Q STR-03						761.31	742.654
11Q	11Q STR-04						163.03	64.605
11Q	11Q STR-06						47.04	8.735
11Q	11Q STR-07						8.89	0.753

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11Q	11Q STR-08						35.17	11.601
11Q	11Q STR-10						17.27	4.355
11Q		11Q CH-01						
11Q			11Q FEAT-04					
11Q			11Q FEAT-05				141.74	15.802
11Q			11Q FEAT-09				39.61	10.917
11R	11R STR-01						20.77	5.704
11R	11R STR-02						27.31	6.597
11R	11R STR-03						61.99	70.305
11R	11R STR-04						47.46	19.202
11R	11R STR-05						33.61	17.793
11R	11R STR-06						15.45	2.600
11R	11R STR-07						72.59	45.717
11R	11R STR-08						28.71	4.156
11R	11R STR-09						21.80	6.342
11R	11R STR-10						20.39	5.579
11R	11R STR-11						12.08	1.392
11R	11R STR-12						26.86	6.603
11R	11R STR-13						15.91	2.773
11R	11R STR-14						60.95	11.491
11R	11R STR-15						80.39	36.843
11R	11R STR-16						7.84	1.298
11R	11R STR-17						23.46	2.984
11R	11R STR-18						9.64	1.704
11R	11R STR-20						12.69	2.226
11R	11R STR-21						255.46	108.049
11R		11R CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11R		11R CH-02						
11R		11R CH-03						
11R		11R CH-04						
11R			11R FEAT-19				88.66	92.904
11R				11R PW-01				
11R				11R PW-02				
11S	11S STR-01						15.04	12.503
11S	11S STR-02						130.72	63.920
11S	11S STR-03						225.47	72.534
11S	11S STR-04						12.73	0.599
11S	11S STR-05						45.84	10.755
11S	11S STR-06						8.22	0.407
11S	11S STR-07						22.41	8.226
11S	11S STR-08						20.79	2.792
11S	11S STR-09						21.33	6.340
11S	11S STR-10						7.47	0.448
11S		11S CH-01						
11S		11S CH-02						
11S				11S PW-01				
11S				11S PW-02				
11S					11S CV-01			
11S					11S CV-02			
11T	11T STR-01						12.27	2.000
11T	11T STR-02						13.46	2.771
11T	11T STR-03						17.00	4.166
11T	11T STR-04						58.45	12.070
11T	11T STR-05						8.40	1.600

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
11T	11T STR-06						46.60	11.631
11T	11T STR-07						35.02	4.721
11T	11T STR-08						200.75	58.436
11T	11T STR-09						61.77	17.287
11T	11T STR-10						7.22	0.939
11T	11T STR-11						8.61	1.213
11T	11T STR-12						18.80	3.096
11T	11T STR-13						8.46	1.023
11T	11T STR-14						216.42	112.553
11T	11T STR-15						16.27	4.918
11T	11T STR-16						116.15	52.558
11T	11T STR-17						56.39	30.405
11T	11T STR-18						20.10	4.612
11T	11T STR-19						30.58	5.089
11T	11T STR-20						9.60	0.869
11T	11T STR-21						14.36	1.665
11T		11T CH-01						
11T		11T CH-02						
11U	11U STR-01						265.03	238.035
11U	11U STR-02						42.22	12.322
11U	11U STR-03						222.79	119.332
11U	11U STR-04						11.64	2.252
11V	11V STR-01						34.47	12.050
11V					11V CV-01			
11V					11V CV-02			
12H	12H STR-01						385.15	316.751
12H	12H STR-02						137.69	66.793

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12H	12H STR-03						139.86	58.941
12H	12H STR-04						107.03	30.486
12H	12H STR-05						29.35	4.683
12H	12H STR-06						157.47	40.000
12H	12H STR-07						18.75	1.156
12H	12H STR-08						31.46	5.925
12H	12H STR-09						16.84	0.924
12H	12H STR-10						29.59	6.682
12H	12H STR-11						25.32	6.571
12H	12H STR-12						86.01	19.935
12H	12H STR-13						48.60	22.114
12H	12H STR-14						295.84	209.706
12H					12H CV-01			
12I	12I STR-01						162.15	84.291
12I	12I STR-02						196.25	113.405
12I	12I STR-03						87.32	27.724
12I	12I STR-04						9.08	1.860
12I	12I STR-05						202.82	56.189
12I	12I STR-06						276.13	156.355
12I	12I STR-07						59.78	17.345
12I	12I STR-08						18.59	13.384
12I	12I STR-09						83.55	27.795
12I	12I STR-10						22.65	4.305
12I	12I STR-11						27.38	9.551
12I				12I PW-01				
12J	12J STR-01						655.68	438.737
12J	12J STR-02						646.51	850.688

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12J				12J PW-01				
12K	12K STR-01						264.39	129.071
12K	12K STR-02						324.57	321.485
12K	12K STR-03						76.82	8.995
12K		12K CH-01					6.76	1.355
12L	12L STR-01						23.46	3.479
12L	12L STR-02						68.07	46.671
12L	12L STR-04						39.99	9.831
12L	12L STR-05						8.62	1.143
12L	12L STR-07						220.48	60.310
12L	12L STR-08						502.92	730.305
12L	12L STR-10						25.75	4.593
12L			12L FEAT-09				3.84	0.445
12L					12L CN-01		1435.73	
12M	12M STR-03						258.30	241.869
12M	12M STR-05						325.28	1708.421
12M	12M STR-06						899.55	1657.851
12M			12M FEAT-01				17.47	3.131
12M						12M CN-01		
12N	12N STR-01						797.28	712.220
12N	12N STR-02						47.61	12.080
12N	12N STR-04						45.92	8.490
12N	12N STR-05						95.31	12.075
12N	12N STR-07						336.98	215.490
12N	12N STR-08						101.25	35.450

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12P	12P STR-01						180.90	61.880
12P	12P STR-02						371.09	292.180
12P	12P STR-03						48.08	10.320
12P	12P STR-04						136.08	146.310
12P	12P STR-05						28.20	6.020
12P	12P STR-06						33.81	5.930
12P	12P STR-07						112.55	21.690
12P	12P STR-08						31.51	4.900
12P			12P FEAT-09				37.63	44.490
12Q	12Q STR-02						26.33	7.290
12Q	12Q STR-03						173.12	31.160
12Q	12Q STR-04						222.46	165.490
12Q	12Q STR-05						165.69	110.420
12Q	12Q STR-07						35.63	8.830
12Q	12Q STR-08						39.34	10.110
12Q	12Q STR-10						72.55	15.180
12Q	12Q STR-11						22.34	4.150
12Q	12Q STR-12						276.16	131.970
12Q	12Q STR-13						43.69	5.570
12Q	12Q STR-14						33.13	2.820
12Q	12Q STR-15						425.40	329.180
12Q	12Q STR-16						134.23	107.600
12Q	12Q STR-17						234.42	39.930
12Q	12Q STR-18						188.56	70.390
12Q	12Q STR-19						17.95	4.370
12Q	12Q STR-20						14.83	1.930
12Q	12Q STR-21						23.41	2.650

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12Q			12Q FEAT-01				32.49	5.530
12Q			12Q FEAT-09				37.63	44.490
12R	12R STR-02						15.19	1.280
12R	12R STR-03						16.03	3.380
12R	12R STR-04						22.38	10.137
12R	12R STR-05						65.56	20.070
12R	12R STR-06						10.95	1.261
12R	12R STR-07						27.22	3.523
12R	12R STR-08						30.74	5.102
12R	12R STR-09						15.86	3.069
12R	12R STR-10						289.16	129.680
12R	12R STR-11						20.51	1.729
12R	12R STR-12						45.32	9.124
12R	12R STR-13						43.62	3.513
12R	12R STR-14						15.79	2.873
12R	12R STR-15						56.56	12.559
12R		12R CH-01						
12R		12R CH-02						
12R				12R PW-01				
12R					12R CV-01			
12R					12R CV-02			
12R					12R CV-03			
12S	12S STR-01						46.05	12.723
12S	12S STR-02						51.54	5.082
12S	12S STR-03						56.46	19.976
12S	12S STR-04						11.50	3.737
12S	12S STR-05						39.46	4.310

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12S	12S STR-06						11.09	1.928
12S		12S CH-01						
12S		12S CH-02						
12S		12S CH-03						
12S		12S CH-04						
12S		12S CH-05						
12S				12S PW-01				
12S				12S PW-02				
12S					12S CV-01			
12S					12S CV-02			
12S					12S CV-03			
12S						12S CN-01	18.22	
12T	12T STR-01						39.47	7.900
12T	12T STR-02						18.16	1.104
12T	12T STR-03						15.81	1.362
12T	12T STR-04						14.82	3.278
12T	12T STR-05						196.47	89.424
12T	12T STR-06						26.89	13.063
12T	12T STR-07						11.47	2.304
12T	12T STR-08						8.22	0.963
12T	12T STR-09						15.03	3.488
12T	12T STR-10						51.49	6.072
12U	12U STR-01						20.32	3.722
12U	12U STR-02						7.22	0.621
12U	12U STR-03						121.01	40.208
12U		12U CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
12U		12U CH-02					5.66	
12U					12U CV-01			
12V	12V STR-01						122.84	63.942
12V	12V STR-02						74.92	57.692
12V		12V CH-01					5.67	
12V					12V CV-01			
12V					12V CV-02			
12W					12W CV-01			
13F	13F STR-01						144.47	127.560
13G	13G STR-01						12.25	1.560
13G	13G STR-03						66.42	18.628
13G	13G STR-05						100.35	70.970
13G	13G STR-06						200.66	111.569
13G	13G STR-07						20.20	5.590
13G	13G STR-08						19.19	5.770
13G	13G STR-09						14.07	4.970
13G		13G CH-01						
13G		13G CH-02						
13G		13G CH-03						
13G			13G FEAT-02				3.22	N/A
13G			13G FEAT-04				N/A	N/A
13H	13H STR-01						43.73	12.216
13H	13H STR-02						32.50	11.855
13H	13H STR-03						16.30	2.007
13H	13H STR-04						118.22	24.693
13H	13H STR-05						155.67	219.412
13H	13H STR-06						164.22	82.574

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13H	13H STR-07						125.43	54.187
13H	13H STR-08						16.65	1.456
13H	13H STR-09						21.94	6.128
13H	13H STR-10						16.59	2.837
13H	13H STR-11						15.32	1.430
13H	13H STR-12						115.88	38.000
13H	13H STR-13						234.49	113.500
13H		13H CH-01						
13H		13H CH-02						
13H		13H CH-03						
13H		13H CH-04						
13H				13H PW-01				
13H				13H PW-02				
13H					13H CV-01			
13I	13I STR-01						8.99	0.947
13I	13I STR-02						20.53	2.282
13I	13I STR-03						44.56	6.780
13I	13I STR-04						340.36	325.667
13I	13I STR-08						156.63	100.972
13I	13I STR-09						35.17	5.446
13I	13I STR-10						9.97	3.085
13I	13I STR-12						11.51	0.632
13I	13I STR-13						12.88	0.522
13I	13I STR-14						182.13	161.576
13I	13I STR-15						17.85	2.403
13I	13I STR-16						11.92	2.400
13I		13I CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13I		13I CH-02					5.07	
13I					13I CV-01		3.94	
13J	13J STR-01						3787.69	214.108
13J	13J STR-02						224.27	113.790
13J	13J STR-04						20.77	5.630
13J	13J STR-05						140.50	38.690
13J	13J STR-06						216.86	113.145
13J	13J STR-07						85.43	54.830
13J	13J STR-09						333.84	208.550
13J	13J STR-10						15.83	2.193
13J	13J STR-11						9.94	1.200
13J	13J STR-12						402.22	348.954
13J	13J STR-13						12.94	2.552
13J	13J STR-14						89.47	N/A
13J	13J STR-15						10.32	3.394
13J	13J STR-16						27.89	5.599
13J		13J CH-01						
13J		13J CH-02					6.67	
13J			13J FEAT-08				3.27	N/A
13K	13K STR-01						218.13	76.762
13K	13K STR-02						14.45	2.293
13K	13K STR-03						18.54	4.186
13K	13K STR-05						12.33	2.217
13K	13K STR-07						32.02	3.950
13K	13K STR-08						11.31	1.068
13K	13K STR-09						107.96	70.037
13K	13K STR-10						219.20	59.135

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13K	13K STR-11						361.75	225.380
13K	13K STR-12						56.56	16.570
13K	13K STR-13						32.61	4.710
13K		13K CH-01						
13K		13K CH-02						
13K		13K CH-03						
13K		13K CH-04						
13K		13K CH-05						
13K		13K CH-06					6.87	
13L	13L STR-01						155.11	19.530
13L	13L STR-02						275.95	122.280
13L	13L STR-03						213.51	108.910
13L	13L STR-04						257.45	133.980
13L	13L STR-05						28.47	4.420
13L	13L STR-06						36.76	8.370
13L	13L STR-07						305.46	143.350
13L	13L STR-08						46.93	9.640
13L	13L STR-09						61.56	17.906
13L	13L STR-10						19.17	3.810
13L	13L STR-11						102.13	25.351
13L	13L STR-12						22.88	7.068
13M	13M STR-01						44.28	7.970
13M	13M STR-02						430.60	449.090
13M	13M STR-03						229.11	196.430
13M	13M STR-04						37.99	6.950
13M	13M STR-05						257.71	115.900
13M	13M STR-06						23.25	4.569

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13M	13M STR-07						112.69	31.326
13M	13M STR-08						20.11	1.157
13M					13M CV-01			
13M	13M STR-09						38.96	10.140
13M	13M STR-10						15.62	2.916
13N	13N STR-02						9.78	0.810
13N	13N STR-05						198.89	56.910
13N	13N STR-06						208.68	141.640
13N	13N STR-07						21.95	3.920
13N	13N STR-08						202.85	115.950
13N	13N STR-09						47.54	3.150
13N	13N STR-10						352.32	168.990
13N	13N STR-11						145.76	46.650
13N	13N STR-12						62.93	10.359
13N	13N STR-13						196.97	132.390
13N	13N STR-15						54.60	44.099
13N	13N STR-16						150.37	43.310
13N	13N STR-17						65.56	15.892
13N	13N STR-18						9.49	0.853
13N	13N STR-19						13.29	3.030
13N	13N STR-20						94.40	147.560
13N		13N CH-01						
13N		13N CH-02						
13N		13N CH-03						
13N		13N CH-04						
13N			13N FEAT-01				5.68	1.462
13P	13P STR-01						276.15	126.000

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13P	13P STR-02						205.16	56.840
13P	13P STR-03						330.02	197.990
13P	13P STR-04						52.05	4.520
13P	13P STR-05						202.87	87.570
13P	13P STR-07						51.02	24.960
13P	13P STR-08						177.95	163.080
13P	13P STR-09						102.87	58.280
13P	13P STR-10						207.21	104.980
13P	13P STR-12						319.07	315.930
13P	13P STR-14						57.30	11.080
13P	13P STR-15						126.41	72.620
13P	13P STR-16						9.13	0.830
13P		13P CH-01						
13P		13P CH-02						
13P		13P CH-03						
13P			13P FEAT-18				120.25	35.150
13Q	13Q STR-01						15.11	2.450
13Q	13Q STR-02						40.34	10.600
13Q	13Q STR-04						26.29	7.740
13Q	13Q STR-05						29.68	4.210
13Q	13Q STR-06						41.13	14.090
13Q	13Q STR-07						207.99	203.780
13Q	13Q STR-08						67.92	30.840
13Q	13Q STR-10						24.75	7.020
13Q	13Q STR-11						9.26	1.490
13Q	13Q STR-12						15.59	4.680
13Q	13Q STR-13						223.03	118.990

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13Q	13Q STR-14						25.10	6.810
13Q	13Q STR-15						182.52	48.380
13Q	13Q STR-16						14.86	3.850
13Q	13Q STR-17						9.13	0.950
13Q	13Q STR-18						23.71	3.250
13Q	13Q STR-19						15.25	5.920
13Q	13Q STR-20						326.53	197.130
13Q		13Q CH-01						
13Q		13Q CH-02						
13Q		13Q CH-03						
13Q		13Q CH-04						
13Q		13Q CH-05						
13Q		13Q CH-06						
13Q		13Q CH-07					4.55	
13Q			13Q FEAT-03				198.61	257.770
13Q			13Q FEAT-18				19.31	2.180
13Q				13Q PW-1				
13R	13R STR-01						30.69	4.690
13R	13R STR-02						33.38	6.970
13R	13R STR-03						257.28	195.220
13R	13R STR-04						118.37	40.510
13R	13R STR-05						204.34	118.690
13R	13R STR-06						15.27	2.975
13R	13R STR-07						36.86	10.500
13R	13R STR-08						8.07	0.889
13R	13R STR-10						42.59	5.500
13R	13R STR-11						11.79	1.430

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13R	13R STR-12						22.22	4.910
13R	13R STR-13						27.62	2.890
13R	13R STR-14						29.73	4.500
13R			13R FEAT-09				7.96	0.776
13R			13R FEAT-15				6.54	0.340
13R					13R CV-01			
13S	13S STR-01						17.86	5.180
13S	13S STR-02						86.21	24.686
13S	13S STR-03						327.52	137.700
13S	13S STR-04						216.01	71.170
13S	13S STR-05						21.25	4.862
13S	13S STR-06						9.89	3.874
13S	13S STR-07						13.16	2.940
13S	13S STR-08						12.38	2.078
13S	13S STR-09						79.67	21.900
13S	13S STR-10						253.05	49.420
13S		13S CH-01						
13S		13S CH-02						
13S				13S PW-01				
13S				13S PW-02				
13S					13S CV-01			
13S					13S CV-02			
13S					13S CV-03			
13T	13T STR-01						25.89	2.108
13T	13T STR-02						61.67	58.210
13T	13T STR-04						19.09	0.940
13T		13T CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
13T		13T CH-02						
13T		13T CH-03						
13T		13T CH-04						
13T		13T CH-05						
13T				13T PW-01				
13U	13U STR-01						9.76	2.740
13U	13U STR-02						10.90	2.810
13U	13U STR-03						12.84	3.330
13U	13U STR-06						77.43	14.850
13U	13U STR-07						125.36	57.150
13U		13U CH-01					7.02	1.580
13U					13U CV-01			
13U					13U CV-02			
13U					13U CV-03			
13U					13U CV-04			
13V					13V CV-01			
13V					13V CV-02			
14F	14F STR-01						67.74	27.300
14F	14F STR-02						7.53	1.210
14F	14F STR-03						17.01	0.970
14F	14F STR-04						18.87	9.810
14F		14F CH-01						
14F		14F CH-02						
14F		14F CH-03						
14F		14F CH-04						
14F		14F CH-05						
14F		14F CH-06						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14F		14F CH-07						
14F		14F CH-08						
14F		14F CH-09						
14F		14F CH-10						
14F				14F PW-01				
14F					14F CV-01			
14G	14G STR-01						196.96	170.520
14G	14G STR-02						75.33	43.250
14G	14G STR-03						31.74	13.272
14G	14G STR-04						43.18	15.190
14G	14G STR-06						11.76	2.646
14G	14G STR-07						14.62	1.858
14G	14G STR-08						7.57	0.877
14G	14G STR-09						17.97	3.490
14G	14G STR-11						15.28	12.980
14G		14G CH-01						
14G		14G CH-02						
14G		14G CH-03						
14G		14G CH-04						
14G		14G CH-05						
14G		14G CH-06						
14G		14G CH-07						
14G		14G CH-08						
14G		14G CH-09						
14G		14G CH-10						
14G		14G CH-11						
14G		14G CH-12						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14G		14G CH-13						
14G			14G FEAT-10				15.47	12.980
14G				14G PW-01				
14H	14H STR-01						26.12	9.530
14H	14H STR-02						64.22	23.460
14H	14H STR-03						7.77	0.830
14H	14H STR-04						8.79	2.005
14H	14H STR-06						126.41	49.742
14H	14I STR-01						17.34	2.946
14H		14H CH-01						
14H		14H CH-02						
14H		14H CH-03						
14H		14H CH-04						
14H				14H PW-01				
14H					14F CV-01			
14H					14F CV-02			
14H					14F CV-03			
14H					14F CV-04			
14H					14F CV-05			
14I	14I STR-02						9.39	1.387
14I	14I STR-05						22.00	4.410
14I	14I STR-06						11.10	1.430
14I	14I STR-07						11.23	1.696
14I	14I STR-08						8.56	0.492
14I	14I STR-09						37.39	7.480
14I	14I STR-10						42.27	13.551
14I	14I STR-11						161.14	83.811

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14I	14I STR-12						34.64	4.985
14I	14I STR-13						113.12	72.648
14I	14I STR-14						24.55	7.322
14I	14I STR-15						26.63	2.470
14I	14I STR-16						17.04	2.436
14I	14I STR-17						16.06	3.399
14I	14I STR-18						26.84	6.179
14I	14I STR-19						17.35	2.882
14I	14I STR-20						15.59	3.424
14I	14I STR-21						77.56	31.010
14I	14I STR-22						16.57	2.657
14I	14I STR-23						44.14	14.130
14I		14I CH-01						
14I		14I CH-02						
14I		14I CH-03						
14I		14I CH-04						
14I		14I CH-05						
14I		14I CH-06						
14I		14I CH-07						
14I		14I CH-08						
14I		14I CH-09						
14I		14I CH-10						
14I		14I CH-11						
14I		14I CH-12						
14I		14I CH-13						
14I		14I CH-14						
14I		14I CH-15						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14I		14I CH-16						
14I		14I CH-17						
14I		14I CH-18						
14I		14I CH-19						
14I		14I CH-20						
14I					14I CV-01			
14J	14J STR-01						374.91	288.020
14J	14J STR-02						24.73	9.697
14J	14J STR-05						56.76	11.104
14J	14J STR-06						30.40	5.001
14J	14J STR-09						33.40	10.936
14J	14J STR-10						16.87	5.275
14J	14J STR-11						19.05	5.375
14J	14J STR-12						161.15	75.462
14J	14J STR-13						32.80	8.149
14J	14J STR-14						15.30	4.932
14J	14J STR-15						30.19	12.614
14J	14J STR-16						18.37	16.952
14J	14J STR-21						11.82	1.181
14J	14J STR-24						14.32	2.711
14J	14J STR-26						12.75	1.727
14J	14J STR-27						99.18	43.774
14J	14J STR-29						14.18	8.007
14J	14J STR-30						26.97	17.334
14J	14J STR-31						22.14	3.920
14J	14J STR-32						24.39	3.127
14J		14J CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14J		14J CH-02						
14J		14J CH-03						
14J		14J CH-04						
14J		14J CH-05						
14J		14J CH-06						
14J		14J CH-07						
14J		14J CH-08						
14J		14J CH-09						
14J		14J CH-10						
14J		14J CH-11						
14J		14J CH-12						
14J		14J CH-13						
14J		14J CH-14						
14J		14J CH-15						
14J		14J CH-16						
14J		14J CH-17					4.45	
14J		14J CH-18					5.41	
14J		14J CH-19					5.42	
14J		14J CH-20					5.58	
14J		14J CH-21					6.49	
14J		14J CH-22					6.90	
14J			14J FEAT-07				83.38	28.980
14J				14J PW-01				
14J				14J PW-02				
14J				14J PW-03				
14J					14J CV-01			
14K	14K STR-02						21.96	4.609

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14K	14K STR-03						19.26	3.351
14K	14K STR-04						12.12	1.169
14K	14K STR-05						99.81	35.973
14K	14K STR-06						31.66	7.370
14K	14K STR-07						28.46	7.309
14K	14K STR-08						9.72	0.687
14K	14K STR-10						18.72	2.377
14K	14K STR-11						14.68	4.770
14K	14K STR-14						128.58	49.520
14K	14K STR-15						37.98	13.052
14K	14K STR-16						20.03	3.901
14K	14K STR-17						134.62	61.939
14K	14K STR-18						28.74	3.973
14K	14K STR-19						35.36	20.501
14K	14K STR-20						37.39	22.858
14K	14K STR-21						12.07	11.063
14K	14K STR-23						7.30	0.793
14K	14K STR-24						23.26	14.985
14K	14K STR-25						448.40	281.309
14K	14K STR-26						10.53	1.200
14K	14K STR-27						10.94	1.406
14K	14K STR-28						101.65	49.327
14K	14K STR-29						72.90	38.048
14K	14K STR-30						29.53	10.546
14K	14K STR-31						22.73	2.058
14K	14K STR-32						8.84	0.542
14K		14K CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14K		14K CH-02						
14K		14K CH-03						
14K		14K CH-04						
14K		14K CH-05						
14K		14K CH-06						
14K		14K CH-07						
14K		14K CH-08						
14K		14K CH-09						
14K		14K CH-10						
14K		14K CH-11						
14K		14K CH-12						
14K		14K CH-13						
14K		14K CH-14						
14K		14K CH-15						
14K		14K CH-16						
14K		14K CH-17						
14K		14K CH-18						
14K		14K CH-19						
14K		14K CH-20						
14K		14K CH-21						
14K		14K CH-22						
14K		14K CH-23						
14K		14K CH-24						
14K		14K CH-25						
14K		14K CH-26						
14K		14K CH-27						
14K		14K CH-28						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14K		14K CH-29						
14K		14K CH-30						
14K			14K FEAT-01				102.22	38.035
14K			14K FEAT-13				24.45	3.000
14K				14K PW-01				
14L	14L STR-01						38.95	6.991
14L	14L STR-02						11.20	1.304
14L	14L STR-03						104.11	29.604
14L	14L STR-04						203.70	156.005
14L	14L STR-05						43.56	13.979
14L	14L STR-06						56.03	7.120
14L	14L STR-07						76.50	19.712
14L	14L STR-08						153.54	84.664
14L	14L STR-09						31.32	11.242
14L	14L STR-10						125.22	30.702
14L	14L STR-11						32.93	8.451
14L	14L STR-12						138.32	62.361
14L	14L STR-13						27.77	5.543
14L	14L STR-14						99.02	5.773
14L	14L STR-15						8.34	1.050
14L	14L STR-16						44.55	9.670
14L	14L STR-17						21.36	3.087
14L			14L FEAT-13				42.16	4.696
14L					14L CV-01			
14M	14M STR-01						77.01	27.270
14M	14M STR-02						36.08	11.490
14M	14M STR-03						16.01	2.280

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14M	14M STR-04						71.35	8.130
14M	14M STR-05						39.87	18.910
14M	14M STR-06						329.13	229.910
14M	14M STR-07						110.83	31.310
14M	14M STR-08						561.55	424.520
14M	14M STR-10						51.86	6.470
14M		14M CH-01						
14N	14N STR-01						57.79	14.813
14N	14N STR-02						135.91	106.621
14N	14N STR-03						104.27	35.340
14N	14N STR-04						30.74	6.662
14N	14N STR-05						149.33	85.669
14N	14N STR-06						84.29	27.546
14N	14N STR-07						19.07	1.550
14N	14N STR-08						31.04	7.757
14N	14N STR-10						18.40	9.352
14N	14N STR-11						131.04	19.997
14N	14N STR-12						20.31	3.537
14N	14N STR-13						39.60	7.658
14N	14N STR-14						27.97	3.319
14N	14N STR-15						19.90	2.972
14N	14N STR-16						17.12	2.130
14N	14N STR-17						43.52	28.200
14N	14N STR-18						24.92	5.301
14N	14N STR-19						217.64	64.505
14N		14N CH-01					6.50	

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14P	14P STR-03						103.48	31.550
14P	14P STR-04						35.82	28.973
14P	14P STR-08						77.88	37.814
14P	14P STR-09						16.92	2.796
14P	14P STR-10						30.66	4.486
14P	14P STR-12						28.67	6.864
14P	14P STR-13						35.33	6.953
14P	14P STR-14						45.89	8.655
14P	14P STR-15						46.03	13.761
14P	14P STR-16						18.93	1.250
14P	14P STR-17						219.78	71.661
14P	14P STR-18						40.85	6.262
14P	14P STR-19						10.53	0.916
14P	14P STR-20						20.46	2.050
14P	14P STR-21						200.23	109.290
14P	14P STR-22						19.28	1.910
14P	14P STR-23						31.85	9.410
14P		14P CH-01						
14P		14P CH-02						
14P		14P CH-03						
14P		14P CH-04						
14P		14P CH-05						
14P		14P CH-06						
14P		14P CH-07						
14P		14P CH-08						
14P			14P FEAT-06				2.10	0.430
14P			14P FEAT-07				111.35	29.830

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14P			14P FEAT-11				6.43	0.438
14P				14P PW-01				
14Q	14Q STR-01						10.18	1.431
14Q	14Q STR-02						26.27	5.749
14Q	14Q STR-04						43.40	5.497
14Q	14Q STR-05						23.47	4.237
14Q	14Q STR-06						41.07	10.924
14Q	14Q STR-07						172.33	116.578
14Q	14Q STR-08						13.45	3.318
14Q	14Q STR-09						23.60	8.440
14Q	14Q STR-10						191.00	6.910
14Q	14Q STR-11						51.54	9.870
14Q	14Q STR-12						100.79	46.230
14Q	14Q STR-13						17.23	5.620
14Q	14Q STR-14						34.65	14.990
14Q		14Q CH-01						
14Q		14Q CH-02						
14Q		14Q CH-03					6.92	
14Q		14Q CH-04						
14Q			14Q FEAT-03				4.07	0.221
14Q				14Q PW-01				
14R	14R STR-01						57.79	18.319
14R	14R STR-02						11.31	1.457
14R	14R STR-03						26.25	5.403
14R	14R STR-04						103.85	22.700
14R	14R STR-05						69.72	13.110
14R	14R STR-06						107.37	36.770

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
14R	14R STR-07						27.68	7.420
14R	14R STR-08						27.35	8.850
14S	14S STR-01						35.30	13.791
14S	14S STR-02						12.39	1.949
14S	14S STR-03						9.43	2.477
14S	14S STR-04						11.64	
14S	14S STR-05						33.61	9.847
14S	14S STR-07						45.35	13.303
14S			14S FEAT-01				33.26	4.056
14S			14S FEAT-02				12.74	1.875
14S			14S FEAT-03				175.98	93.283
14S				14S PW-01				
14T	14T STR-01						34.31	7.710
14T	14T STR-02						40.35	13.582
14T				14T PW-01				
15F	15F STR-01						16.08	3.761
15F	15F STR-02						11.81	1.281
15F	15F STR-04						49.32	2.646
15F	15F STR-05						8.20	1.204
15F	15F STR-06						25.90	2.296
15F	15F STR-07						177.31	134.275
15F	15F STR-09						10.83	2.359
15F	15F STR-10						15.02	2.628
15F		15F CH-01						
15F		15F CH-02						
15F		15F CH-03						
15F		15F CH-04						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15F		15F CH-05						
15F				15F PW-1				
15F				15F PW-2				
15F				15F PW-3				
15F				15F PW-4				
15F						15F CN-01	6.25	
15G	15G STR-02						23.52	2.035
15G		15G CH-01						
15G		15G CH-02						
15G		15G CH-03						
15G		15G CH-04						
15G		15G CH-05						
15G					15G CV-01			
15H	15H STR-01						158.14	74.802
15H	15H STR-02						10.77	3.136
15H	15H STR-04						117.35	72.034
15H		15H CH-01						
15H		15H CH-02						
15H		15H CH-03						
15H		15H CH-04					5.58	
15H					15H CV-01			
15H					15H CV-02			
15H					15H CV-03			
15H					15H CV-04			
15I	15I STR-01						41.43	7.212
15I	15I STR-02						53.59	25.336

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15I	15I STR-03						9.15	1.321
15I	15I STR-04						63.36	19.843
15I	15I STR-05						8.69	1.853
15I	15I STR-06						17.48	5.598
15I	15I STR-08						44.59	27.584
15I	15I STR-10						77.65	37.328
15I	15I STR-11						22.61	11.177
15I	15I STR-12						14.88	4.751
15I		15I CH-01						
15I		15I CH-02						
15I		15I CH-03						
15I		15I CH-04						
15I		15I CH-05						
15I		15I CH-06						
15I		15I CH-07					5.89	
15J	15J STR-02						63.84	35.612
15J	15J STR-03						13.41	0.989
15J	15J STR-04						47.21	20.628
15J	15J STR-05						10.74	1.755
15J	15J STR-08						23.16	4.968
15J	15J STR-09						17.68	4.680
15J	15J STR-11						25.02	10.433
15J	15J STR-12						59.38	10.800
15J	15J STR-14						15.46	2.470
15J	15J STR-15						20.00	3.610
15J	15J STR-16						56.46	28.920
15J		15J CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15J		15J CH-02						
15J		15J CH-03						
15J		15J CH-04						
15J		15J CH-05						
15J		15J CH-06						
15J		15J CH-07						
15J		15J CH-08						
15J		15J CH-09					4.72	
15J		15J CH-10					5.53	2.890
15J		15J CH-11					3.10	
15J			15J FEAT-01				206.45	134.169
15K	15K STR-01						101.60	29.221
15K	15K STR-02						69.45	11.577
15K	15K STR-03						82.51	44.229
15K	15K STR-04						25.51	8.431
15K	15K STR-05						18.69	7.550
15K	15K STR-06						13.62	N/A
15K	15K STR-07						18.62	2.948
15K	15K STR-08						177.62	66.309
15K	15K STR-09						19.07	1.653
15K	15K STR-11						17.58	2.742
15K	15K STR-13						17.32	3.689
15K	15K STR-15						18.53	6.020
15K	15K STR-16						48.94	10.702
15K	15K STR-17						8.29	1.217
15K	15K STR-18						12.84	2.183
15K	15K STR-19						21.51	1.226

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15K	15K STR-20						22.56	16.193
15K	15K STR-21						12.24	1.750
15K	15K STR-22						15.46	3.300
15K	15K STR-27						13.23	0.170
15K	15K STR-29						129.33	115.610
15K	15K STR-30						12.91	2.960
15K	15K STR-31						8.08	0.904
15K	15K STR-32						15.13	3.032
15K	15K STR-33						12.35	1.681
15K	15K STR-35						8.02	1.120
15K		15K CH-01						
15K		15K CH-02						
15K		15K CH-03						
15K		15K CH-04						
15K		15K CH-05						
15K		15K CH-06						
15K		15K CH-07						
15K		15K CH-08						
15K		15K CH-09						
15K		15K CH-10						
15K		15K CH-11					2.07	0.050
15K		15K CH-12					2.20	0.170
15K		15K CH-13					3.87	0.830
15K		15K CH-14					3.17	
15K		15K CH-15					5.13	0.800
15K		15K CH-16					6.58	1.380
15K		15K CH-17					9.66	1.074

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15K		15K CH-18					3.99	0.262
15K				15K PW-01				
15L	15L STR-01						9.05	0.541
15L	15L STR-02						20.27	3.694
15L	15L STR-03						168.20	51.128
15L	15L STR-04						18.03	4.094
15L	15L STR-05						48.08	11.569
15L	15L STR-06						12.72	1.733
15L	15L STR-07						9.38	1.975
15L	15L STR-08						13.35	4.250
15L	15L STR-09						20.37	5.350
15L	15L STR-10						15.48	16.330
15L	15L STR-11						110.03	44.250
15L	15L STR-12						8.50	0.960
15L	15L STR-14						13.22	2.310
15L	15L STR-15						205.51	121.200
15L	15L STR-16						12.57	3.340
15L	15L STR-17						9.45	0.690
15L	15L STR-18						12.62	4.300
15L	15L STR-19						10.76	1.330
15L	15L STR-20						14.26	1.570
15L	15L STR-21						8.05	0.240
15L	15L STR-24						36.66	14.770
15L	15L STR-25						18.31	7.110
15L	15L STR-27						7.92	1.590
15L	15L STR-28						12.11	2.500
15L	15L STR-29						7.98	1.450

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15L	15L STR-30						16.03	3.620
15L	15L STR-31						36.14	7.140
15L	15L STR-32						183.44	92.110
15L	15L STR-33						29.00	6.250
15L	15L STR-34						18.87	3.694
15L		15L CH-01					4.24	
15L		15L CH-02						
15L		15L CH-03						
15L		15L CH-04						
15L		15L CH-05					5.07	0.420
15L		15L CH-06					1.65	0.100
15L		15L CH-07					5.47	0.780
15L		15L CH-08					6.40	0.610
15L		15L CH-09					5.45	0.310
15L					15L CV-01			
15L					15L CV-02			
15L					15L CV-03			
15L					15L CV-04			
15L					15L CV-05			
15L					15L CV-06			
15L					15L CV-07			
15M	15M STR-01						61.92	13.191
15M	15M STR-02						30.64	6.950
15M	15M STR-05						102.10	50.420
15M	15M STR-06						36.69	12.360
15M	15M STR-08						10.71	2.280
15M	15M STR-09						14.45	1.540

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15M	15M STR-11						20.79	3.730
15M	15M STR-12						9.19	0.910
15M	15M STR-12						10.72	0.910
15M	15M STR-13						57.99	40.470
15M	15M STR-14						158.67	91.140
15M	15M STR-15						12.76	2.020
15M	15M STR-16						14.76	1.880
15M	15M STR-17						17.65	3.060
15M	15M STR-18						21.08	4.940
15M	15M STR-19						37.78	16.630
15M	15M STR-20						13.26	4.860
15M	15M STR-21						156.00	113.480
15M	15M STR-22						12.38	2.470
15M	15M STR-23						328.18	226.160
15M	15M STR-24						65.99	43.120
15M	15M STR-27						9.39	2.120
15M		15M CH-01						
15M		15M CH-02					4.21	0.410
15M		15M CH-03					4.09	0.280
15M		15M CH-04					4.33	0.200
15M		15M CH-05					5.33	0.960
15M				15M PW-01				
15M				15M PW-02				
15M					15M CV-01			

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15M					15M CV-02			
15M					15M CV-03			
15M					15M CV-04			
15M					15M CV-05			
15M					15M CV-06			
15M	15M STR-26						76.41	20.050
15N	15N STR-01						788.77	842.740
15N	15N STR-02						217.42	253.480
15N	15N STR-03						100.44	47.340
15N	15N STR-04						7.71	7.900
15N	15N STR-05						13.44	2.900
15N	15N STR-06						25.65	6.620
15N	15N STR-09						502.85	434.360
15N			15N FEAT-07				12.02	1.100
15N			15N FEAT-08				12.30	1.960
15N			15N FEAT-09				5.47	0.930
15N			15N FEAT-10				2.84	0.330
15N			15N FEAT-11				8.48	1.640
15N			15N FEAT-12				9.88	0.820
15N				15N PW-01				
15N					15N CV-01			
15N					15N CV-02			
15N					15N CV-03			
15N					15N CV-04			
15P	15P STR-01						83.26	46.380
15P	15P STR-02						8.81	1.320
15P	15P STR-03						34.39	16.600

Section	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15P	15P STR-04						68.50	35.070
15P	15P STR-05						43.15	12.810
15P	15P STR-07						15.67	2.250
15P	15P STR-08						20.32	4.850
15P	15P STR-09						10.37	2.240
15P	15P STR-10						335.26	207.120
15P	15P STR-11						83.54	29.530
15P	15P STR-12						14.20	3.710
15P	15P STR-13						19.23	6.430
15P	15P STR-14						7.20	1.240
15P	15P STR-15						32.07	8.090
15P	15P STR-16						20.63	8.090
15P	15P STR-17						17.30	6.850
15P				15P PW-01				
15P					15P CV-01			
15P					15P CV-02			
15P			15P FEAT-06				82.02	16.650
15Q	15Q STR-01						8.25	1.650
15Q	15Q STR-02						21.56	13.670
15Q	15Q STR-03						11.93	1.790
15Q	15Q STR-04						146.70	80.410
15Q	15Q STR-05						34.51	13.670
15Q	15Q STR-06						10.47	2.070
15Q	15Q STR-07						37.66	13.360
15Q	15Q STR-08						15.53	1.180
15Q					15Q CV-01			
15R	15R STR-01						23.14	9.460

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15R	15R STR-02						23.93	7.640
15R	15R STR-03						81.21	25.310
15R	15R STR-04						23.93	4.950
15R	15R STR-05						39.33	17.290
15R	15R STR-06						31.39	9.370
15R	15R STR-07						34.43	14.578
15R	15R STR-08						138.16	37.578
15R	15R STR-09						26.74	6.562
15R	15R STR-10						36.63	12.304
15R	15R STR-11						13.96	3.200
15R	15R STR-12						13.20	1.562
15S	15S STR-01						29.87	4.252
15S	15S STR-02						50.66	13.826
15S	15S STR-03						70.47	17.348
15S	15S STR-04						39.04	12.771
15S	15S STR-05						17.92	4.107
15S	15S STR-06						16.77	3.629
15S	15S STR-07						17.11	3.176
15S	15S STR-08						9.76	1.648
15S	15S STR-09						9.29	1.135
15S	15S STR-10						72.50	23.811
15S	15S STR-11						27.22	4.727
15S	15S STR-12						10.53	2.583
15S	15S STR-13						12.01	4.973
15S	15S STR-14						19.63	3.975
15S	15S STR-15						28.11	9.171
15U	15U STR-01						54.42	15.604

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
15W	15W STR-01						9.14	1.721
15X	15X STR-01						26.47	9.682
15X	15X STR-02						26.59	12.239
15X	15X STR-03						16.68	
15X	15X STR-04						12.63	
16F				16F PW-1				
16J	16J STR-01						15.24	1.500
16J	16J STR-03						7.63	1.220
16J	16J STR-04						10.20	1.850
16J	16J STR-06						10.60	1.610
16J	16J STR-08						15.15	4.120
16J	16J STR-10						70.16	21.410
16J	16J STR-11						32.76	26.350
16J	16J STR-12						21.17	2.830
16J	16J STR-13						13.66	4.350
16J	16J STR-14						10.60	1.620
16J	16J STR-15						26.31	19.380
16J	16J STR-18						13.35	3.140
16J		16J CH-02					2.25	0.060
16J		16J CH-03					3.88	0.510
16J		16J CH-04					6.29	0.360
16J		16J CH-05					6.72	0.870
16J				16J PW-1				
16J		16J CH-01						
16K	16K STR-01						258.86	246.200
16K	16K STR-02						28.07	5.940
16K	16K STR-03						48.66	10.510

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
16K	16K STR-04						28.88	11.070
16K	16K STR-05						13.70	2.710
16K	16K STR-06						11.41	1.140
16L	16L STR-01						169.48	86.180
16L	16L STR-02						137.96	63.260
16L	16L STR-03						51.84	15.020
16L	16L STR-05						12.28	2.350
16L	16L STR-06						52.03	11.230
16L		16L CH-01					3.16	0.360
16L				16L PW-1				
16M	16M STR-01						10.37	0.850
16M	16M STR-02						69.54	34.820
16M	16M STR-03						13.10	5.430
16M	16M STR-04						63.78	28.030
16M	16M STR-05						92.10	38.980
16M	16M STR-06						12.14	3.060
16M	16M STR-07						12.13	2.970
16M	16M STR-08						34.23	7.770
16M	16M STR-09						51.38	29.090
16M	16M STR-10						66.82	13.480
16M	16M STR-11						17.91	4.450
16M	16M STR-12						66.16	24.780
16M	16M STR-13						9.92	0.820
16M	16M STR-14						13.02	2.070
16M					16M CV-01			
16N	16N STR-01						44.15	22.750
16N	16N STR-02						9.72	1.740

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
16N	16N STR-03						9.92	1.850
16N	16N STR-05						72.70	27.200
16N	16N STR-06						16.07	4.680
16N	16N STR-07						10.39	2.550
16N	16N STR-08						12.72	1.820
16N	16N STR-09						8.23	1.110
16N	16N STR-10						15.26	3.180
16N	16N STR-11						26.45	10.440
16N	16N STR-12						32.98	13.470
16N	16N STR-13						35.63	15.740
16N	16N STR-14						23.03	10.520
16N	16N STR-15						48.73	12.350
16N	16N STR-16						29.19	8.580
16N	16N STR-17						15.44	3.200
16N	16N STR-18						7.42	1.620
16N	16N STR-21						18.61	8.660
16N	16N STR-22						16.98	4.590
16N		16N CH-01					6.79	1.080
16N			16N FEAT-19				6.03	0.140
16N				16N PW-1				
16P	16P STR-01						96.48	55.960
16P	16P STR-02						46.47	8.960
16P	16P STR-03						8.19	0.910
16P	16P STR-04						8.86	2.050
16P	16P STR-05						12.97	8.010
16P	16P STR-06						10.17	3.850
16P	16P STR-08						21.43	5.870

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
16P		16P CH-01					4.85	0.720
16P			16P FEAT-02				2.41	1.440
16R	16R STR-01						19.80	3.897
16R	16R STR-02						45.01	8.675
16R	16R STR-03						20.14	5.375
16R	16R STR-04						39.67	11.001
16R	16R STR-05						11.70	1.735
16R	16R STR-06						99.47	41.842
16R	16R STR-07						16.87	3.782
16R	16R STR-08						12.39	3.284
16R	16R STR-09						54.74	22.767
16R	16R STR-10						24.69	11.664
16R	16R STR-11						64.46	30.850
16R	16R STR-12						61.26	30.249
16R		16R CH-01						
16R		16R CH-02						
16R		16R CH-03						
16R		16R CH-04						
16R		16R CH-05						
16S	16S STR-01						18.80	4.221
16S	16S STR-02						34.35	13.060
16S	16S STR-03						9.64	0.601
16S	16S STR-04						59.92	15.434
16S	16S STR-05						13.91	2.309
16S	16S STR-06						30.55	8.996
16S	16S STR-07						160.71	94.985
16S	16S STR-08						63.57	29.148

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
16S	16S STR-10						36.70	11.755
16S	16S STR-11						16.11	3.503
16S	16S STR-12						97.12	35.393
16S	16S STR-13						19.43	3.752
16S	16S STR-14						10.04	1.078
16S	16S STR-15						7.43	1.341
16S	16S STR-16						9.05	1.212
16S	16S STR-20						14.37	3.881
16S	16S STR-21						22.20	6.809
16S	16S STR-22						16.65	3.960
16S	16S STR-23						12.31	5.077
16S		16S CH-01						
16S		16S CH-04					4.69	0.916
16S			16S FEAT-02				16.65	5.777
16S				16S CV-1				
16S				16S PW-1				
16S	16S STR-17						71.27	36.731
16S	16S STR-18						80.36	29.952
16S		16S CH-02					7.54	1.315
16T	16T STR-01						59.03	2.593
16T	16T STR-02						10.64	27.558
16V	16V STR-01						15.78	2.539
17G	17G STR-01						15.15	2.400
17G	17G STR-02						14.80	1.310
17H	17H STR-01						47.67	25.160
17H	17H STR-02						20.89	3.780
17J	17J STR-01						40.16	13.700

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
17J	17J STR-02						48.28	20.570
17J	17J STR-03						7.95	1.220
17J	17J STR-04						13.17	1.620
17J	17J STR-05						17.76	3.170
17J	17J STR-06						8.40	0.959
17K	17K STR-01						21.14	3.730
17K	17K STR-02						13.79	2.252
17K		17K CH-01						
17K		17K CH-02					5.11	
17L	17L STR-01						27.94	8.680
17L	17L STR-02						24.71	6.710
17L	17L STR-03						28.56	8.680
17L	17L STR-04						26.07	9.056
17L					17L CV-01			
17L					17L CV-02			
17L					17L CV-03			
17M	17M STR-01						15.90	5.110
17M	17M STR-02						20.16	5.410
17M	17M STR-03						30.12	9.210
17M	17M STR-04						40.74	20.330
17M					17M CV-01			
17M					17M CV-02			
17N	17N STR-01						36.98	9.100
17N	17N STR-02						11.28	1.830
17N	17N STR-03						77.92	31.460
17N	17N STR-04						10.14	2.630
17N	17N STR-05						76.32	13.967

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
17N	17N STR-06						27.86	1.719
17N	17N STR-07						13.99	4.418
17N	17N STR-08						33.54	9.428
17N	17N STR-09						19.15	5.145
17P	17P FEAT-01						67.02	8.830
17P	17P STR-02						23.98	8.920
17P			17P FEAT-01				67.02	8.830
17T	17T STR-01						20.14	3.932
17T	17T STR-02						46.44	12.483
17T	17T STR-03						14.94	1.395
18F						18F CN-01		
18G	18G STR-01						24.71	9.090
18G		18G CH-01						
18G		18G CH-02						
18I	18I STR-01						16.20	3.536
18J	18J STR-01						10.42	1.201
18J			18J FEAT-01				42.15	7.099
18L	18L STR-01						29.16	8.152
18L		18L CH-01					96.60	
18N		18N CH-01						
18P	18P STR-01						96.60	50.683
18P	18P STR-02						101.32	43.965
19F	19F STR-01						13.86	1.600
19F	19F STR-02						7.12	0.800
19F	19F STR-03						26.57	4.930
19F	19F STR-04						17.72	2.340

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
19F	19F STR-05						8.63	0.960
19F		19F CH-01						
19F		19F CH-02						
19F		19F CH-03						
19F		19F CH-04						
19F		19F CH-05						
19F		19F CH-06						
19F		19F CH-07						
19F		19F CH-08						
19G	19G STR-01						25.75	5.860
19G	19G STR-02						8.81	1.770
19G	19G STR-03						12.24	1.830
19G		19G CH-01					12.64	
19G		19G CH-02					5.83	
19G		19G CH-03						
19H	19H STR-01						43.99	N/A
19H	19H STR-02						25.06	N/A
19H		19H CH-01						
19H		19H CH-02						
19H		19H CH-03						
19I	19I STR-01						20.44	2.852
19I	19I STR-02						64.60	15.141
19I	19I STR-03						14.11	0.386
19I	19I STR-04						25.51	5.562
19I	19I STR-05						11.21	0.493
19I	19I STR-06						10.54	0.891
19I		19I CH-01						

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
19I				19I PW-01				
19J	19J STR-01						57.85	16.785
19J	19J STR-02						45.14	8.263
19J	19J STR-03						12.75	1.558
19M	19M STR-01						12.79	2.387
19M					19M CV-01			
19N					19N CV-01			
20F	20F STR-01						57.56	18.030
20F	20F STR-02						9.55	1.660
20F	20F STR-03						19.17	2.100
20F	20F STR-04						18.08	2.720
20F	20F STR-05						17.61	2.430
20F	20F STR-06						8.45	N/A
20F	20F STR-07						10.91	0.880
20F	20F STR-08						8.77	N/A
20F	20F STR-09						8.90	N/A
20F	20F STR-10						14.60	1.760
20F	20F STR-11						15.81	3.068
20F	20F STR-12						11.53	1.629
20F	20F STR-13						24.72	3.997
20F		20F CH-01						
20F		20F CH-02						
20G	20G STR-01						21.40	3.470
20G	20G STR-02						28.03	7.380
20G	20G STR-03						28.70	N/A
20G	20G STR-04						14.89	N/A
20G	20G STR-05						31.54	N/A

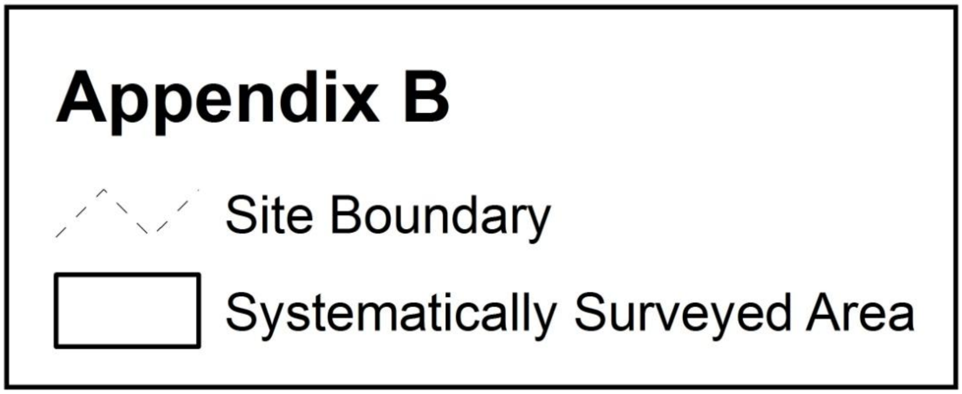
Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
20G	20G STR-06						19.66	N/A
20G	20G STR-07						14.22	N/A
20G	20G STR-08						20.33	N/A
20G	20G STR-09						18.99	N/A
20G	20G STR-10						24.72	N/A
20G		20G CH-01						
20G		20G CH-02						
20G		20G CH-03					5.26	
20G				20G PW-01				
20G				20G PW-02				
20H	20H STR-01						9.76	1.940
20H	20H STR-02						25.72	3.022
20I	20I STR-01						39.90	13.088
20J	20J STR-01						26.33	4.196
20J	20J STR-02						10.83	1.955
20N	20N STR-01						13.96	2.814
20P		20P CH-01						
21E						21E CN-01	3306.86	
21F	21F STR-01						12.40	0.899
21F	21F STR-02						10.91	0.528
21F	21F STR-03						14.42	0.655
21F	21F STR-04						23.12	3.855
21F			21F FEAT-01				N/A	
21F			21F FEAT-02				N/A	
21F			21F FEAT-03				N/A	
21F			21F FEAT-04				N/A	

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
21F			21F FEAT-05				N/A	
21F			21F FEAT-06				N/A	
21F			21F FEAT-07				N/A	
21G	21G STR-01						20.89	5.935
21G	21G STR-02						27.71	8.310
21G	21G STR-03						48.72	13.133
21G	21G STR-04						55.58	
21G	21G STR-05						54.35	15.629
21G	21G STR-06						12.62	1.291
21G	21G STR-07						38.74	9.162
21G	21G STR-08						35.38	16.559
21G	21G STR-09						23.38	6.319
21G	21G STR-10						10.76	1.697
21G	21G STR-11						18.19	6.781
21G	21G STR-12						19.89	2.637
21G	21G STR-13						13.58	2.558
21G	21G STR-14						29.65	10.710
21G	21G STR-15						13.94	2.459
21G	21G STR-16						18.56	4.214
21G	21G STR-17						9.99	1.486
21G	21G STR-18						27.93	6.770
21G	21G STR-19						10.49	1.007
21H	21H STR-02						7.26	0.563
21H	21H STR-03						7.76	0.965
21H	21H STR-04						10.67	2.796
21H	21H STR-05						38.83	18.730
21H	21H STR-06						53.65	8.310

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
21H	21H STR-08						23.86	7.384
21H				21H PW-01				
21H				21H PW-02				
21H				21H PW-03				
21H				21H PW-4				
22E	22E STR-01						29.12	9.188
22E	22E STR-02						34.91	10.395
22G	22G STR-01						36.45	11.405
22G	22G STR-02						19.82	11.785
22G	22G STR-03						9.93	1.601
22G	22G STR-04						12.63	2.995
22G	22G STR-05						23.02	4.922
22G	22G STR-06						42.87	11.712
22G	22G STR-07						15.11	4.883
22G	22G STR-08						80.17	38.433
22G	22G STR-09						89.43	34.698
22G	22G STR-10						18.95	2.406
22G	22G STR-11						24.73	2.907
22G	22G STR-12						34.93	13.775
22G	22G STR-13						56.91	32.861
22G	22G STR-14						19.16	3.177
22G	22G STR-15						20.63	4.347
22G	22G STR-16						20.21	6.288
22G	22G STR-17						12.00	1.197
22G	22G STR-18						9.82	1.067
22G	22G STR-19						40.51	18.219
22H	22H STR-01						21.26	7.248

Sec-tion	Structure #	Chich #	Feature #	Wall #	Cave/Micro cenote #	Cenote #	Basal Area	Volume
22H	22H STR-02						37.69	9.237
22H	22H STR-03						16.66	3.303
22H	22H STR-04						27.65	8.214
22H	22H STR-05						18.50	3.100
22H	22H STR-06						15.40	2.199
22H	22H STR-07						12.07	2.266
22H	22H STR-08						56.65	13.899
22H				22H PW-01				
23G	23G STR-01						33.69	10.491
23G	23G STR-02						14.08	1.812
23G	23G STR-03						17.38	4.892
23H	23H STR-01						10.88	2.472

APPENDIX B - SYSTEMATICALL MAPPED AND SURVEYED GRID SECTIONS



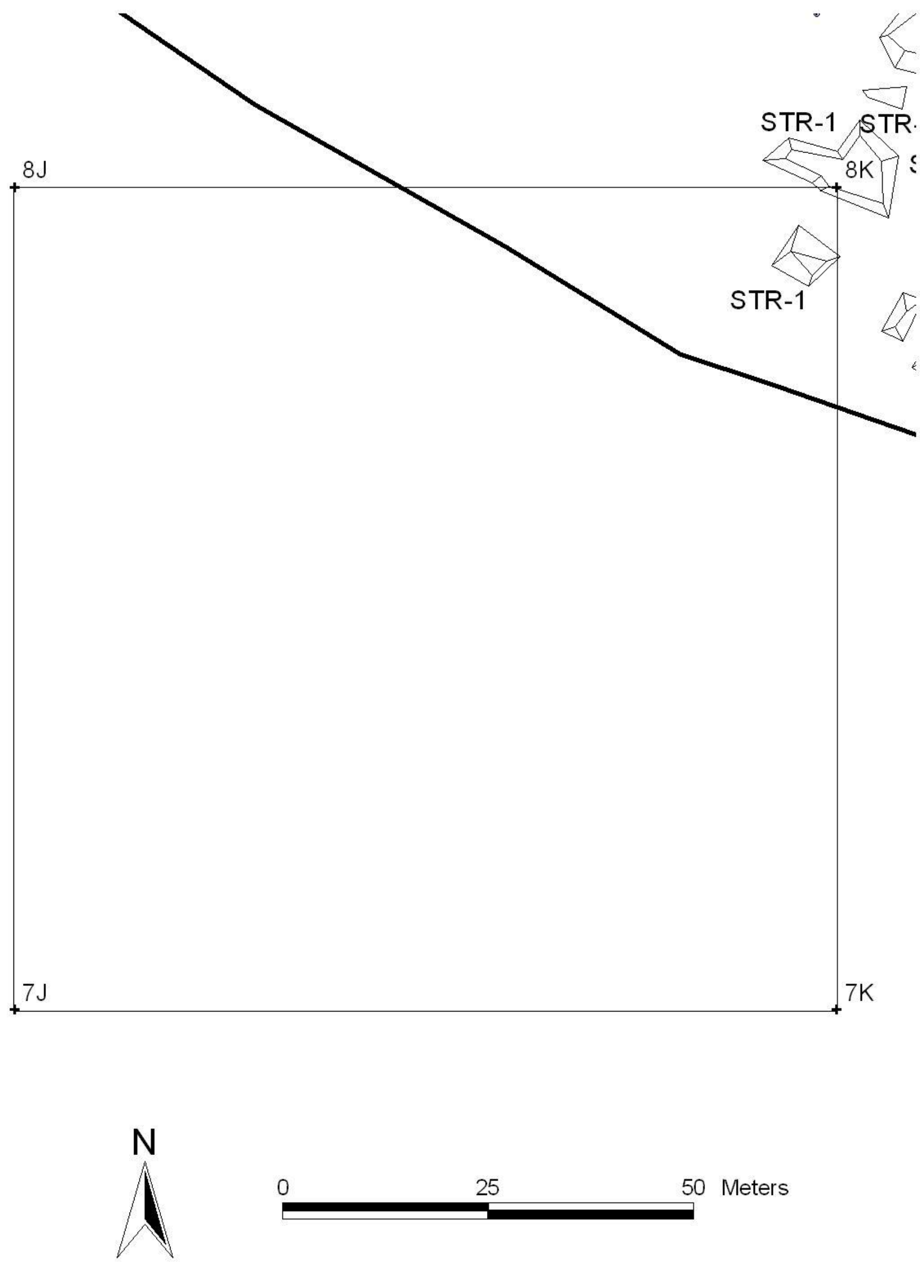


Figure B.1. Map of Section 7J.

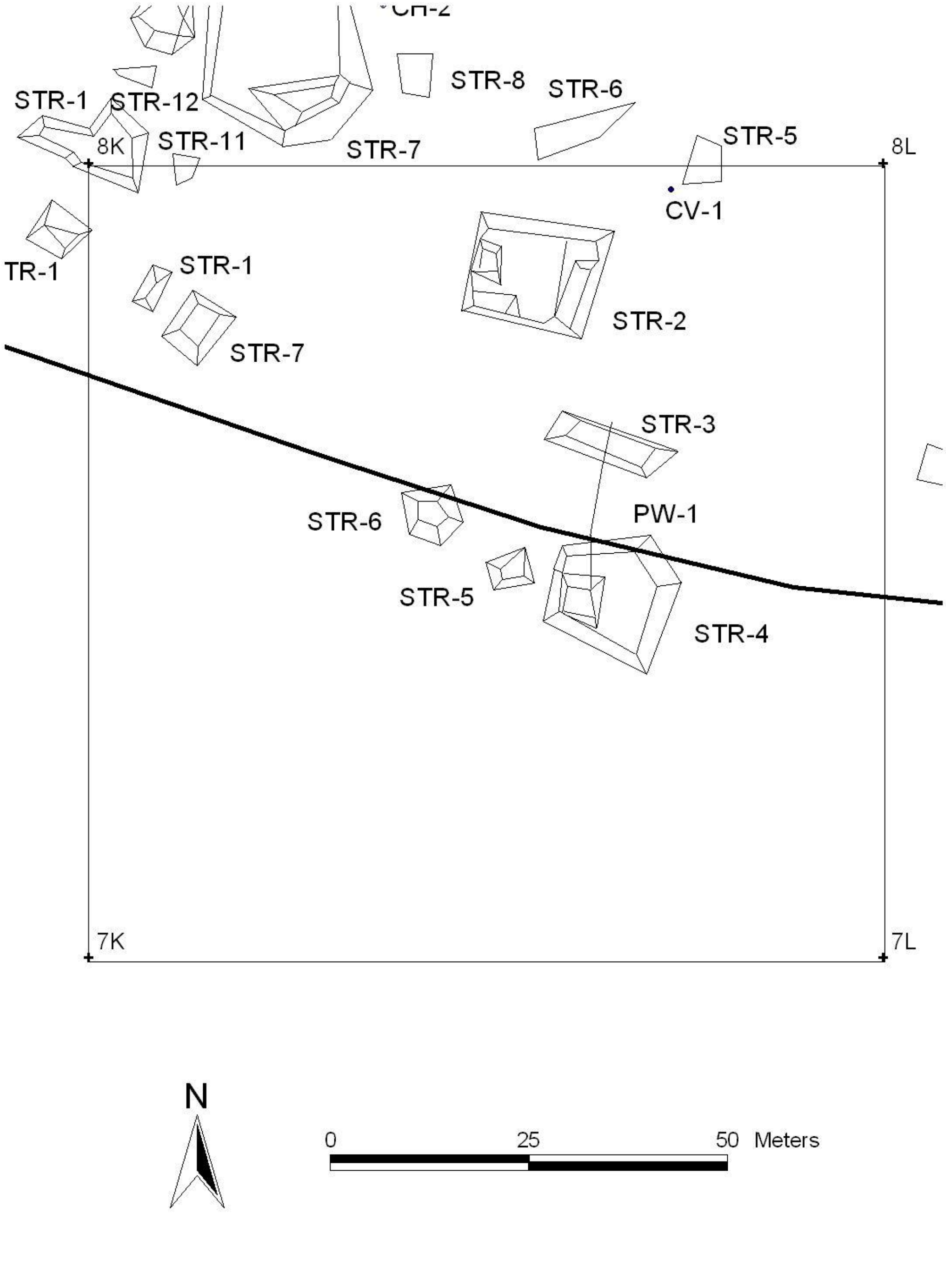


Figure B.2. Map of Section 7K.

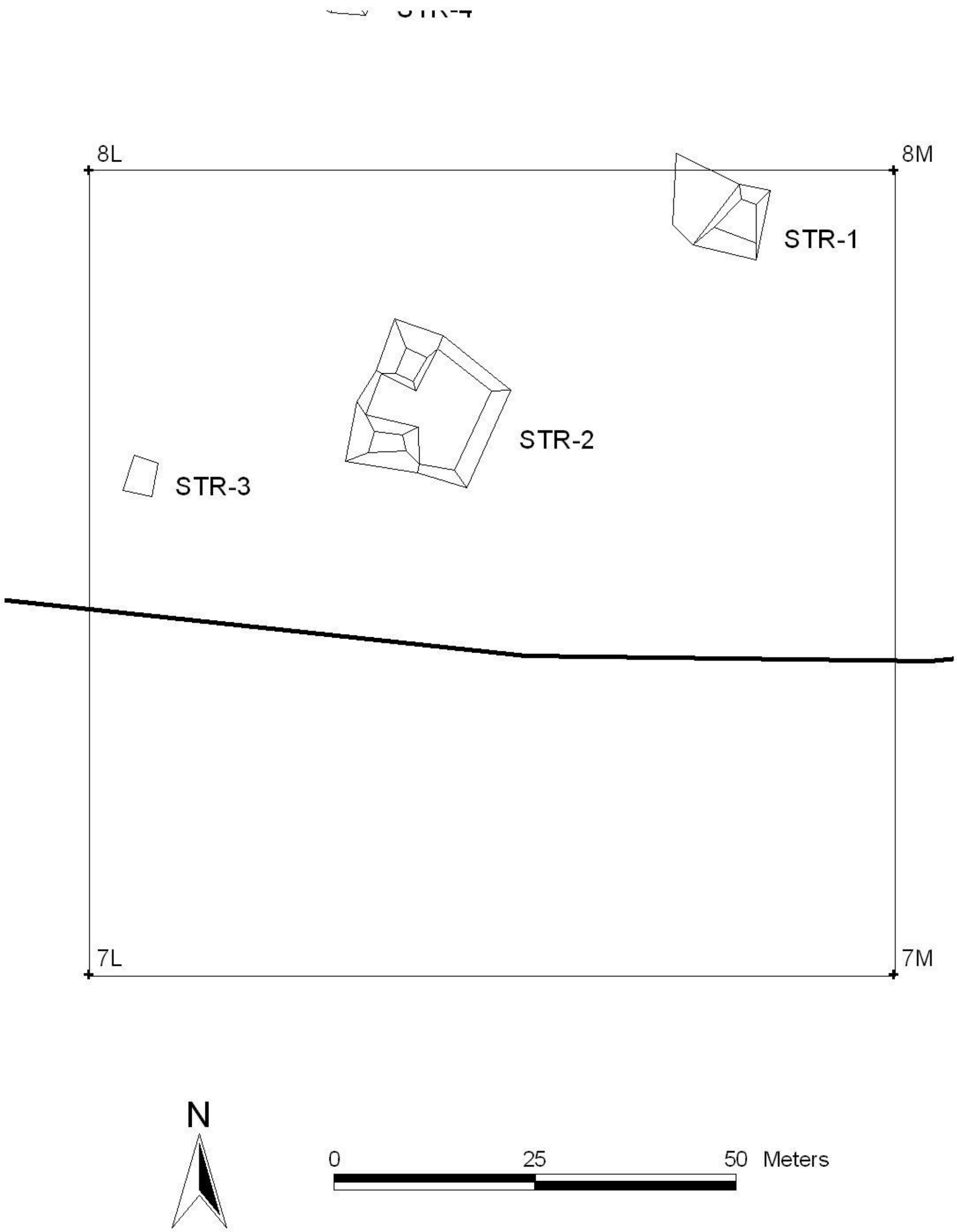


Figure B.3. Map of Section 7L.

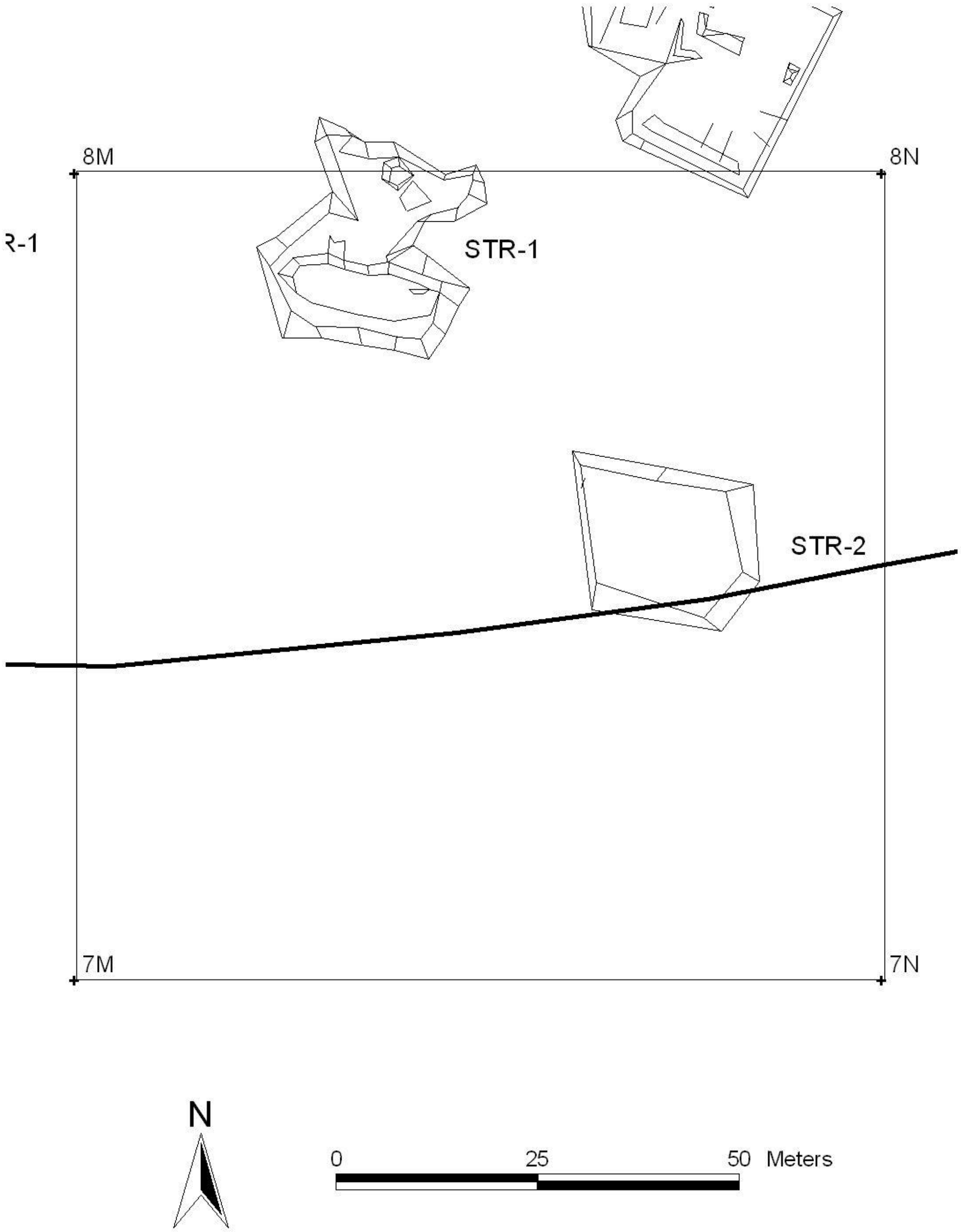


Figure B.4. Map of Section 7M.

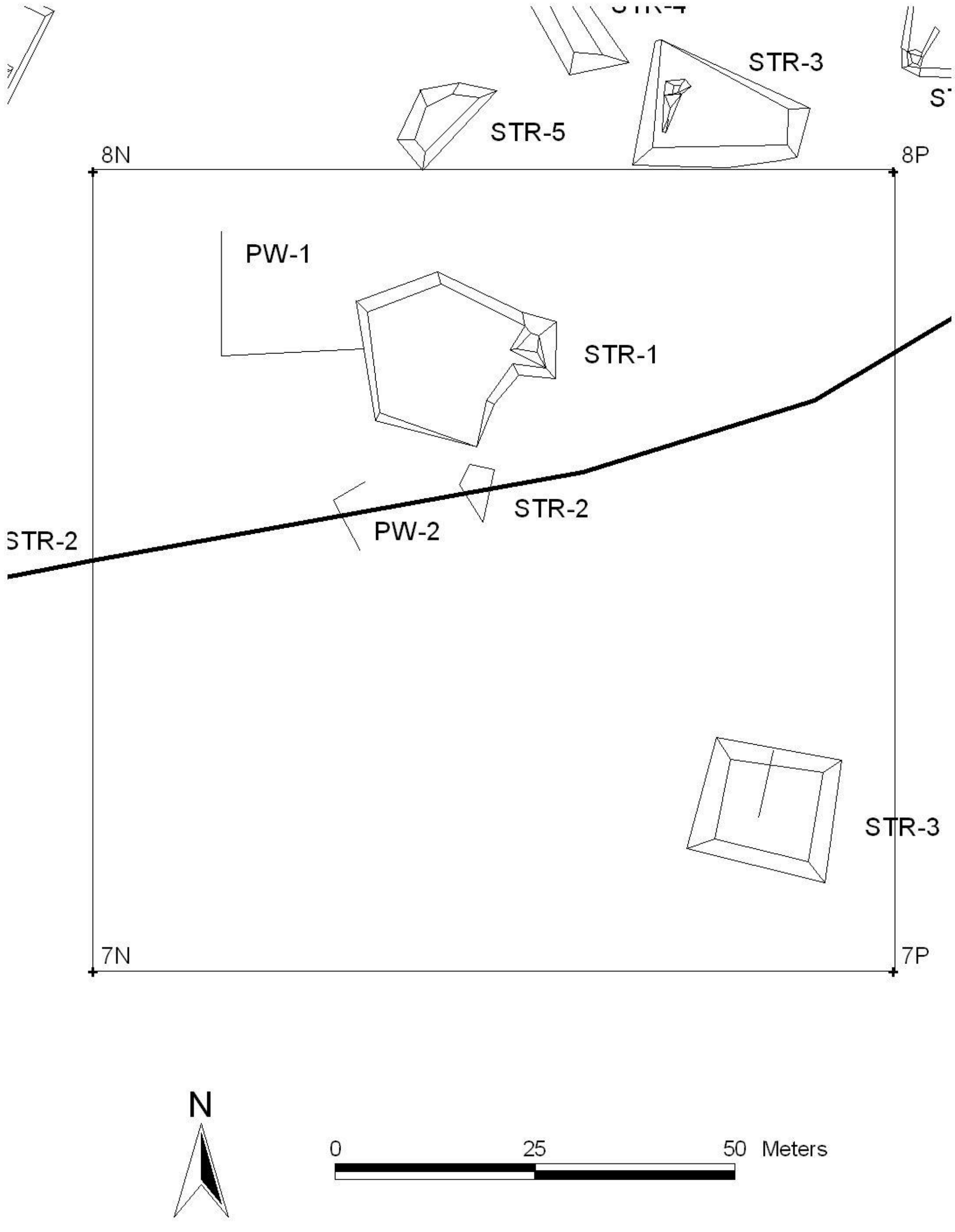


Figure B.5. Map of Section 7N.

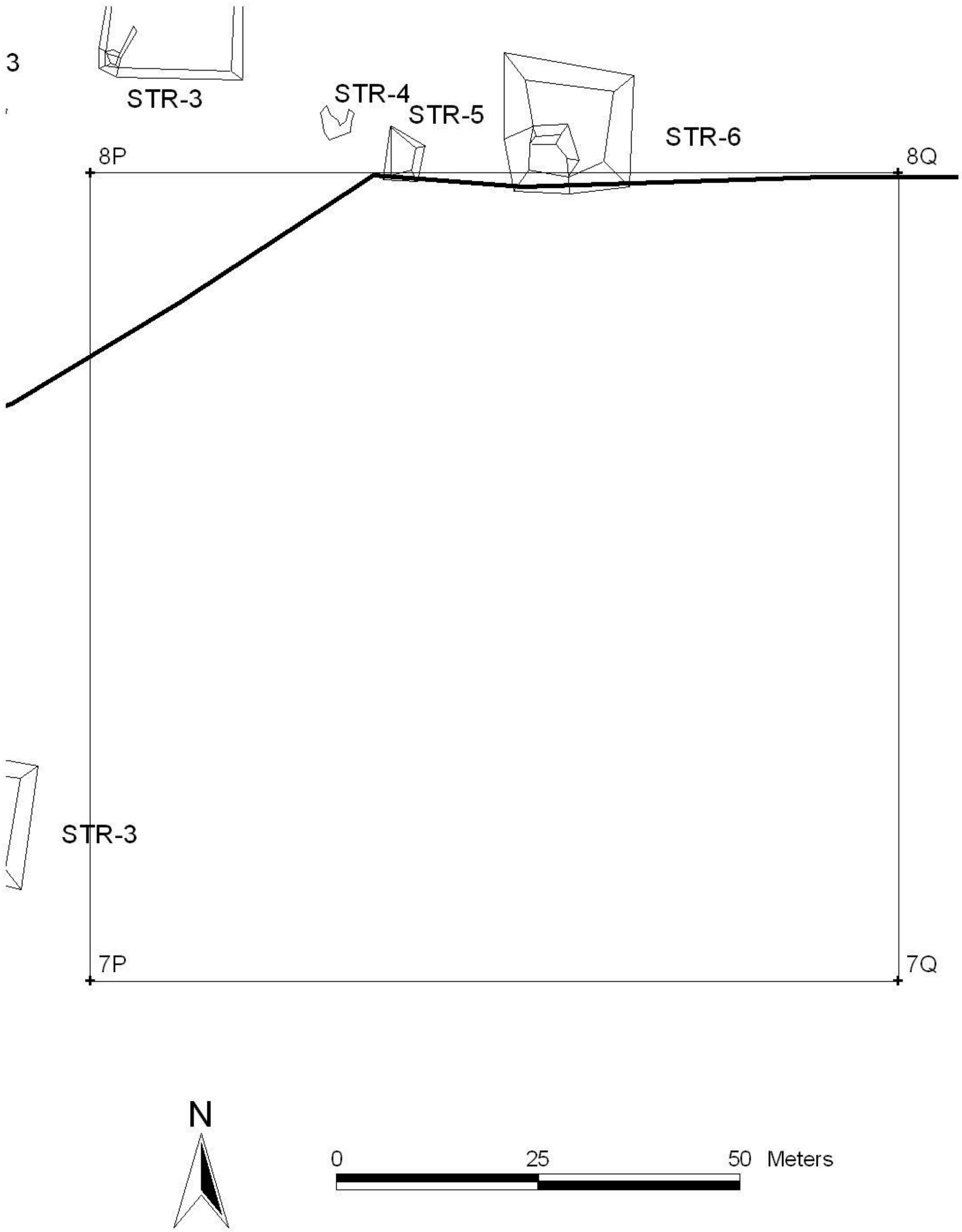


Figure B.6. Map of Section 7P.

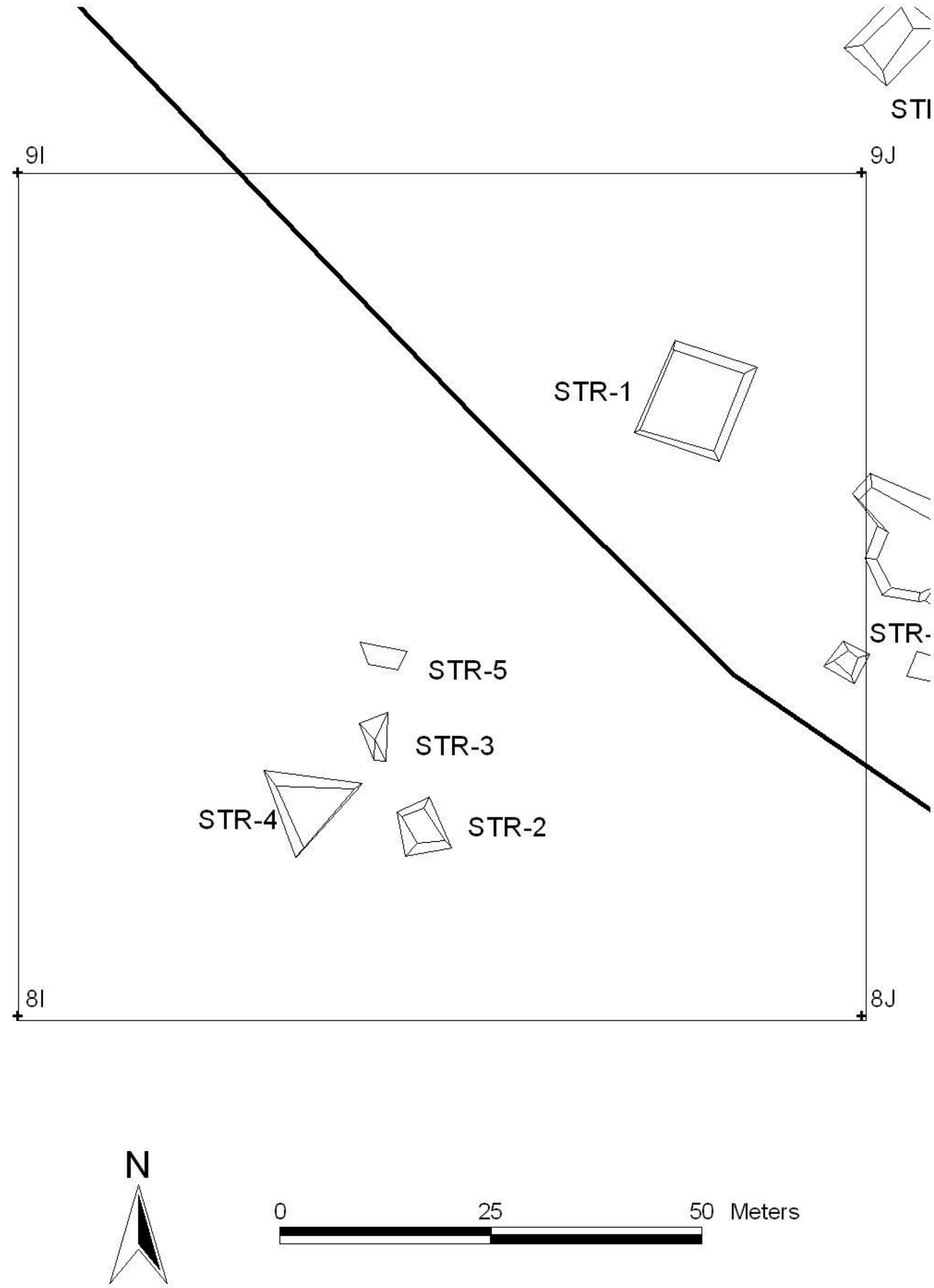


Figure B.7. Map of Section 8I.

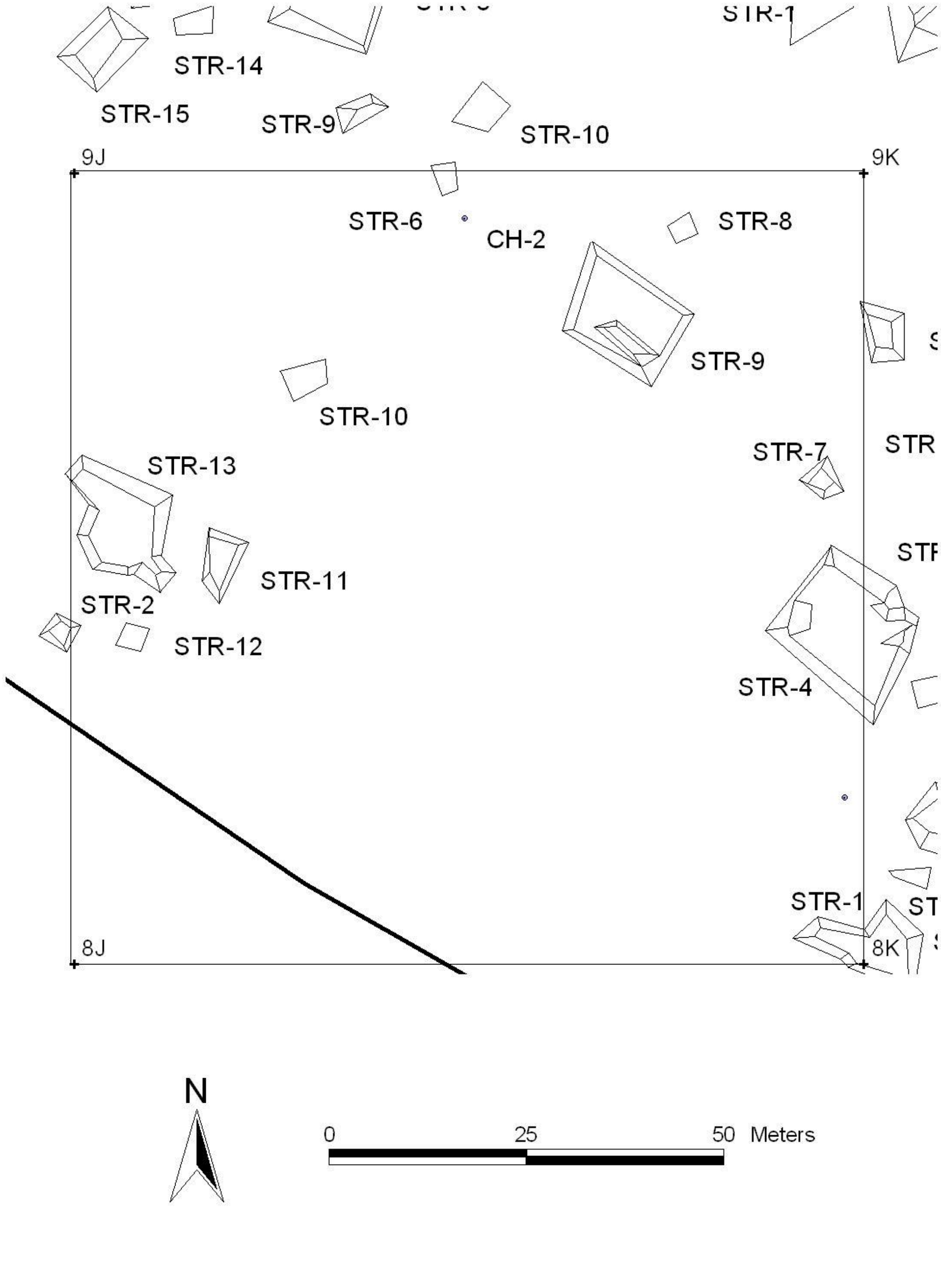


Figure B.8. Map of Section 8J.

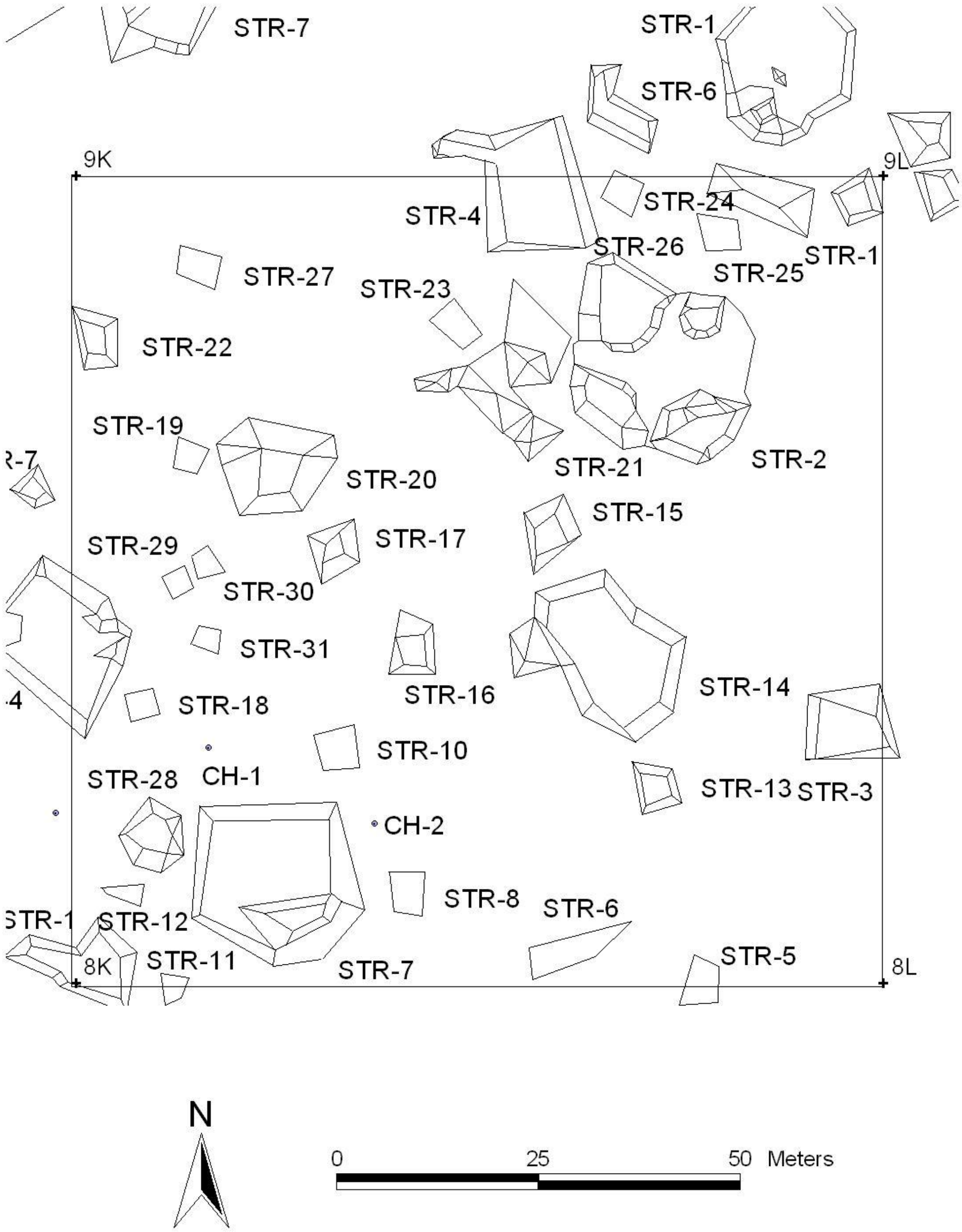


Figure B.9. Map of Section 8K.

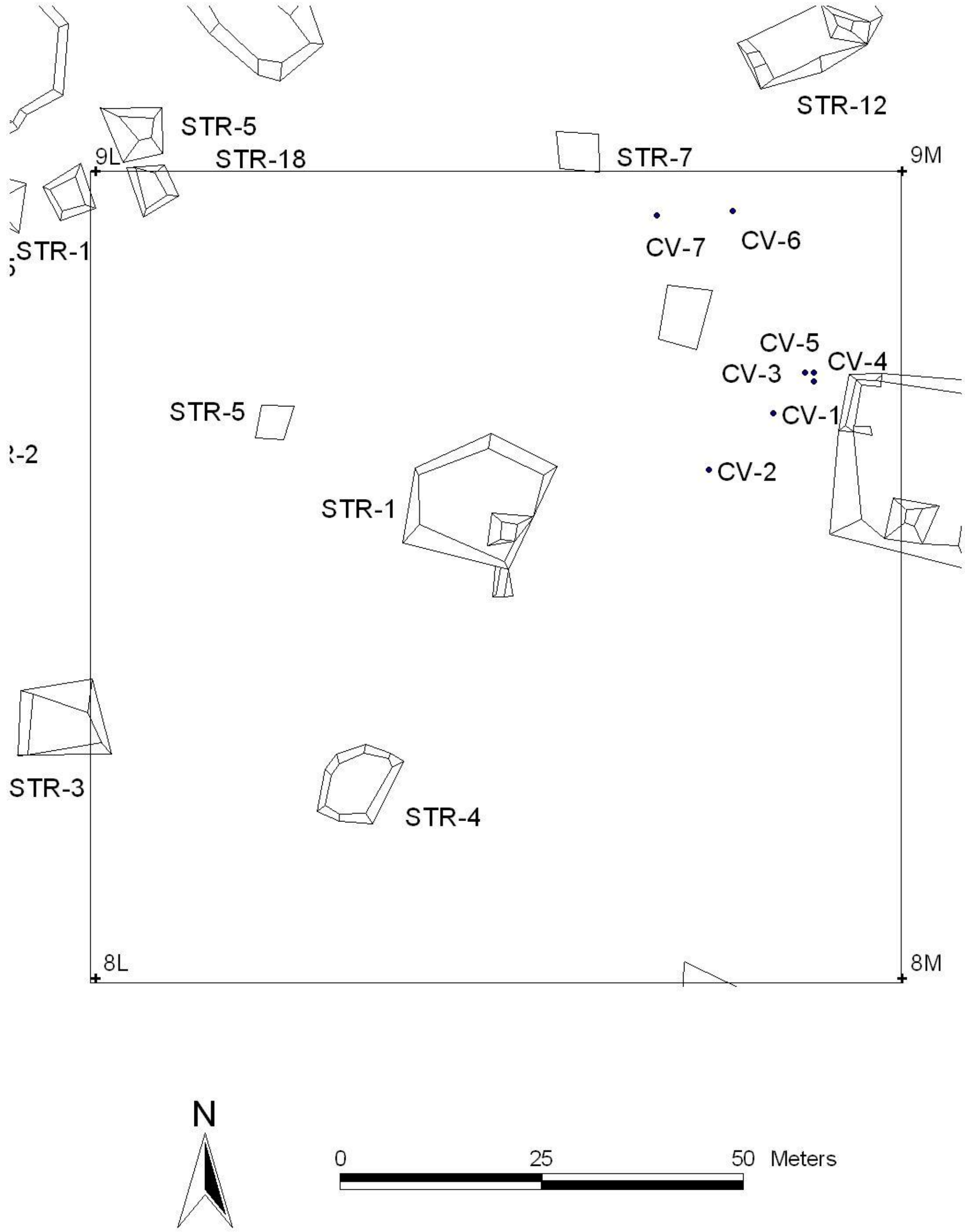


Figure B.10. Map of Section 8L.

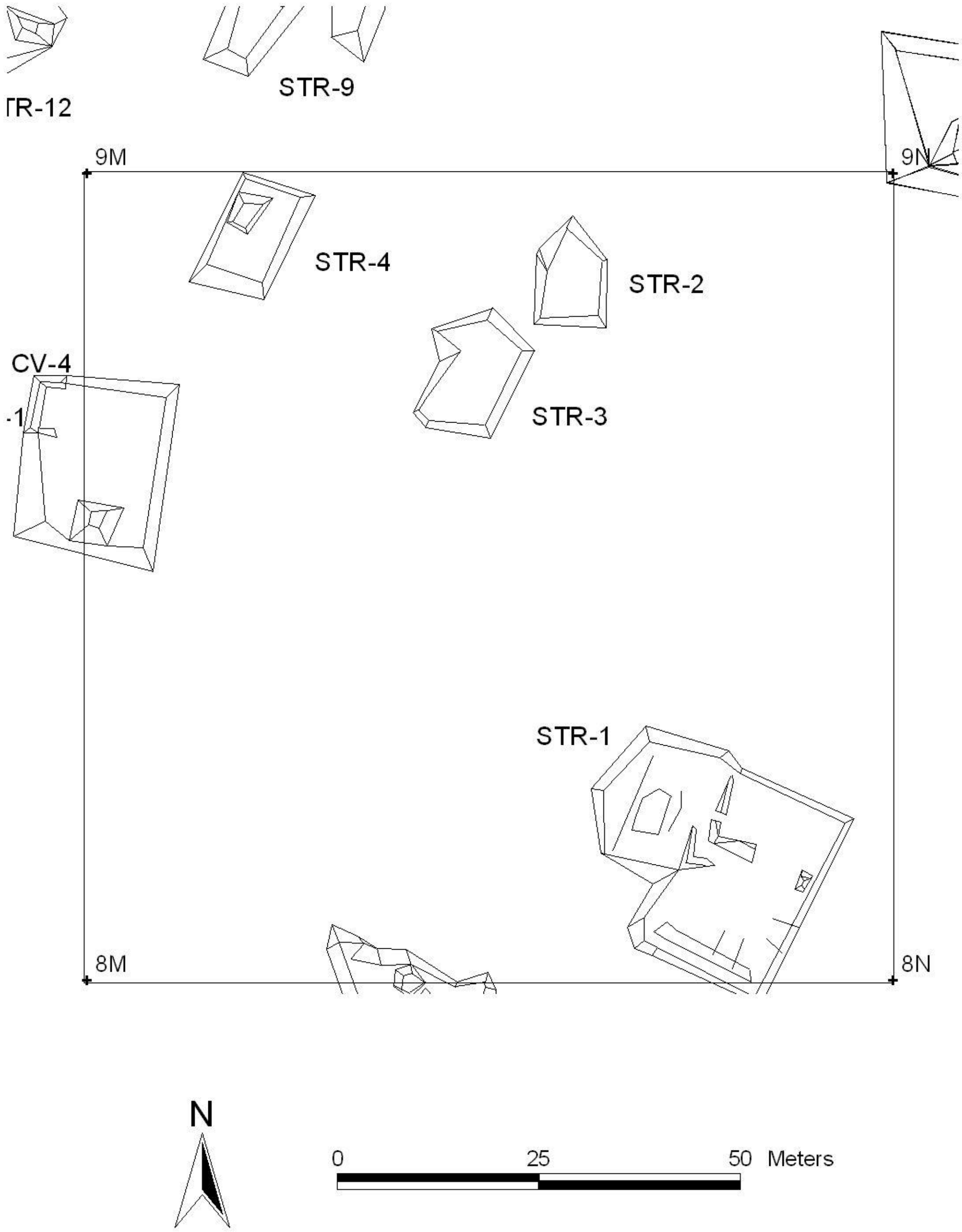


Figure B.11. Map of Section 8M.

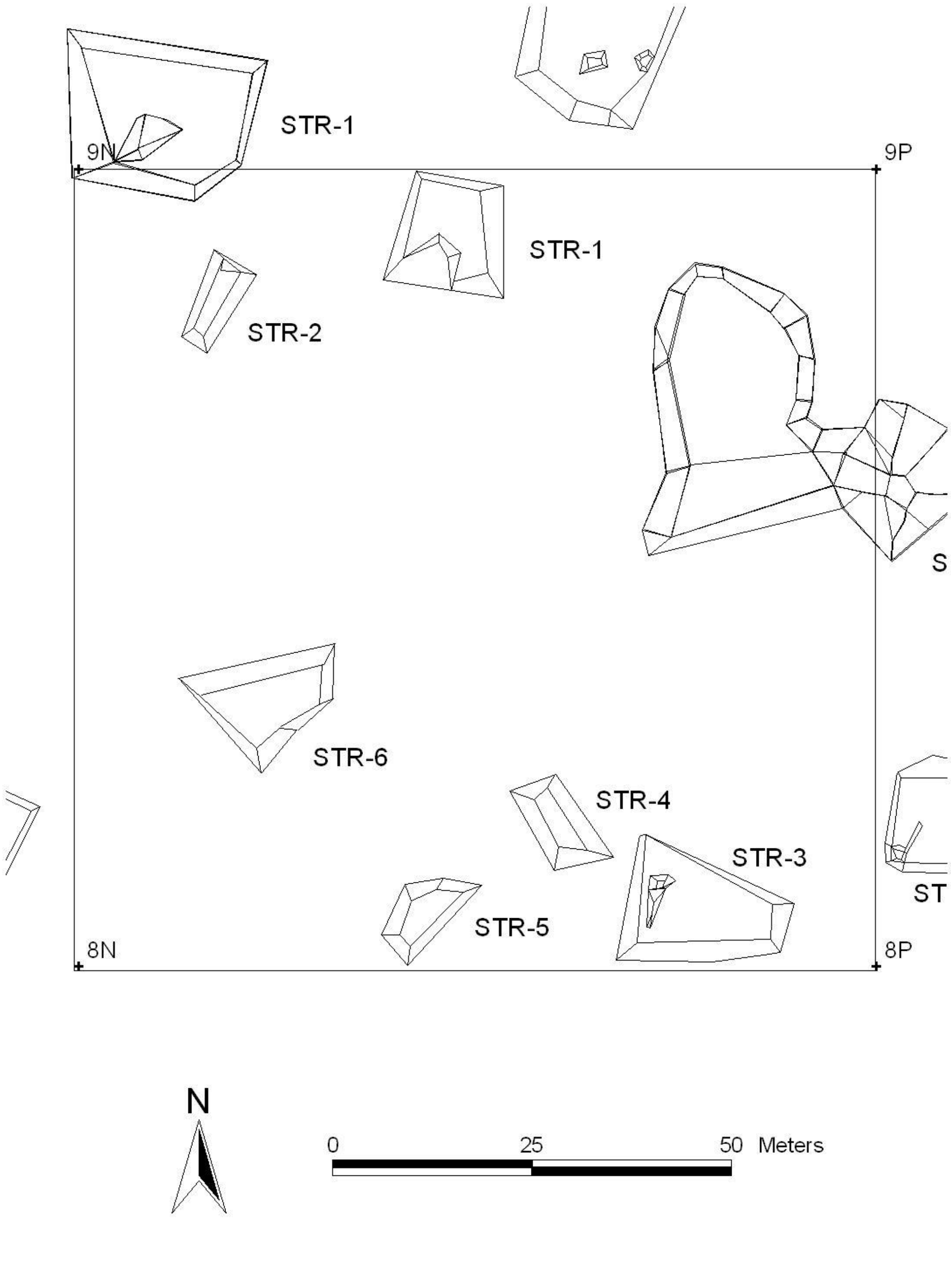


Figure B.12. Map of Section 8N.

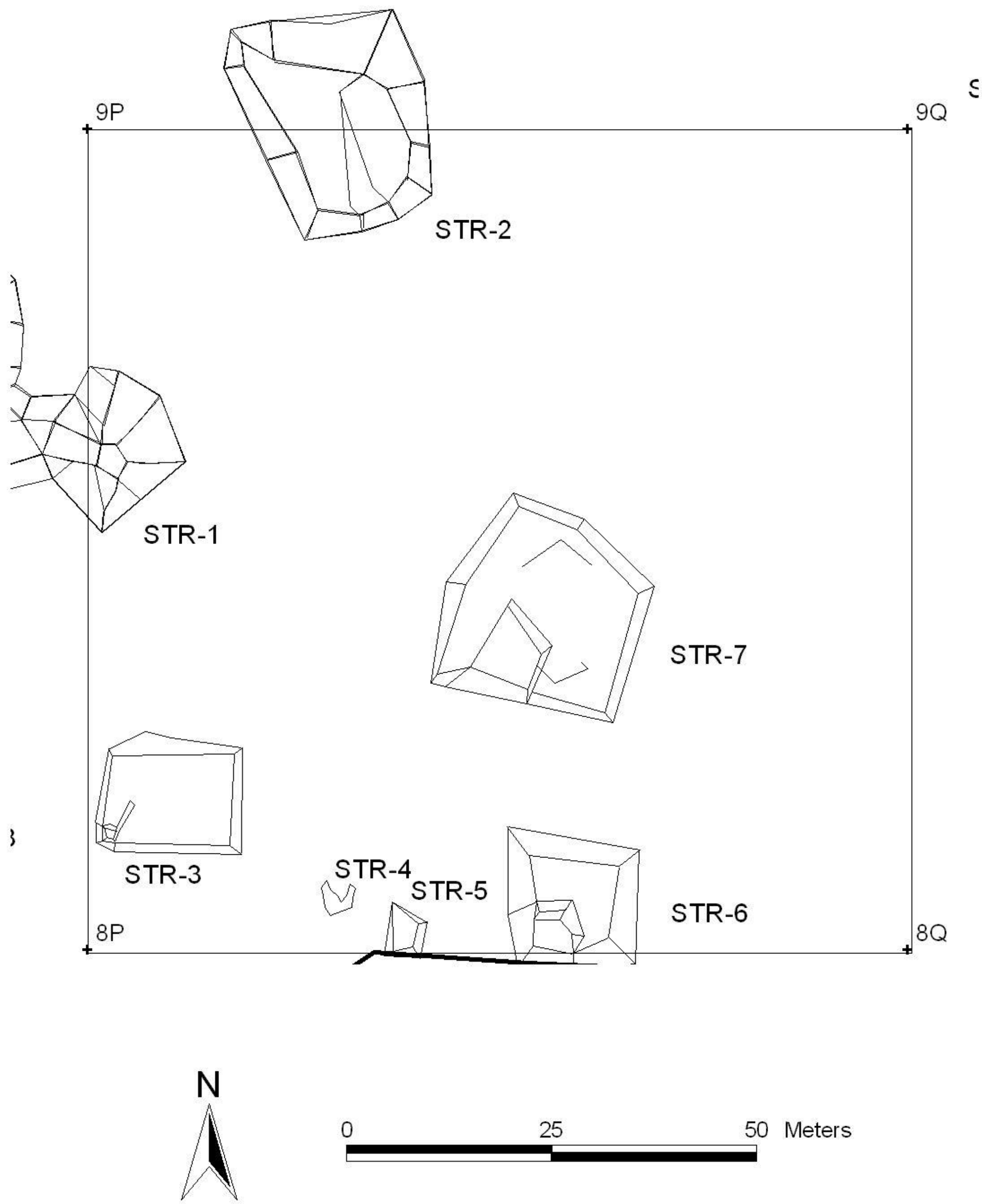


Figure B.13. Map of Section 8P.

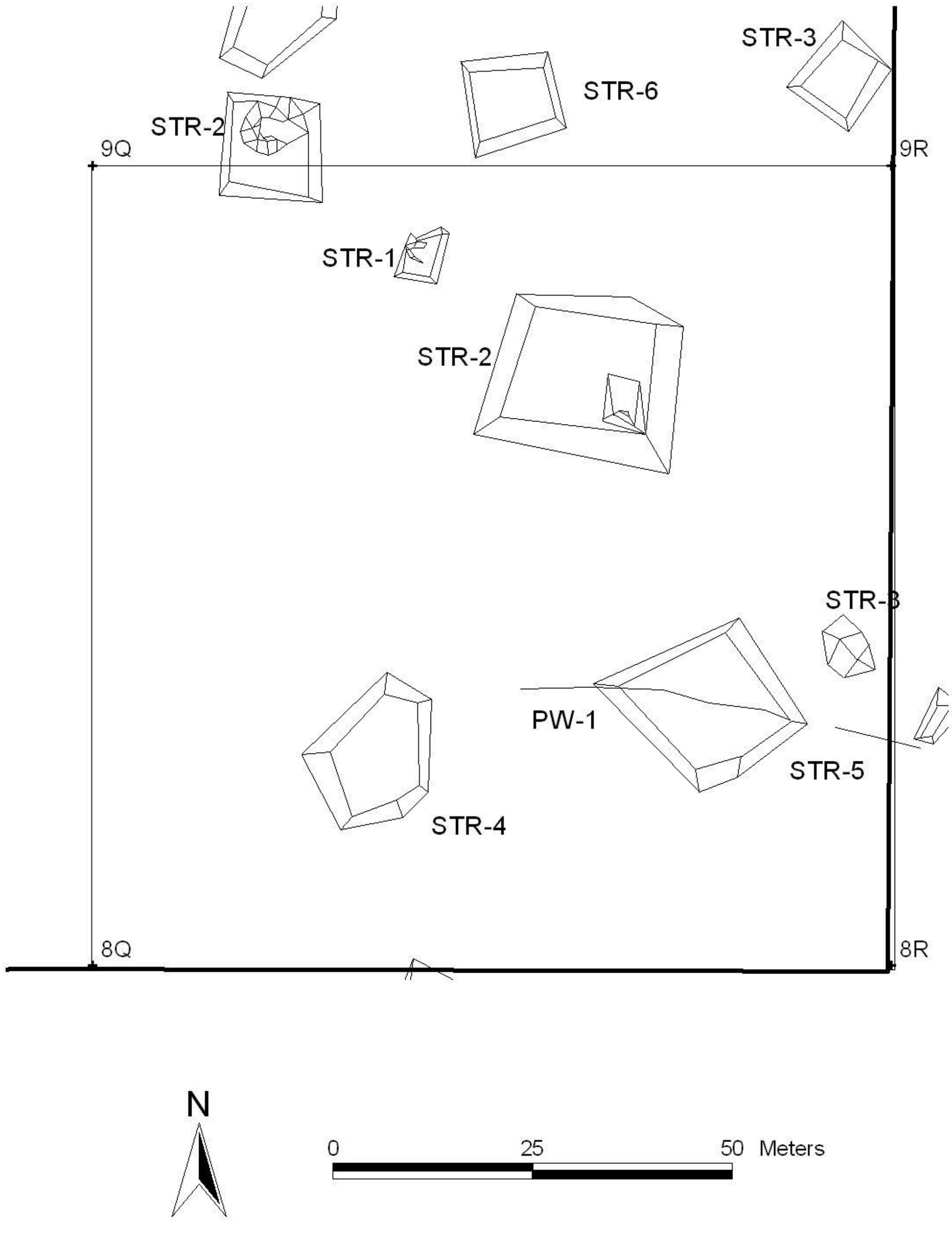


Figure B.14. Map of Section 8Q.

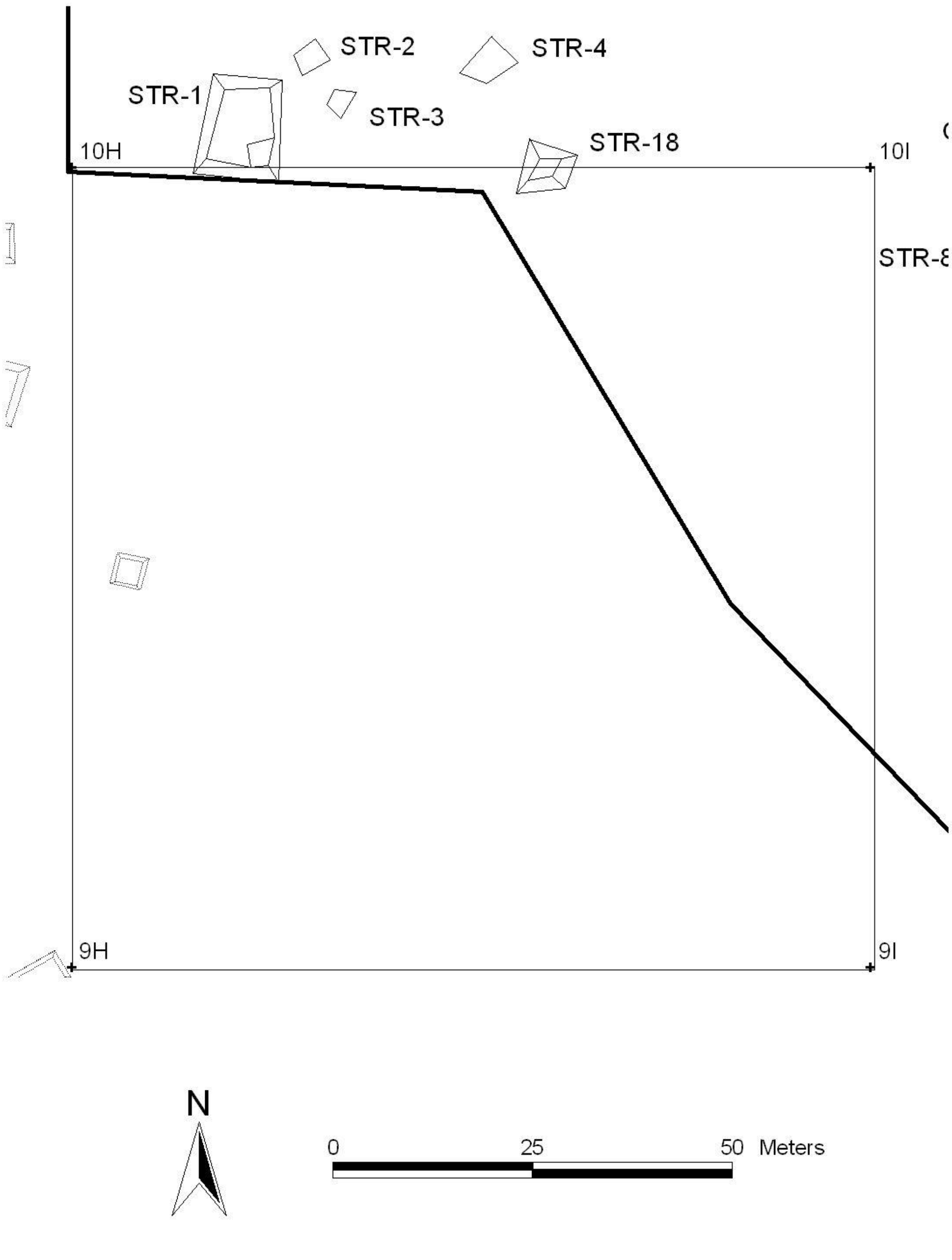


Figure B.15. Map of Section 9H.

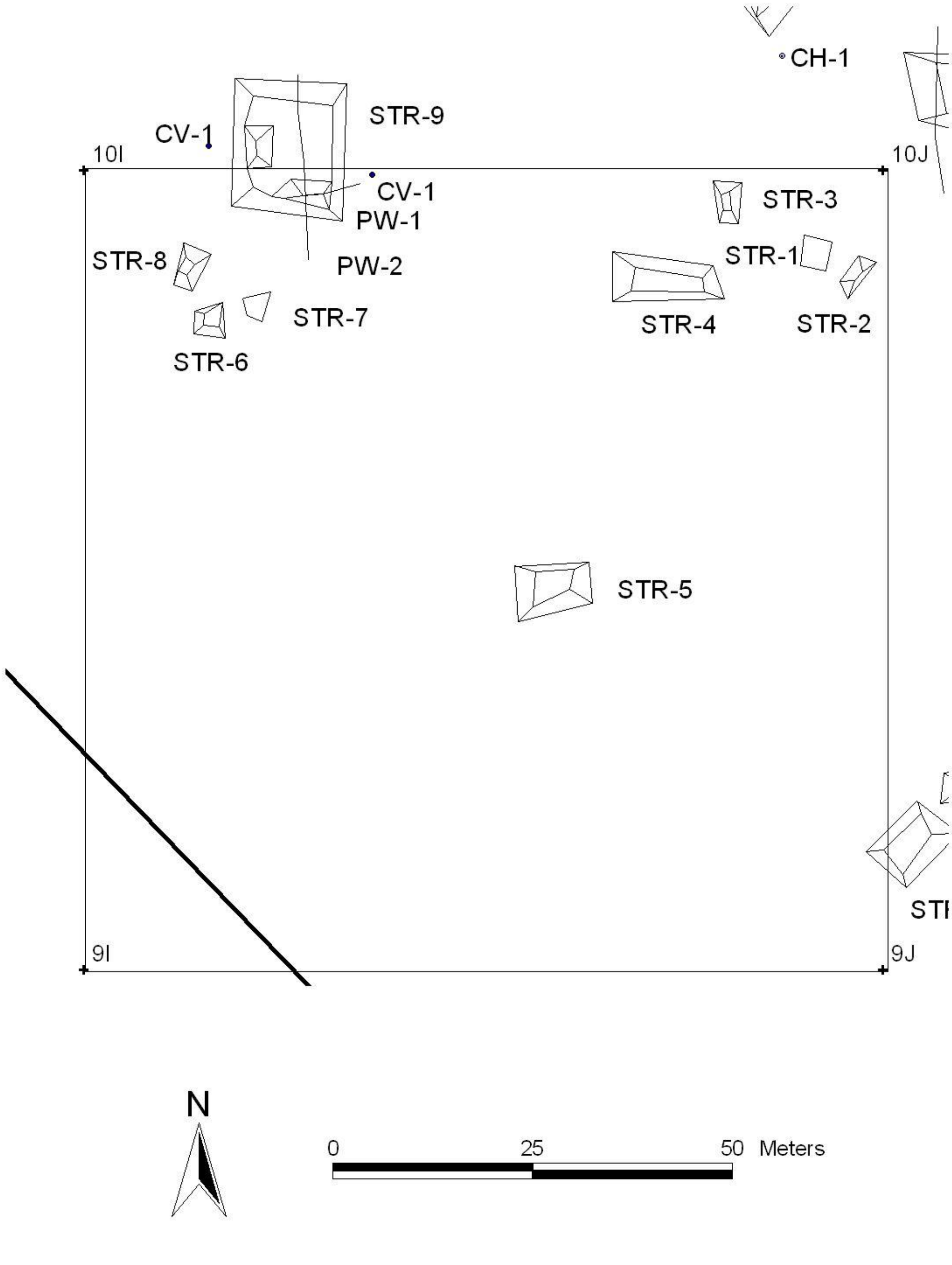


Figure B.16. Map of Section 9I.

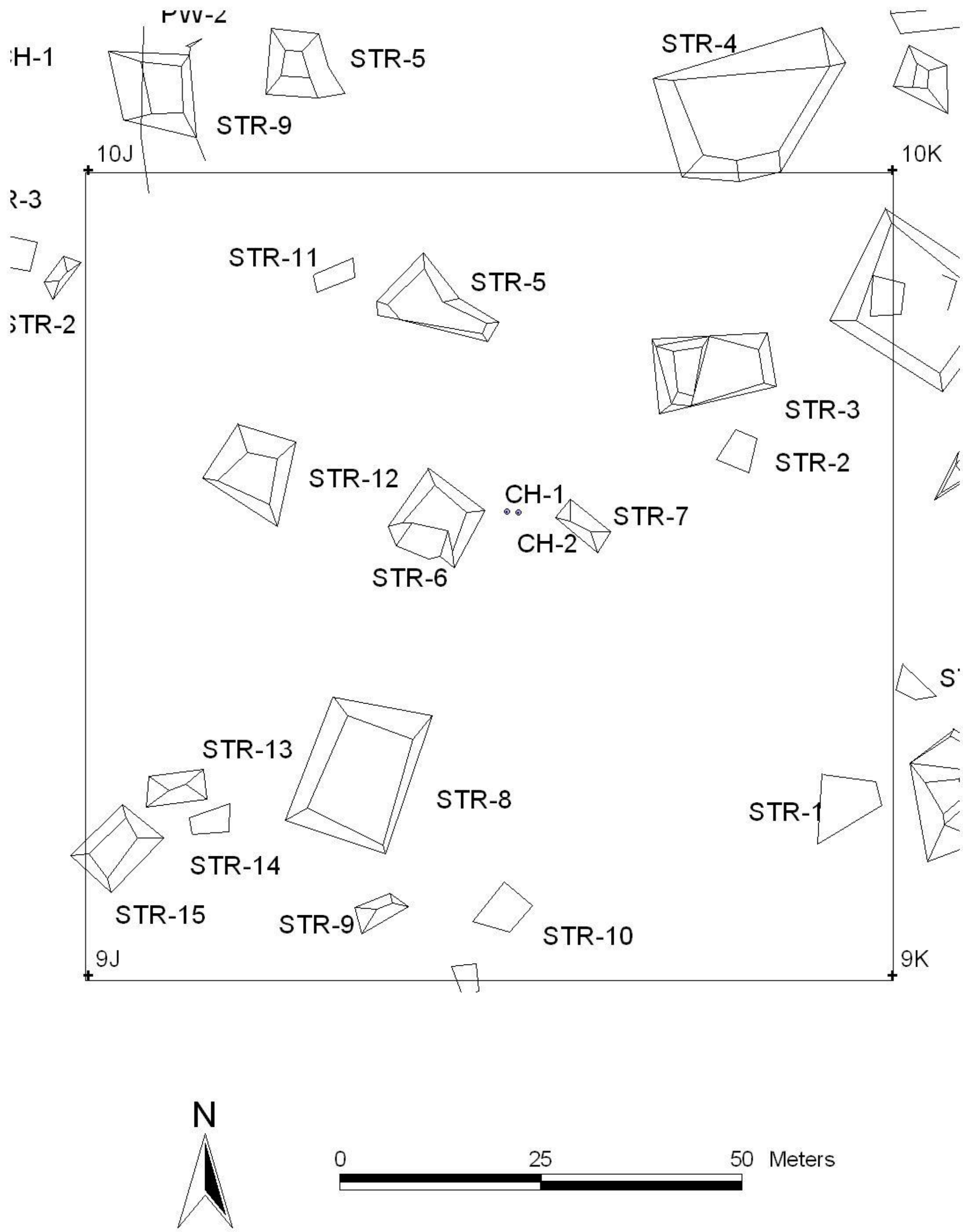


Figure B.17. Map of Section 9J.

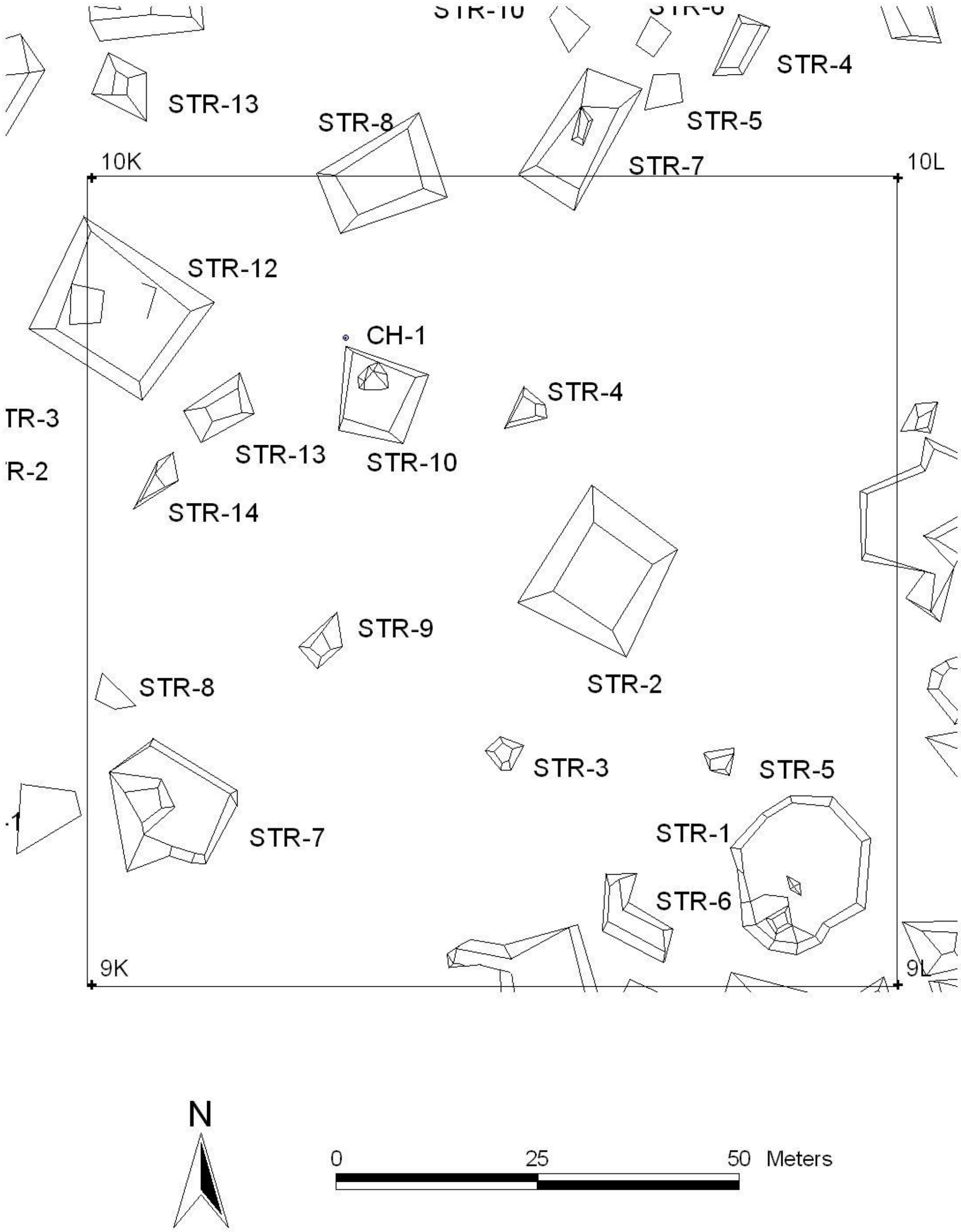


Figure B.18. Map of Section 9K.

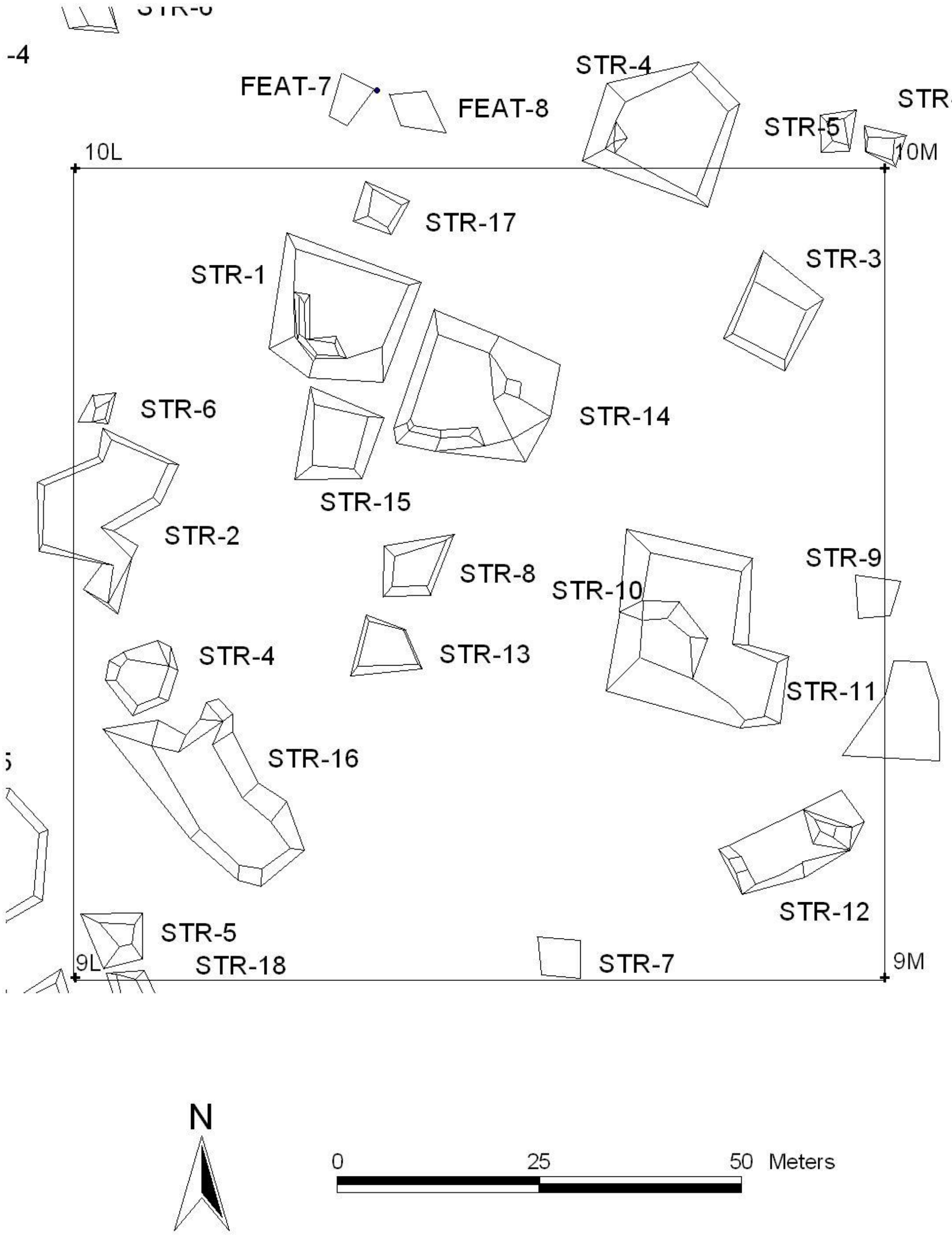


Figure B.19. Map of Section 9L.

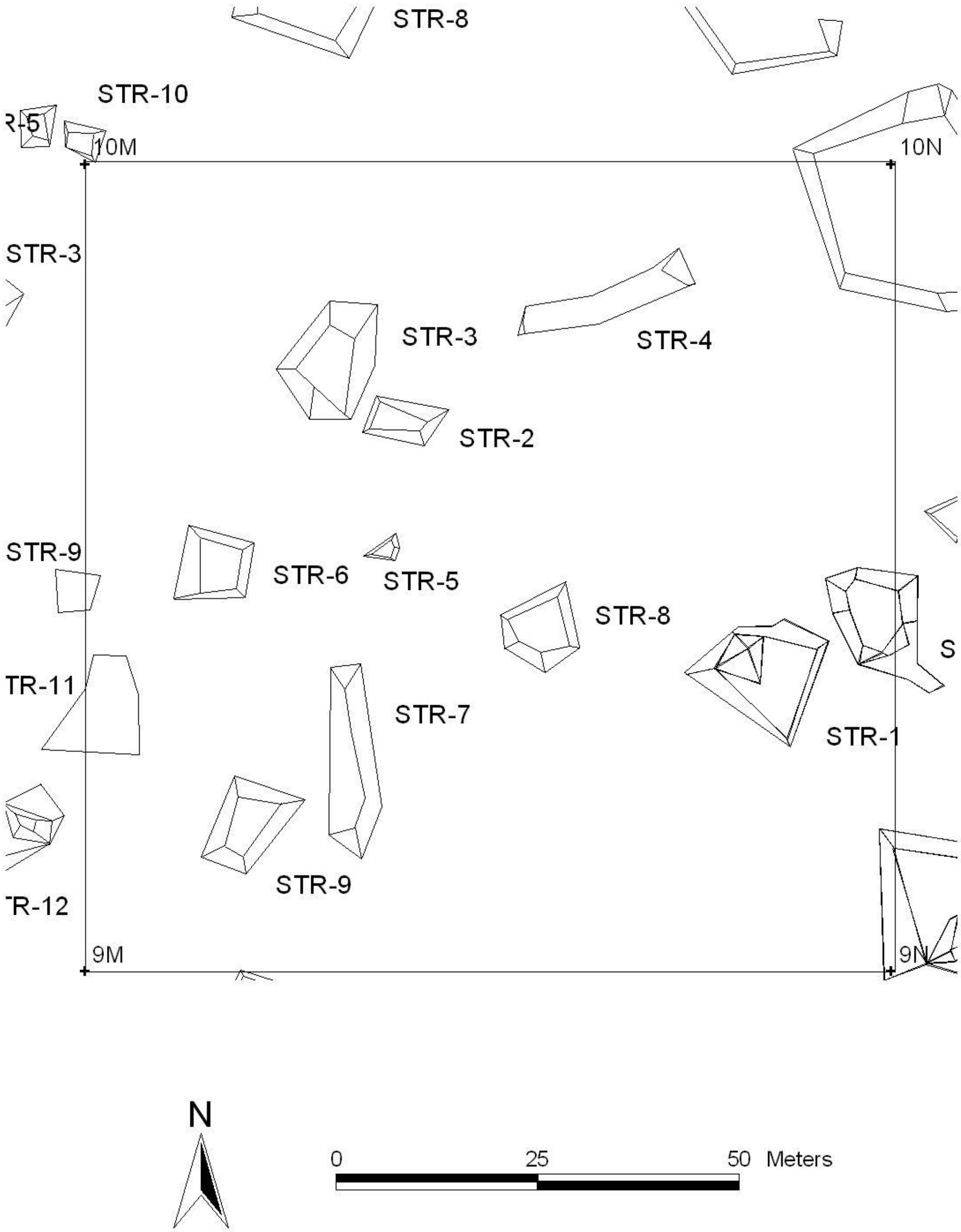


Figure B.20. Map of Section 9M.

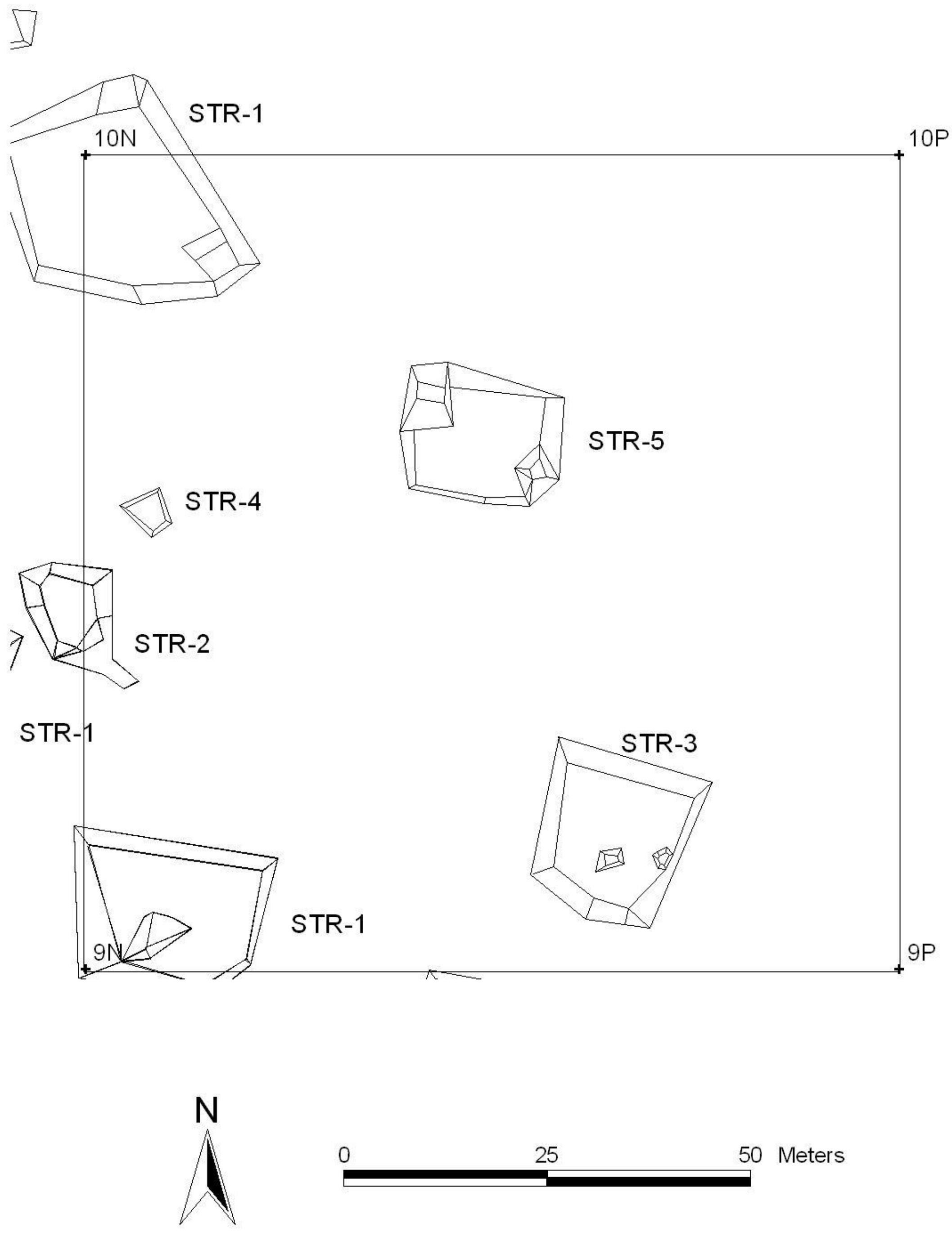


Figure B.21. Map of Section 9N.

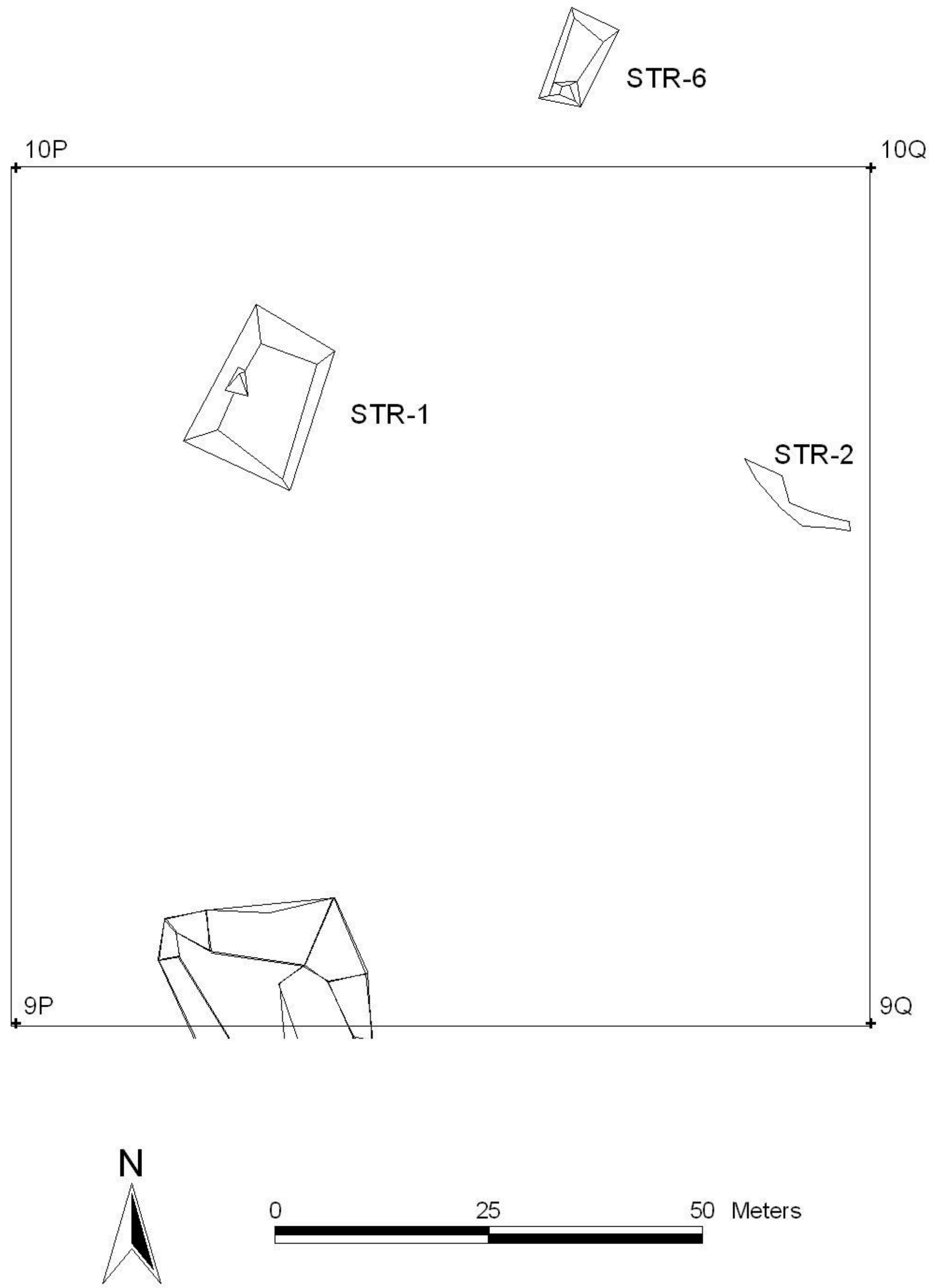


Figure B.22. Map of Section 9P.

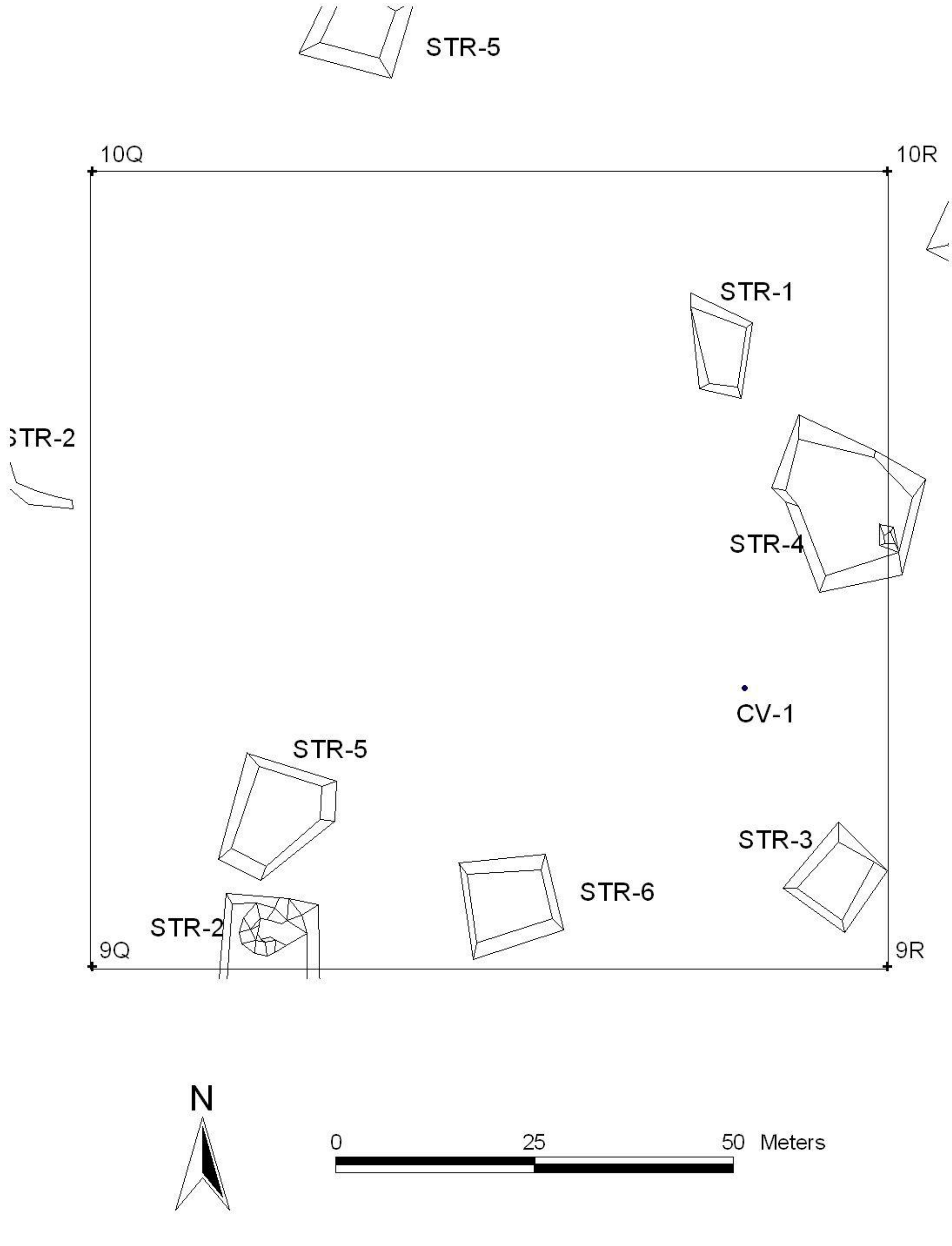


Figure B.23. Map of Section 9Q.

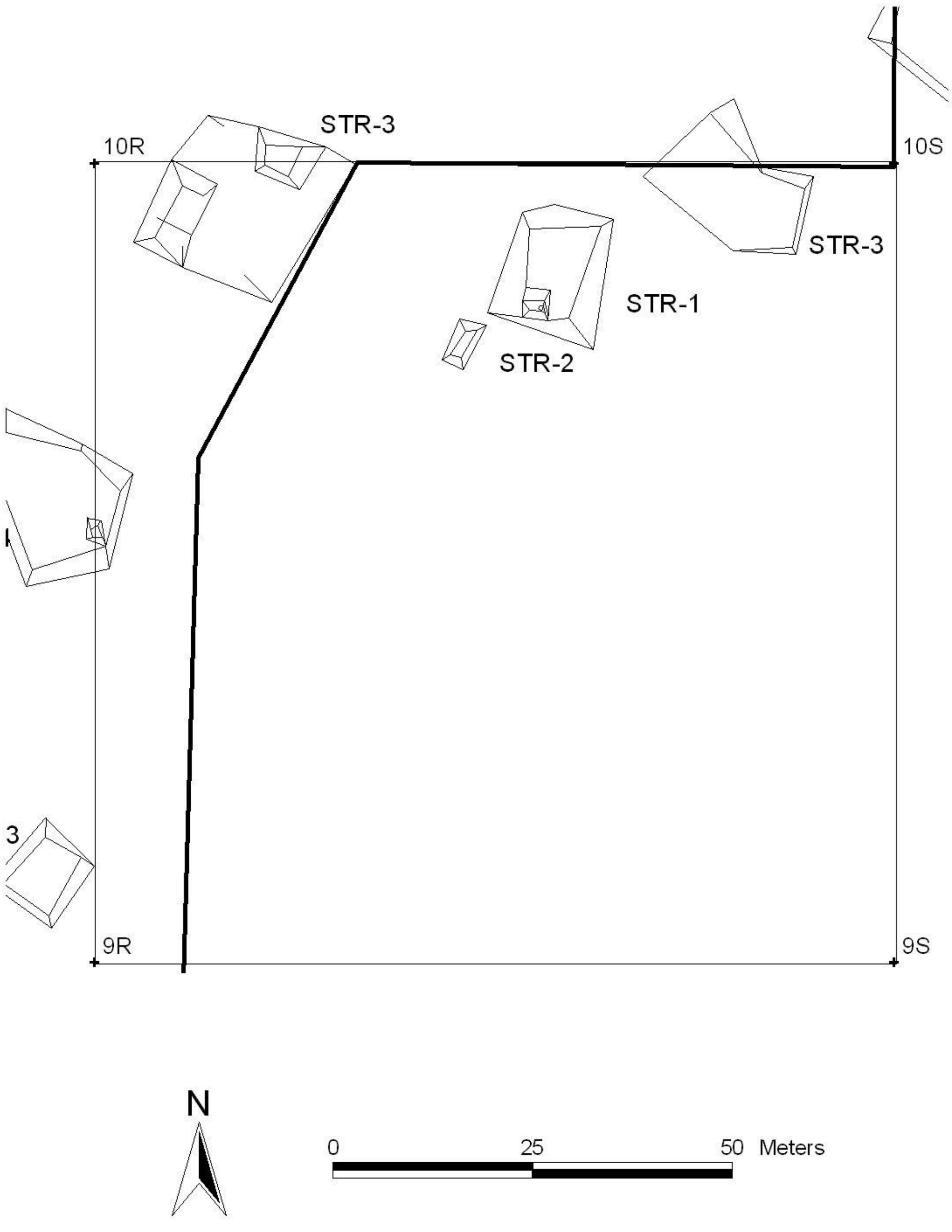


Figure B.24. Map of Section 9R.

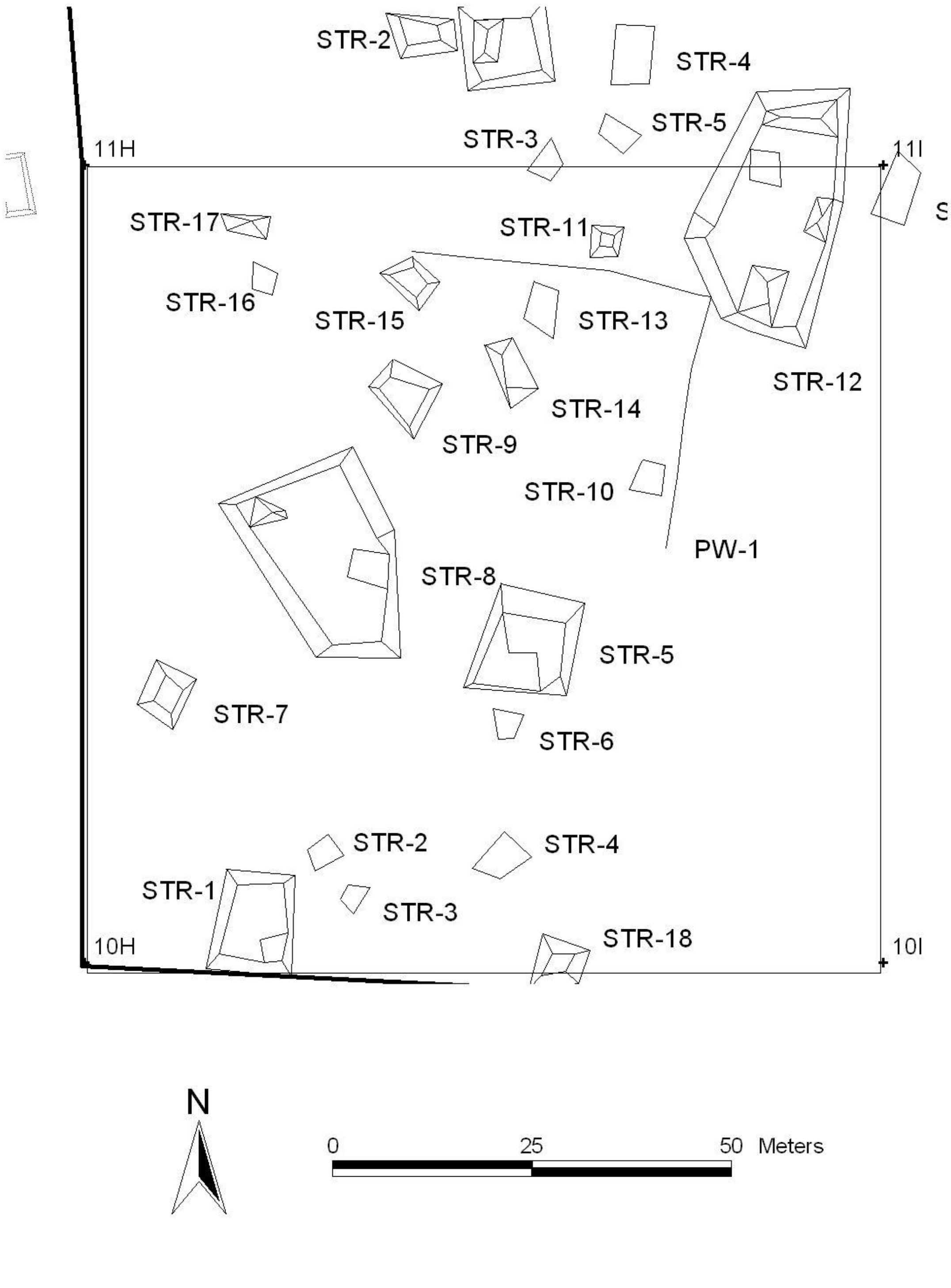


Figure B.25. Map of Section 10H.

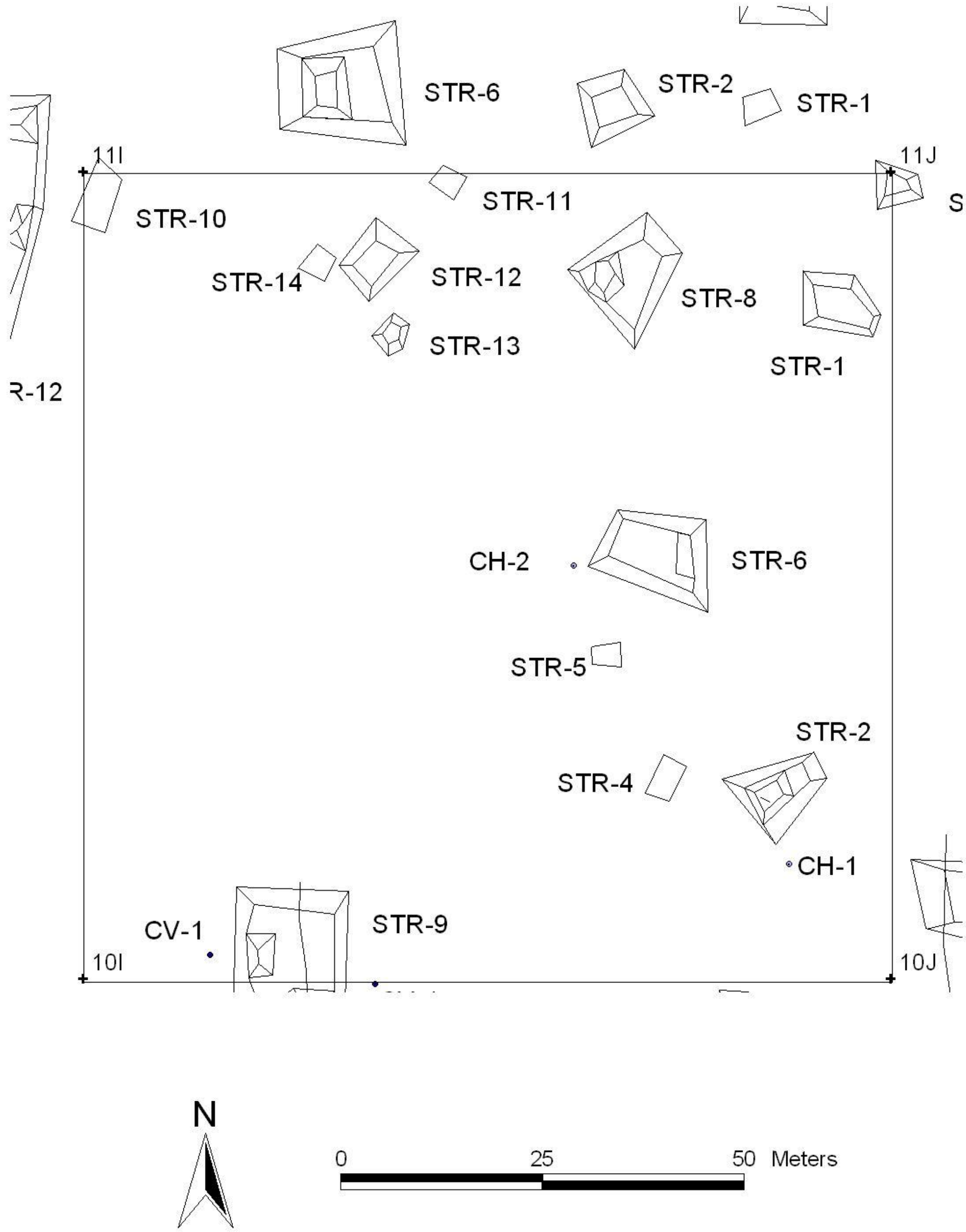


Figure B.26. Map of Section 10I.

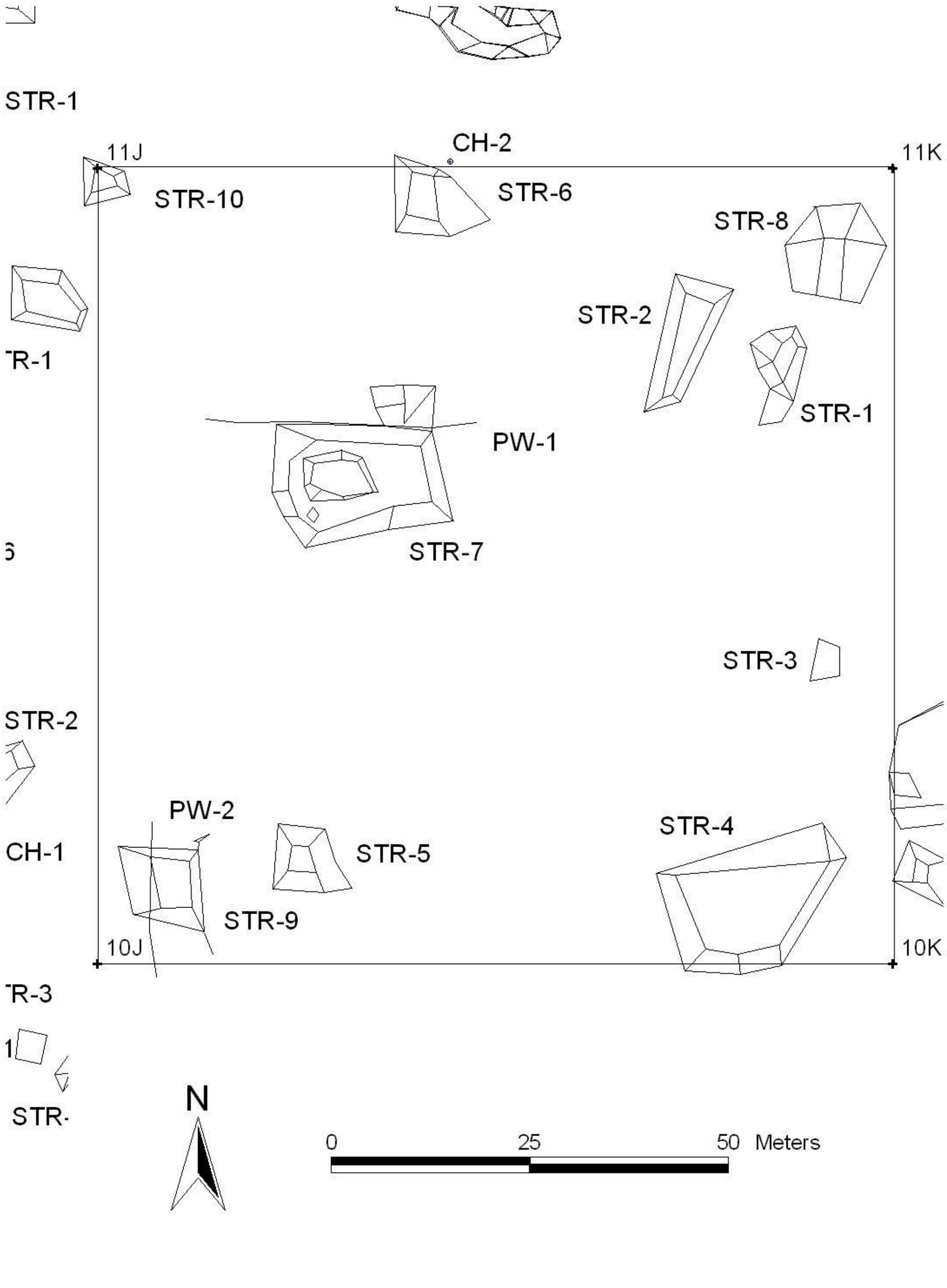


Figure B.27. Map of Section 10J.

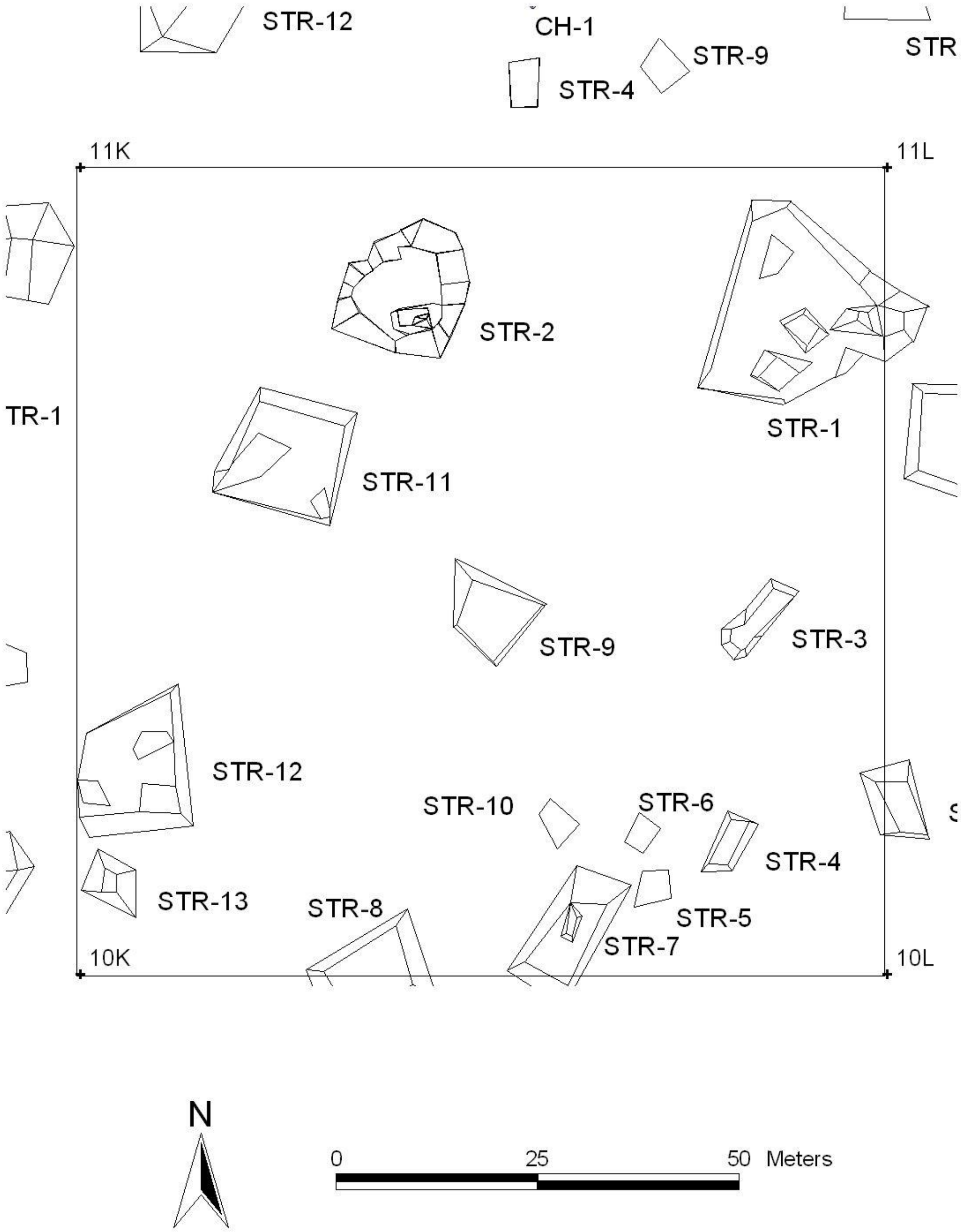


Figure B.28. Map of Section 10K.

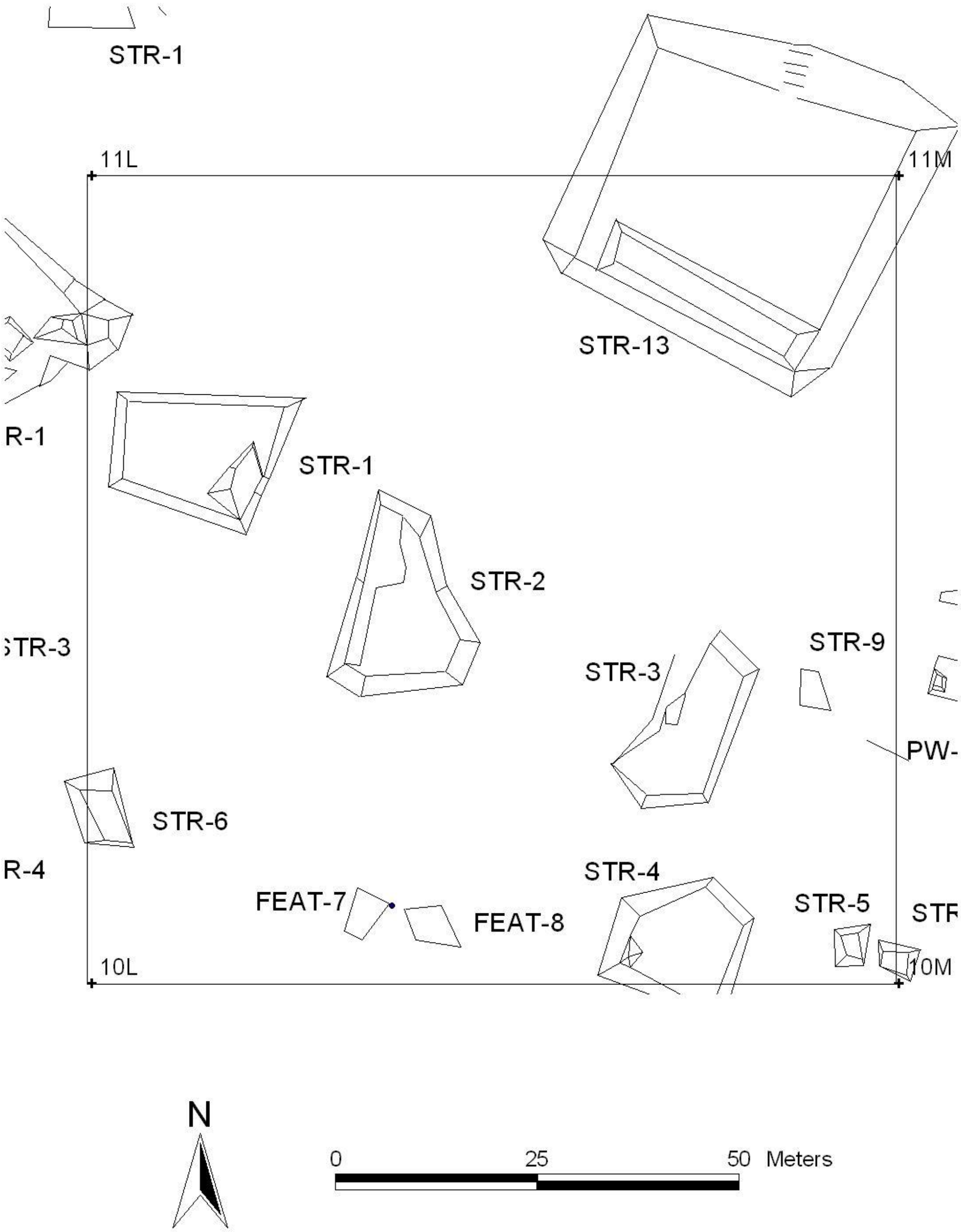


Figure B.29. Map of Section 10L.

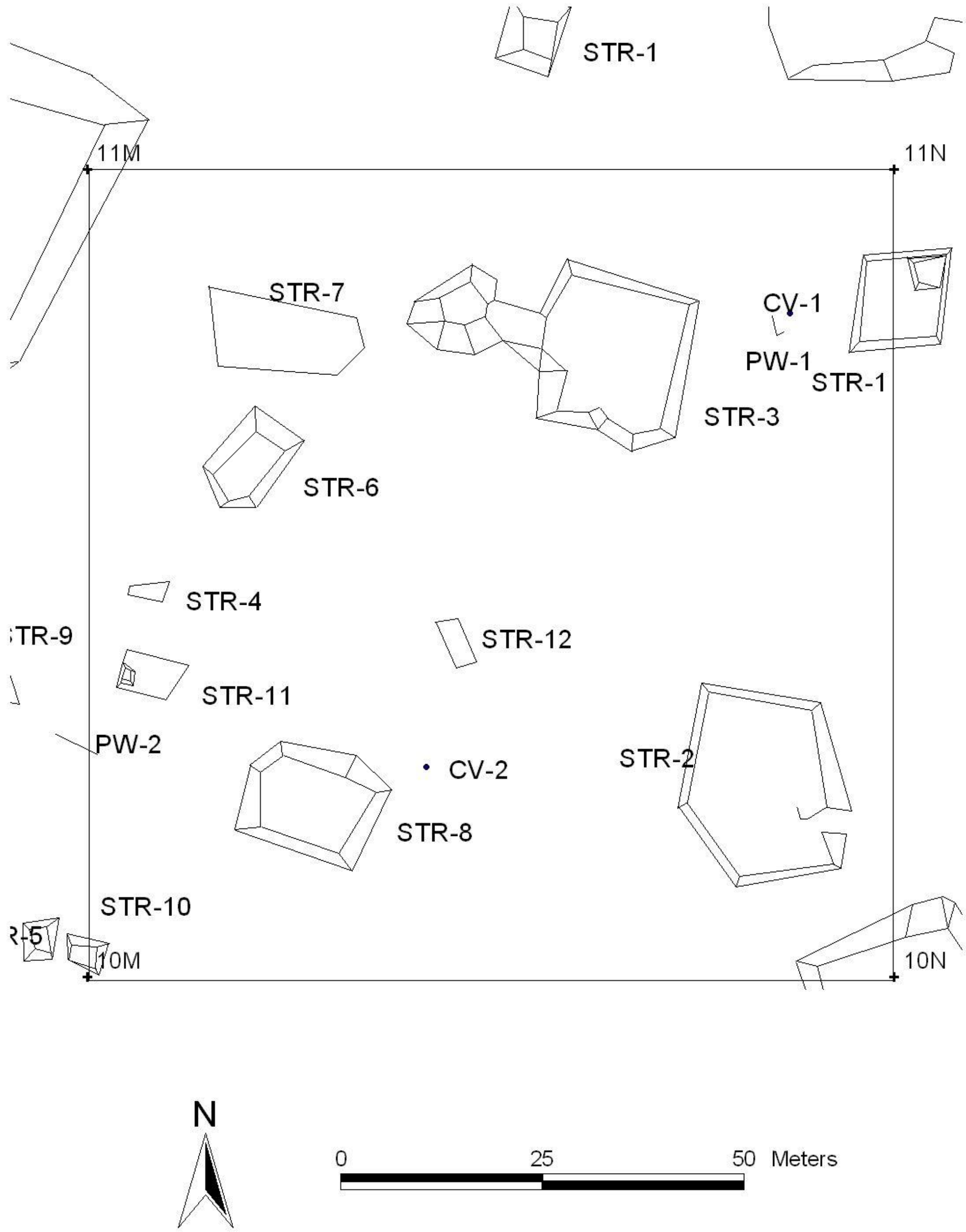


Figure B.30. Map of Section 10M.

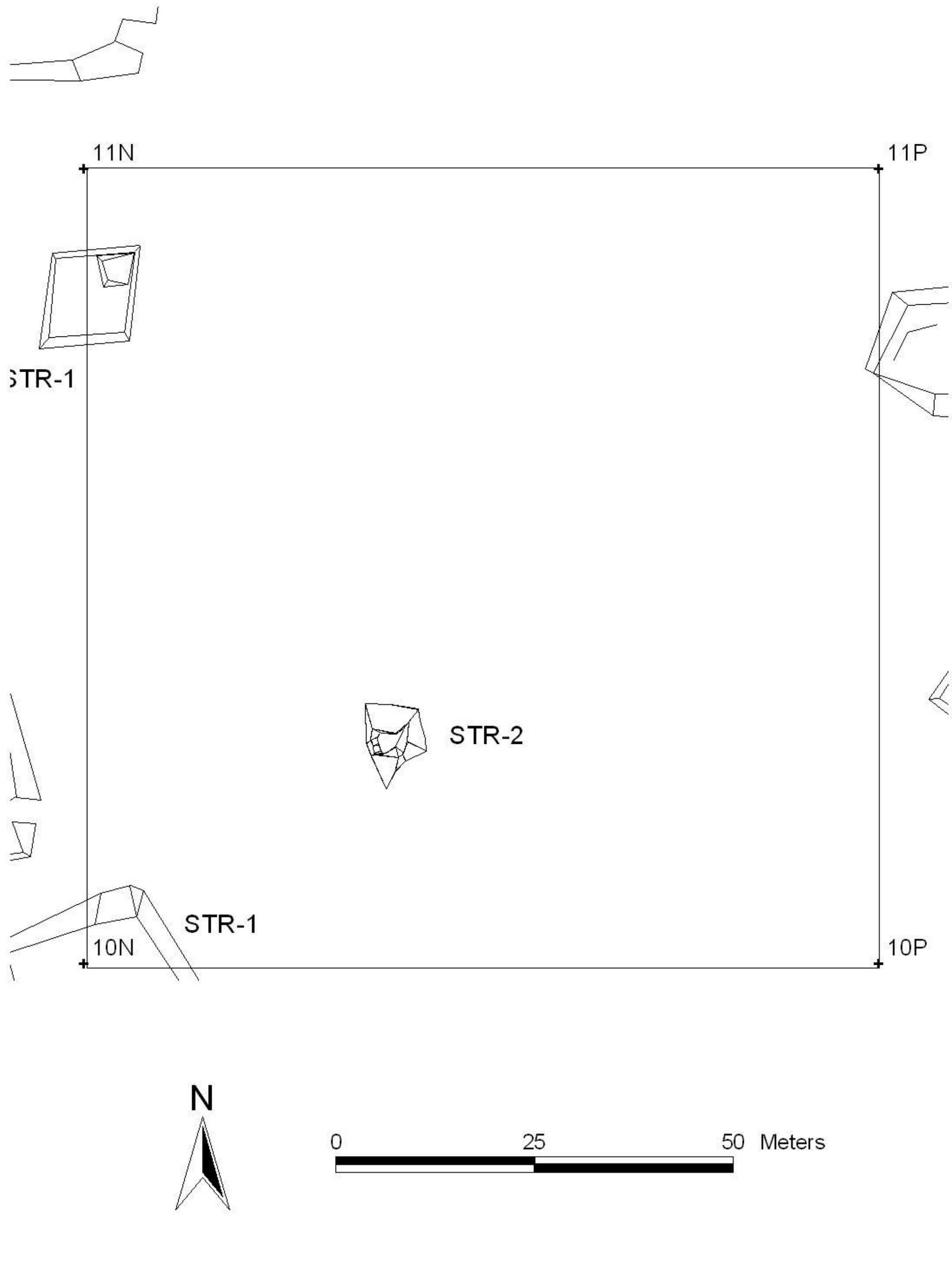


Figure B.31. Map of Section 10N.

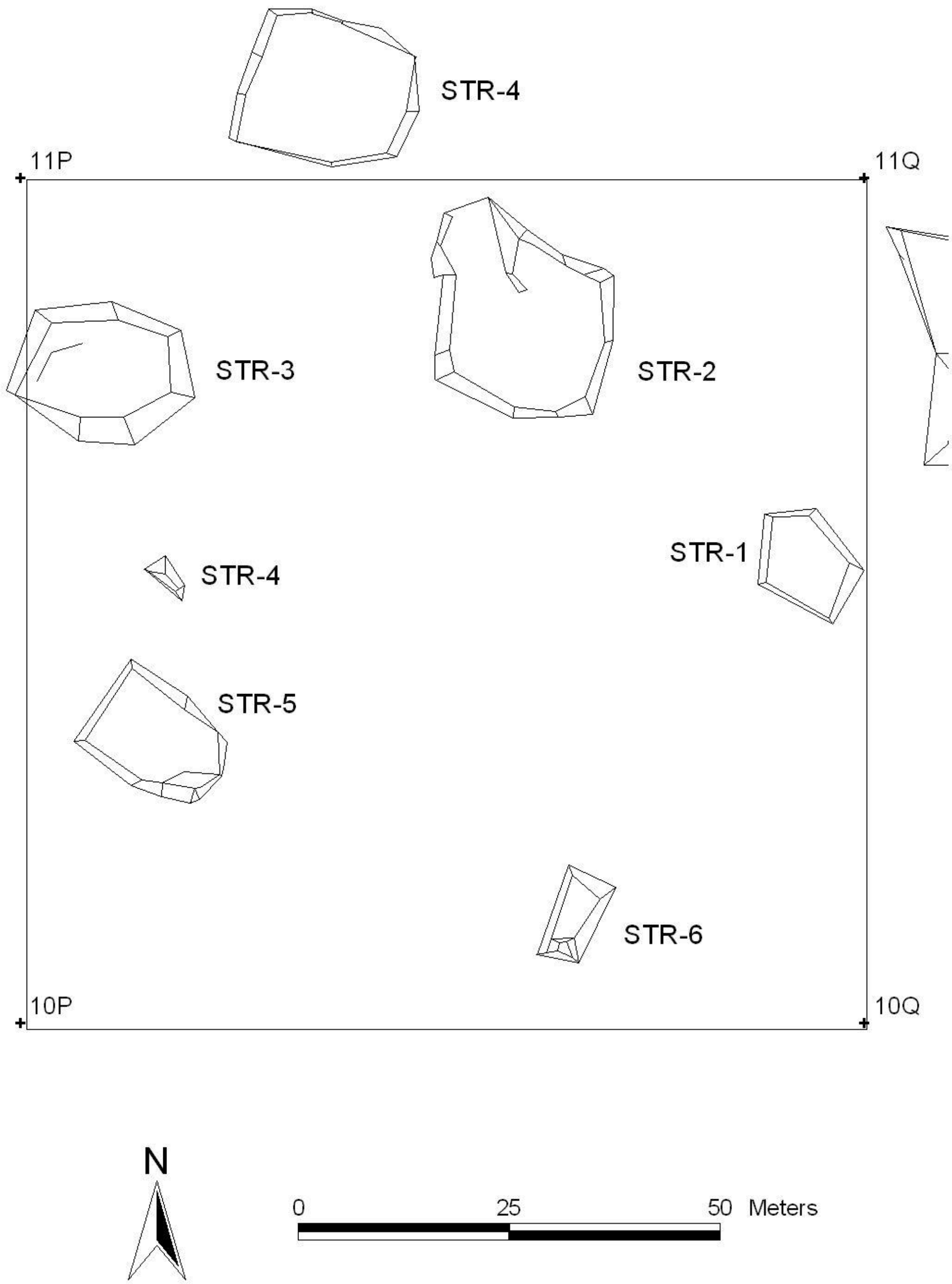


Figure B.32. Map of Section 10P.

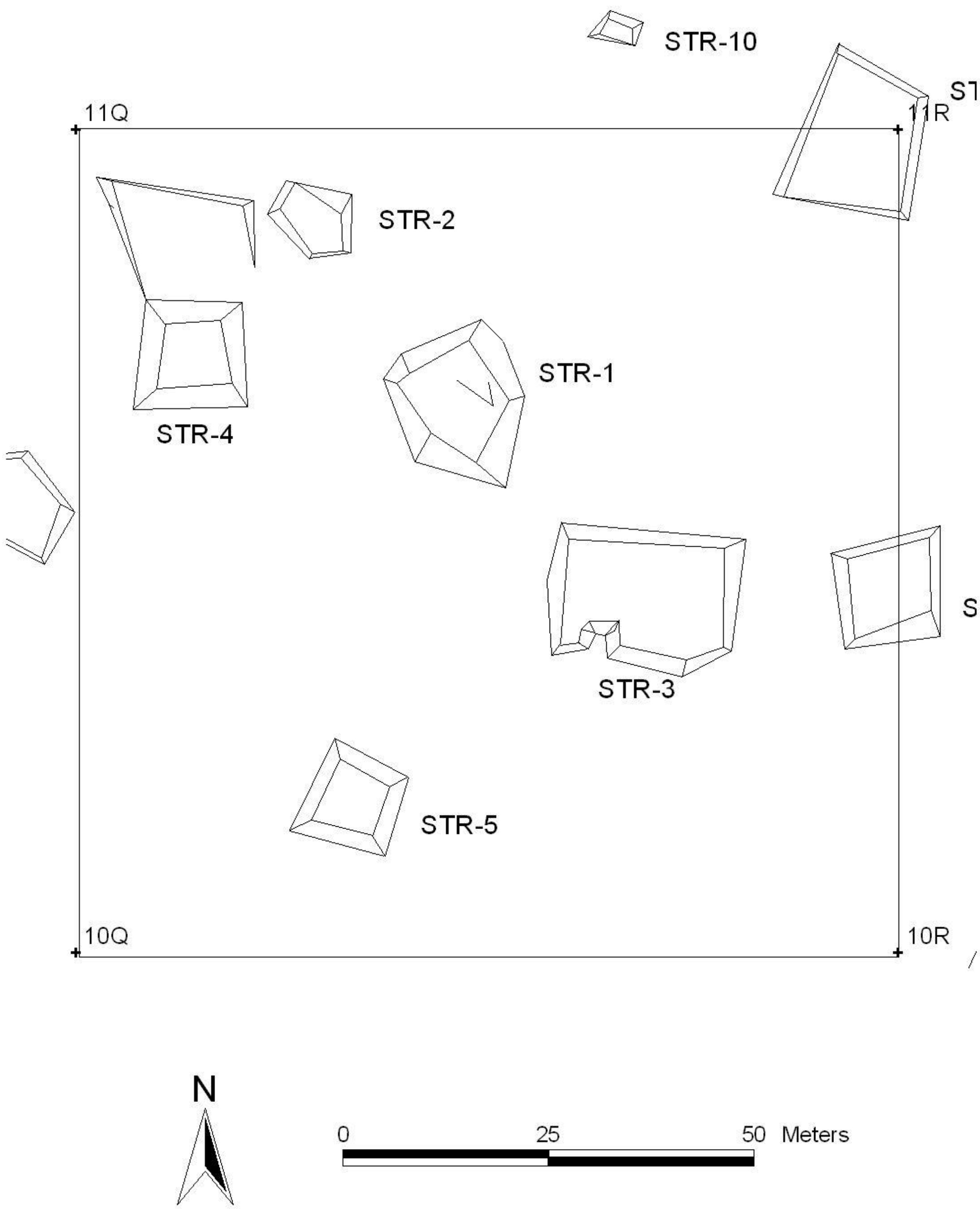


Figure B.33. Map of Section 10Q.

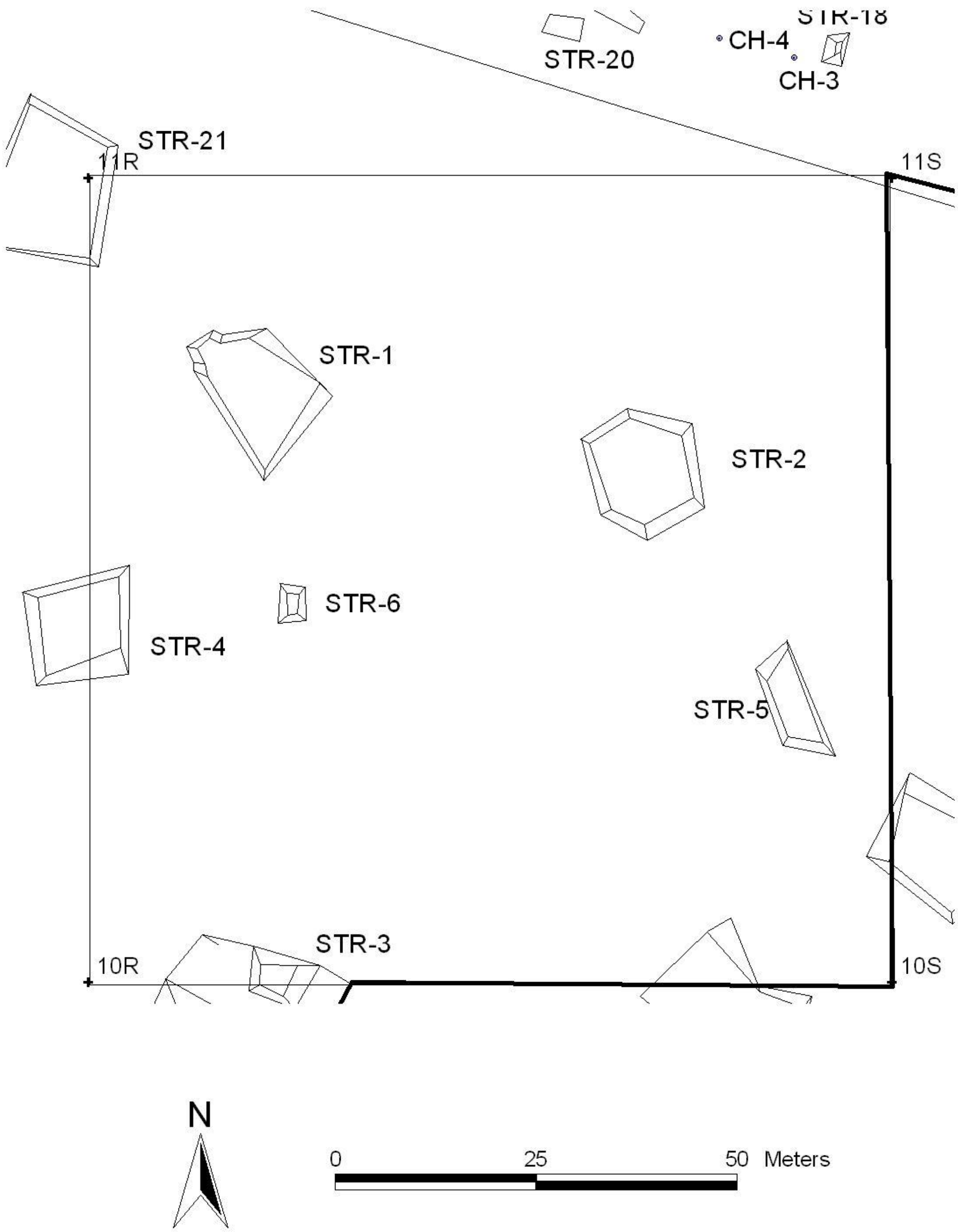


Figure B.34. Map of Section 10R.

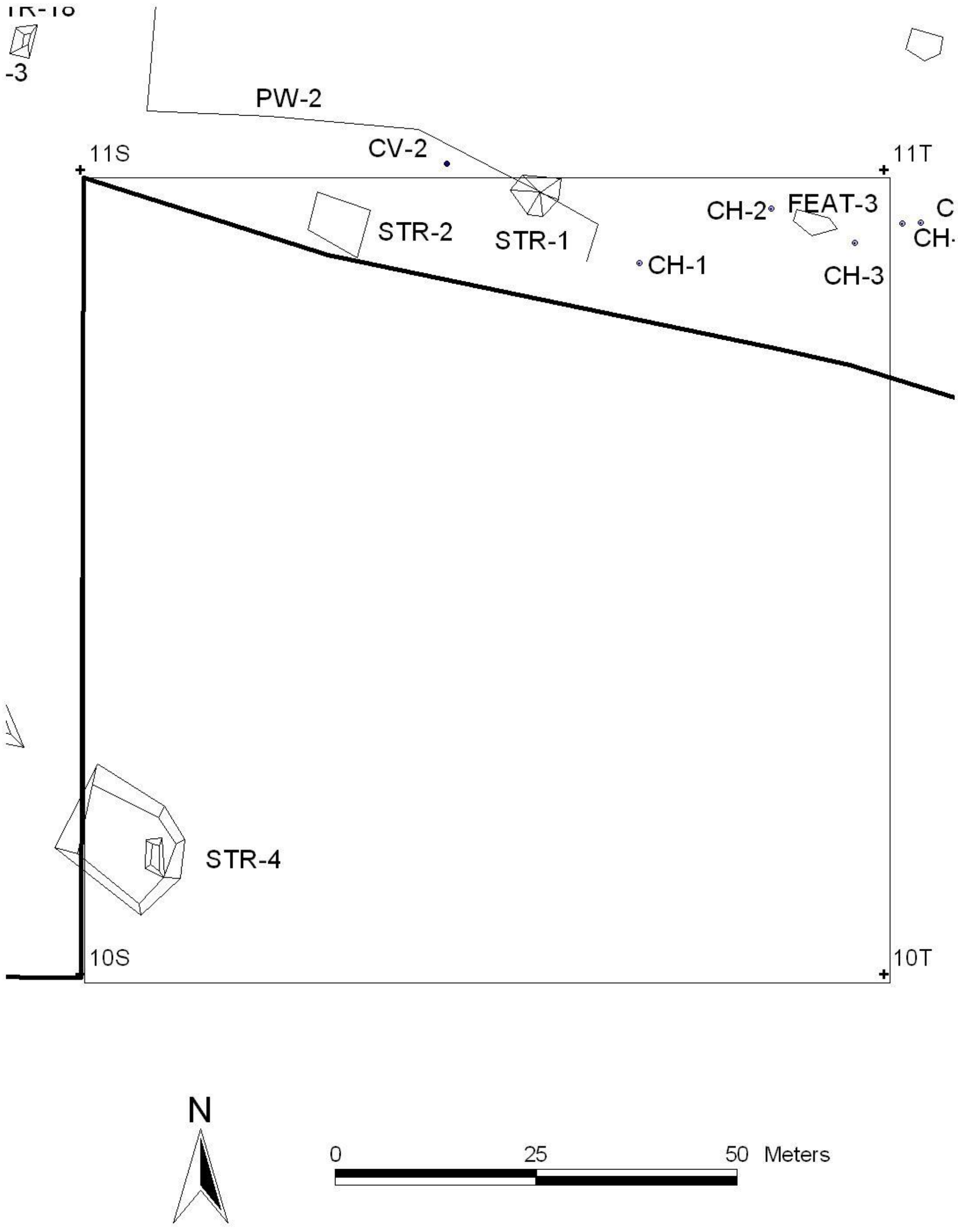


Figure B.35. Map of Section 10S.

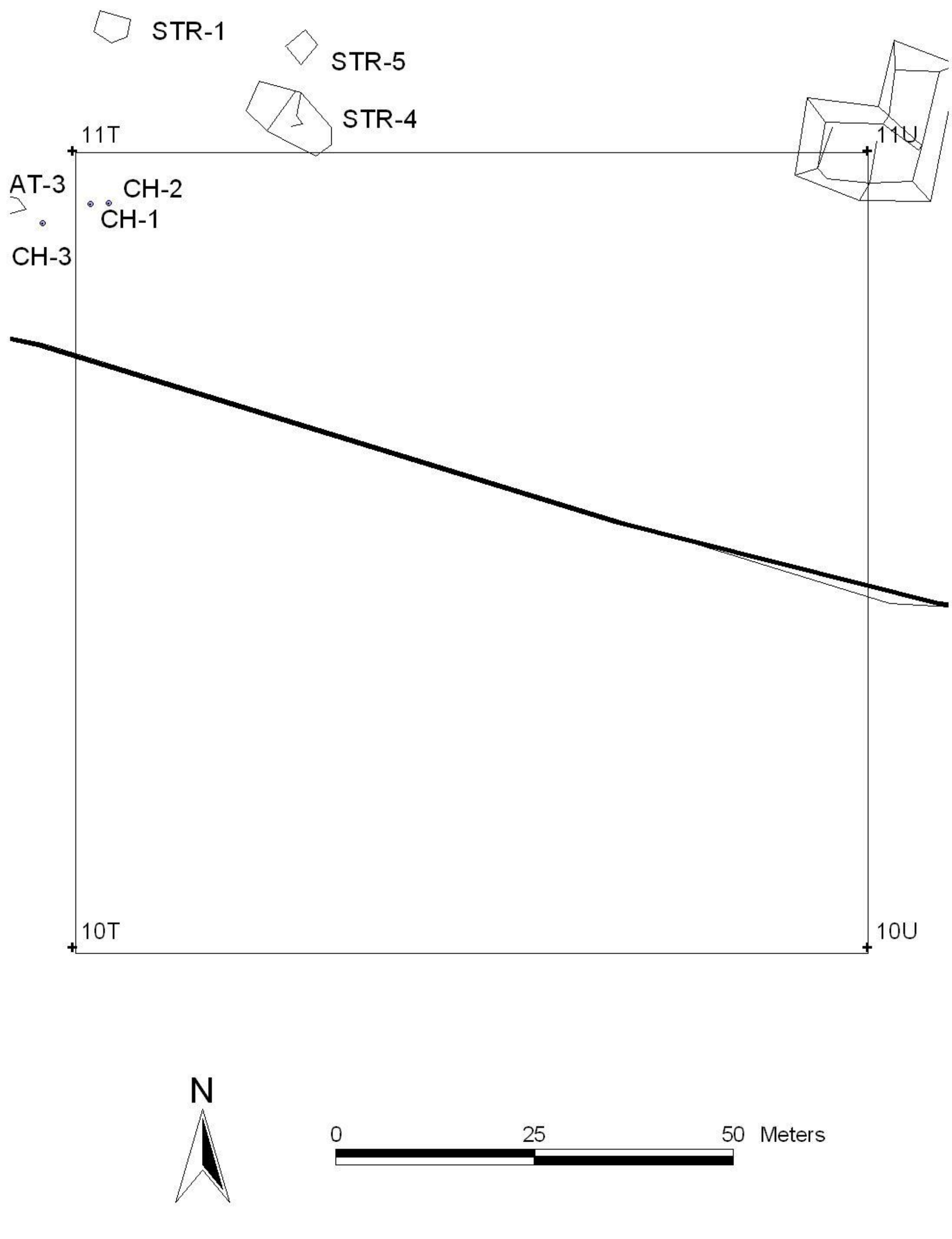


Figure B.36. Map of Section 10T.

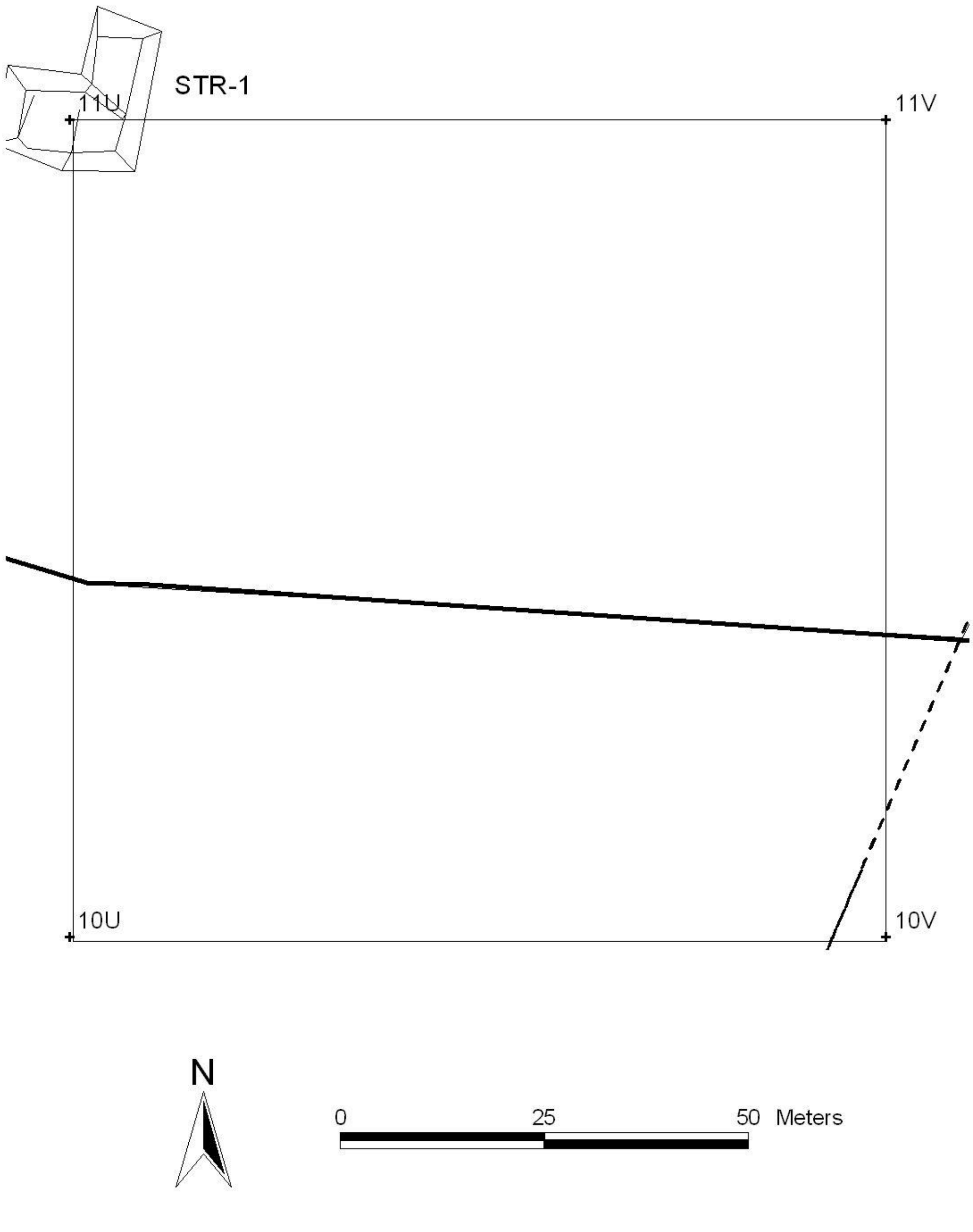


Figure B.37. Map of Section 10U.

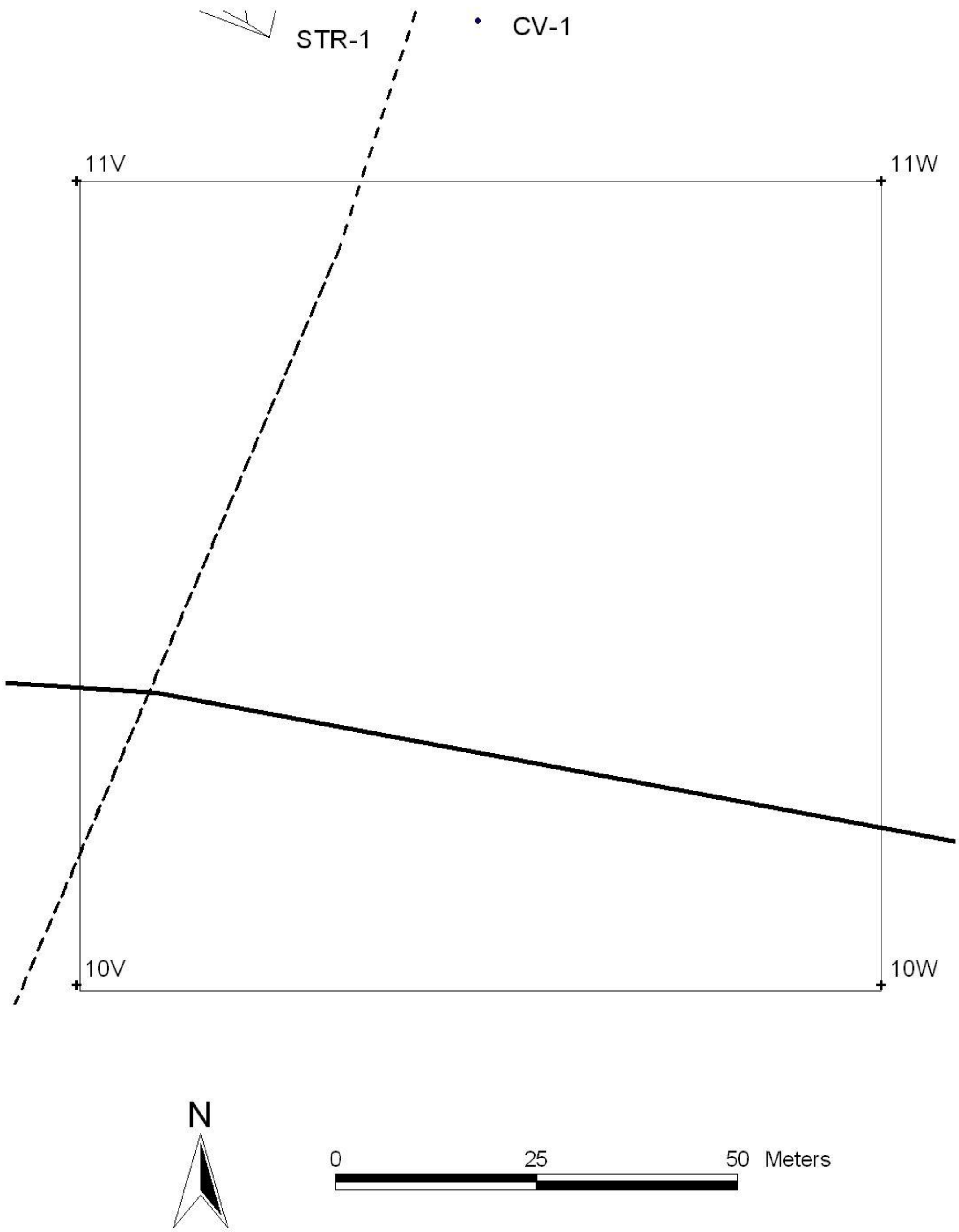


Figure B.38. Map of Section 10V.

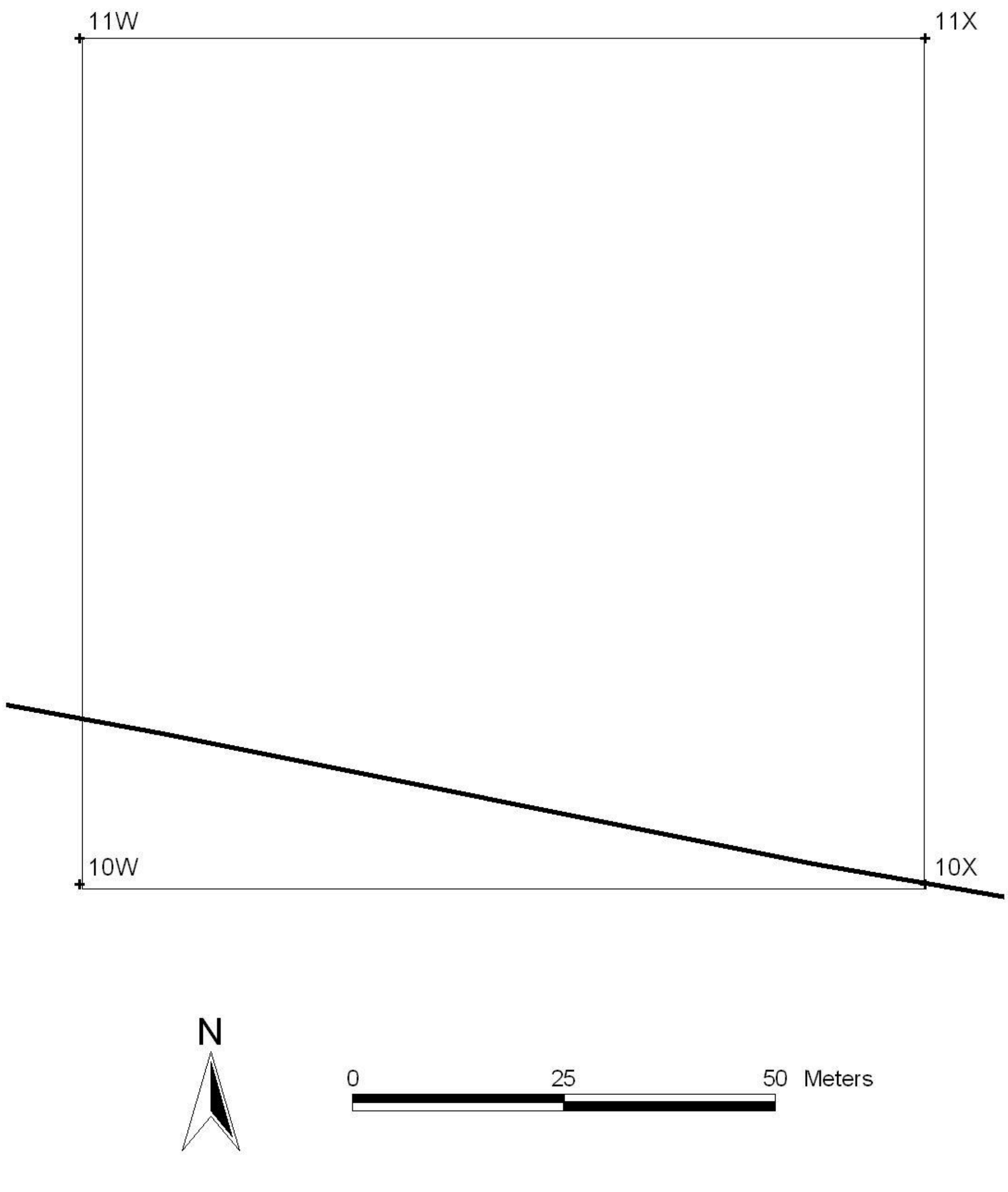


Figure B.39. Map of Section 10W.

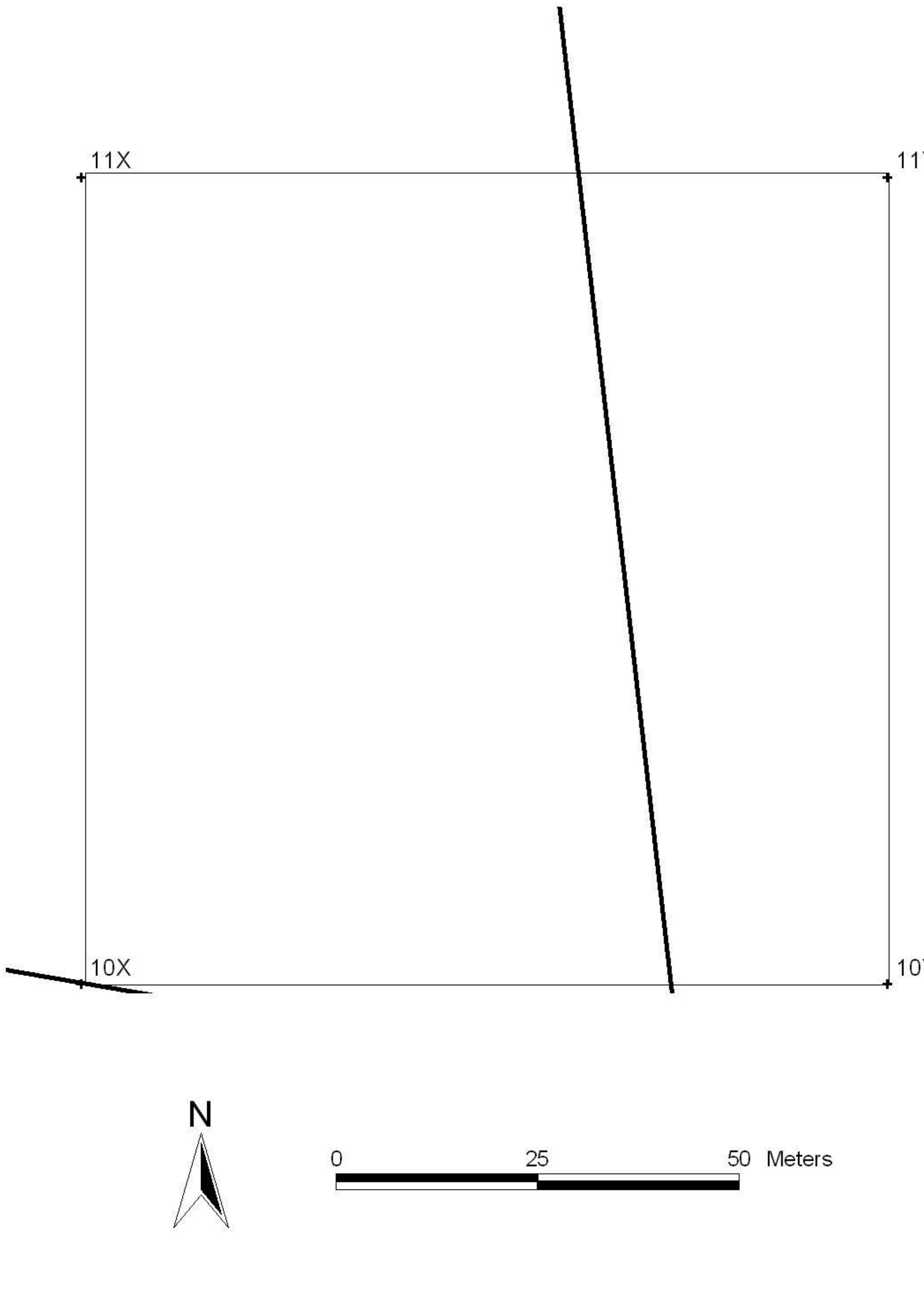


Figure B.40. Map of Section 10X.

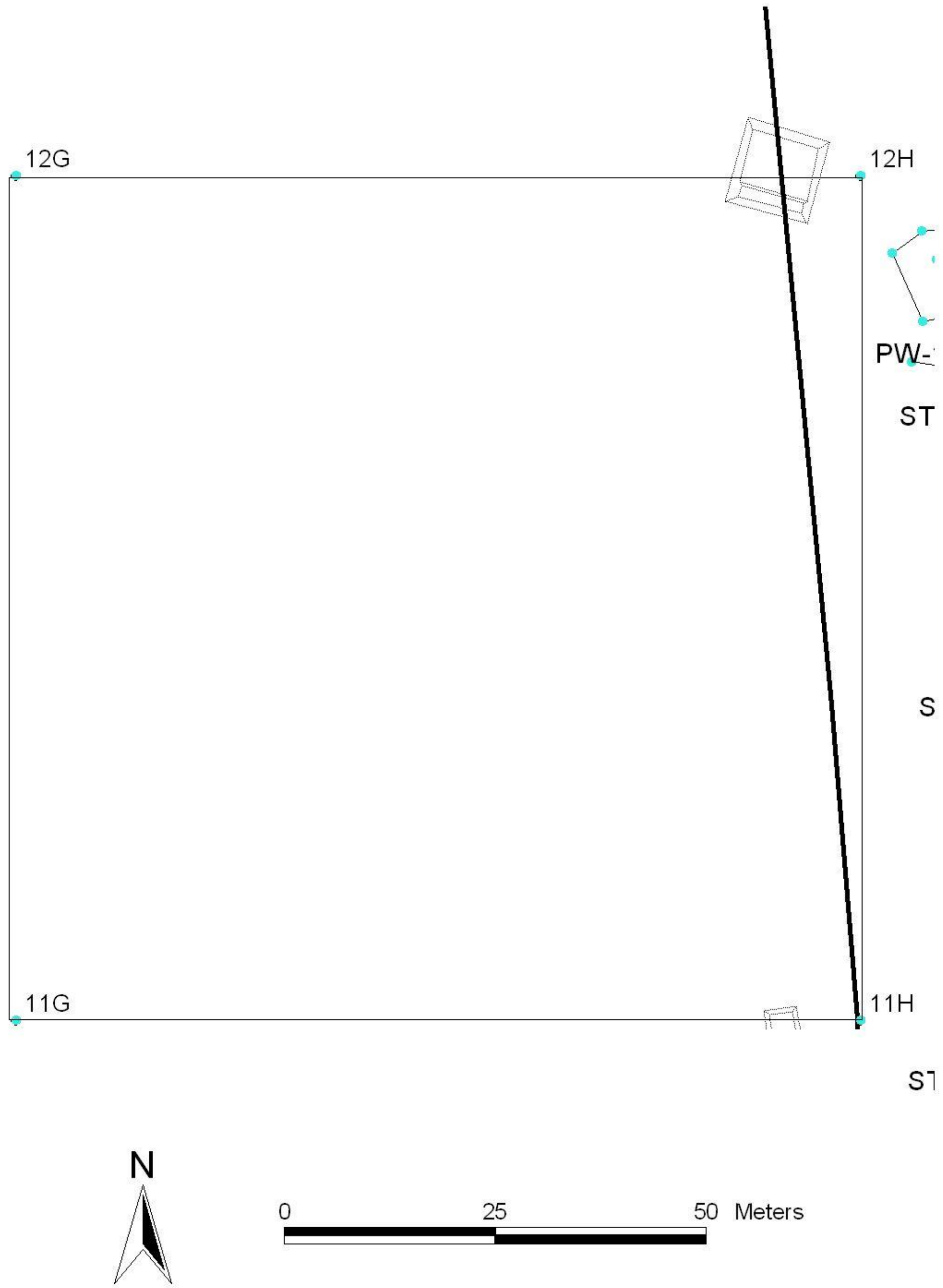


Figure B.41. Map of Section 11G.

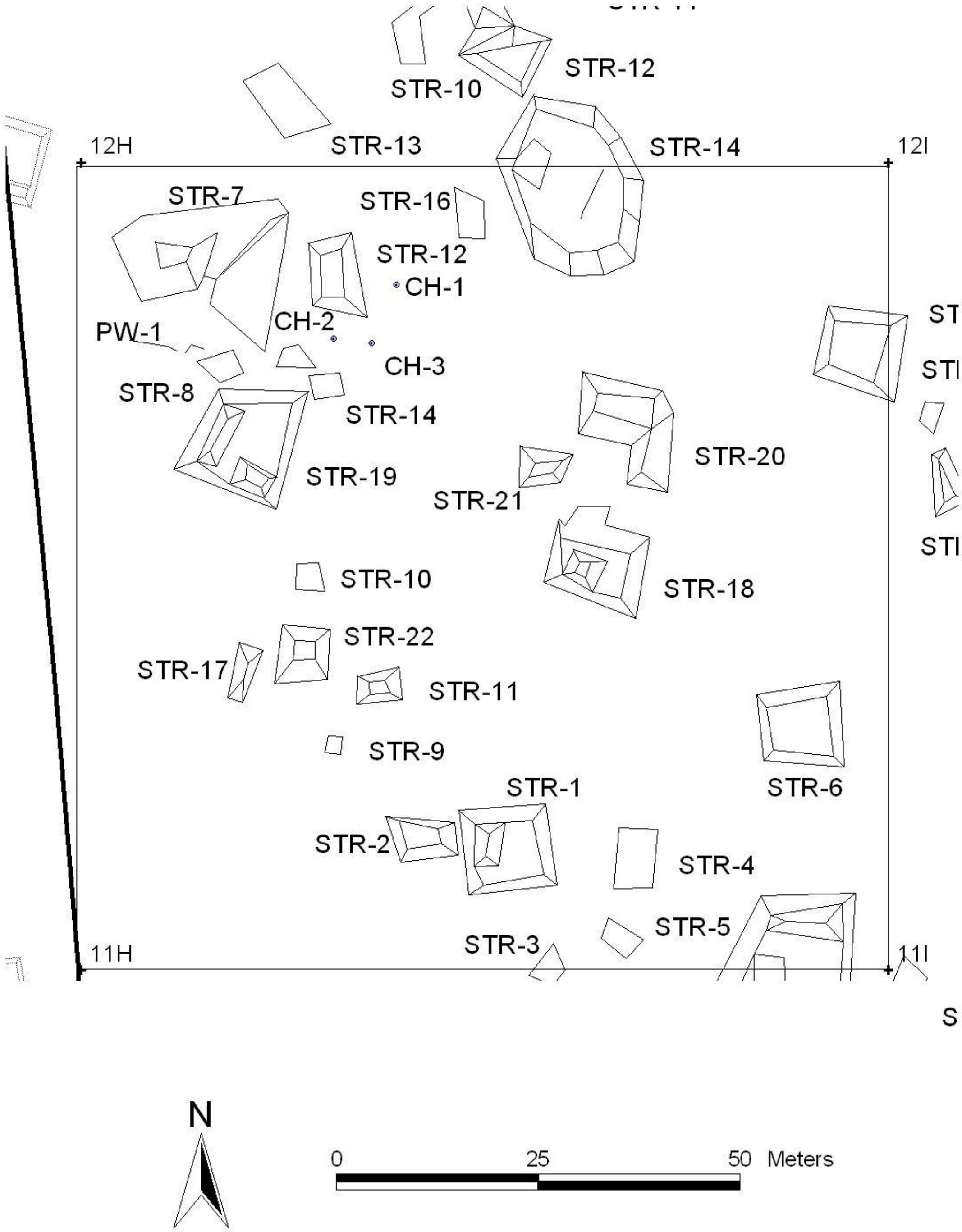


Figure B.42. Map of Section 11H.

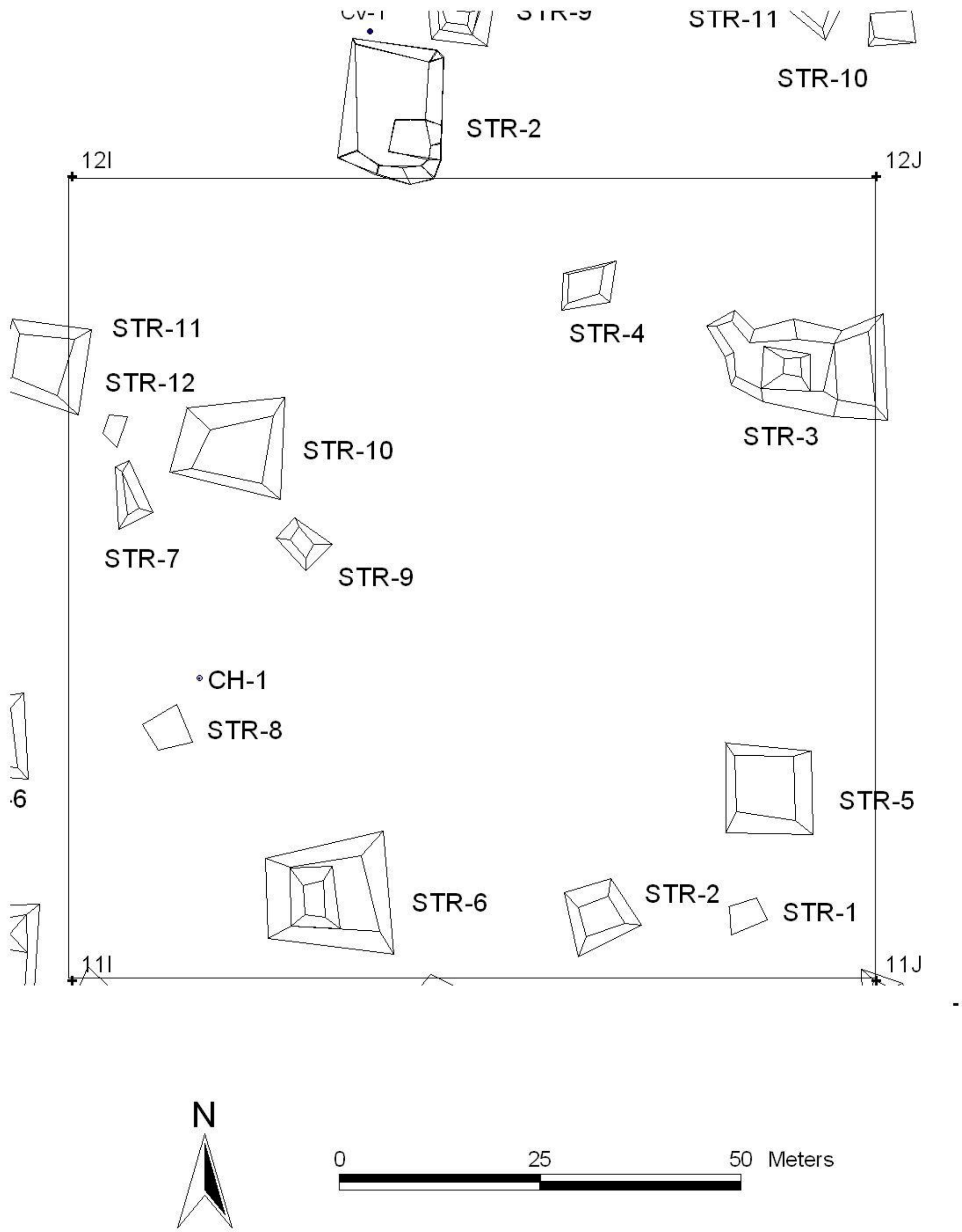


Figure B.43. Map of Section 11I.

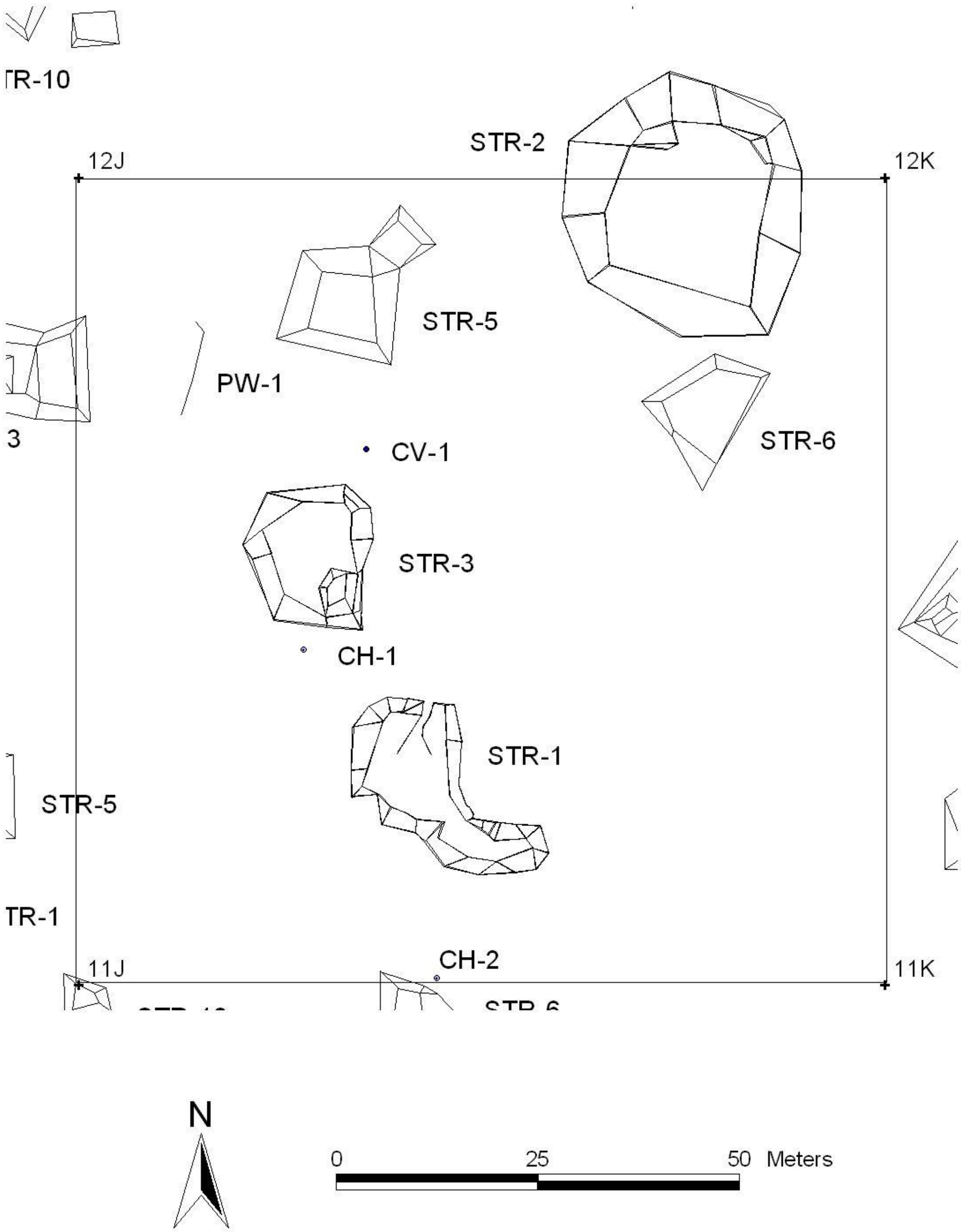


Figure B.44. Map of Section 11J.

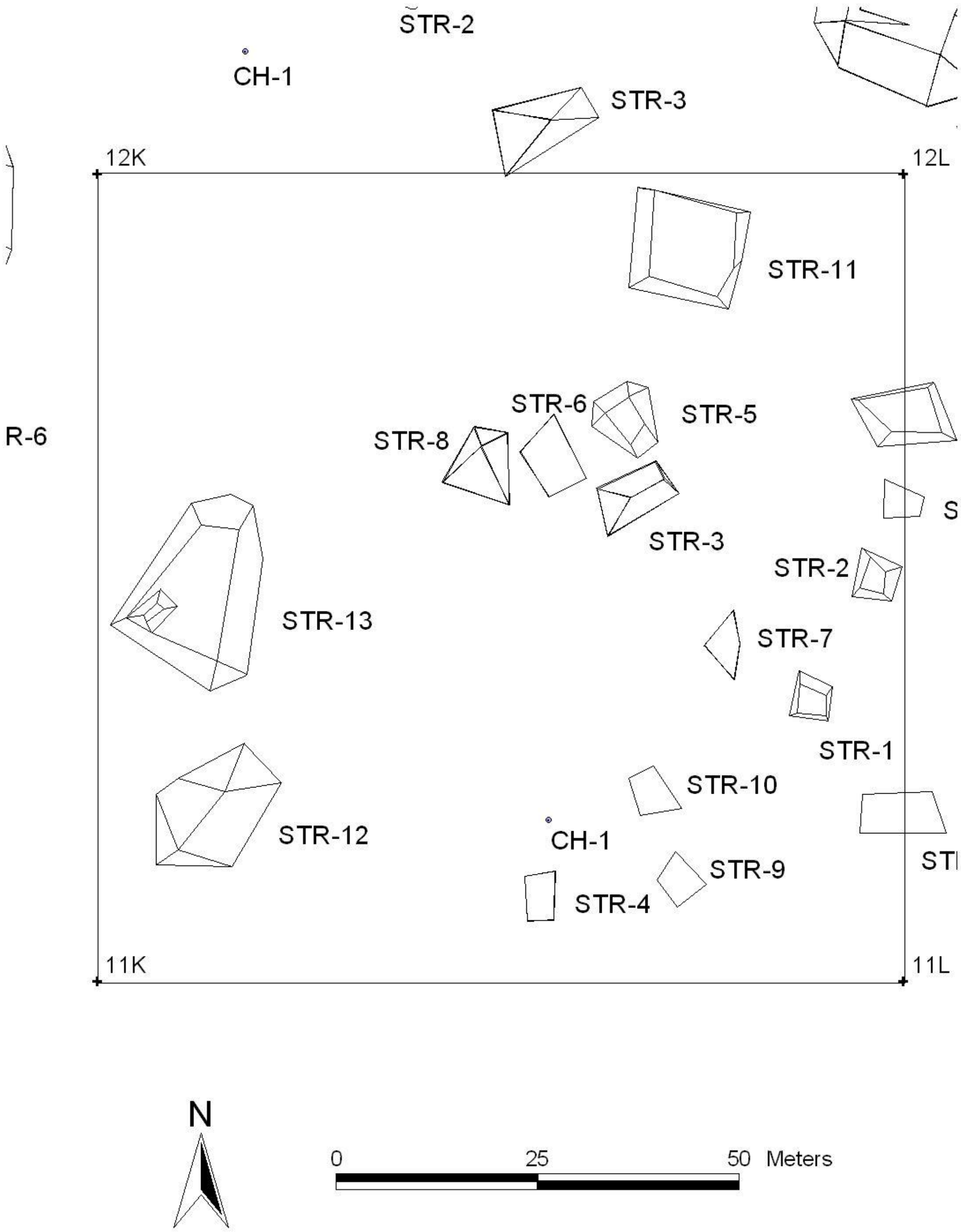


Figure B.45. Map of Section 11K.

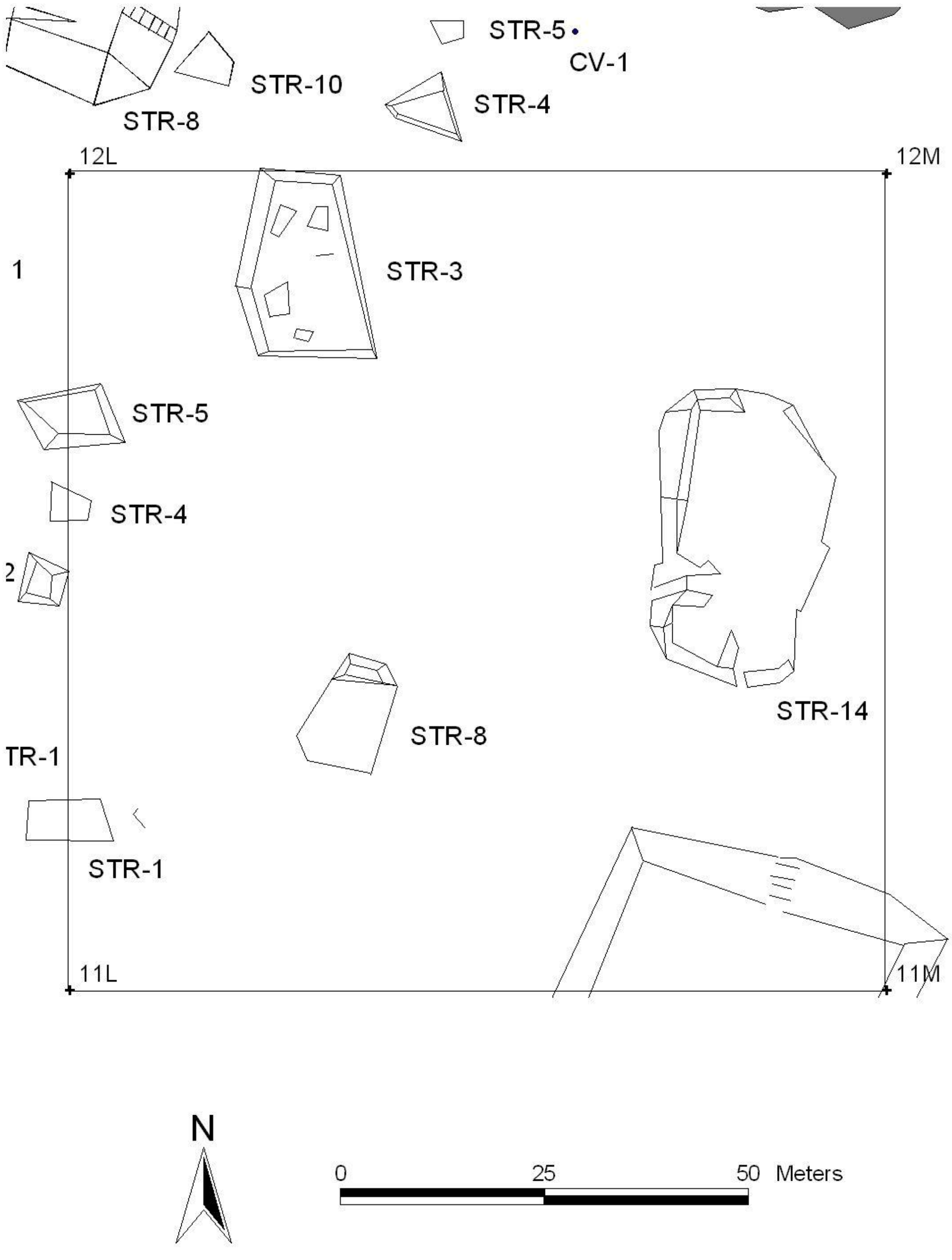


Figure B.46. Map of Section 11L.

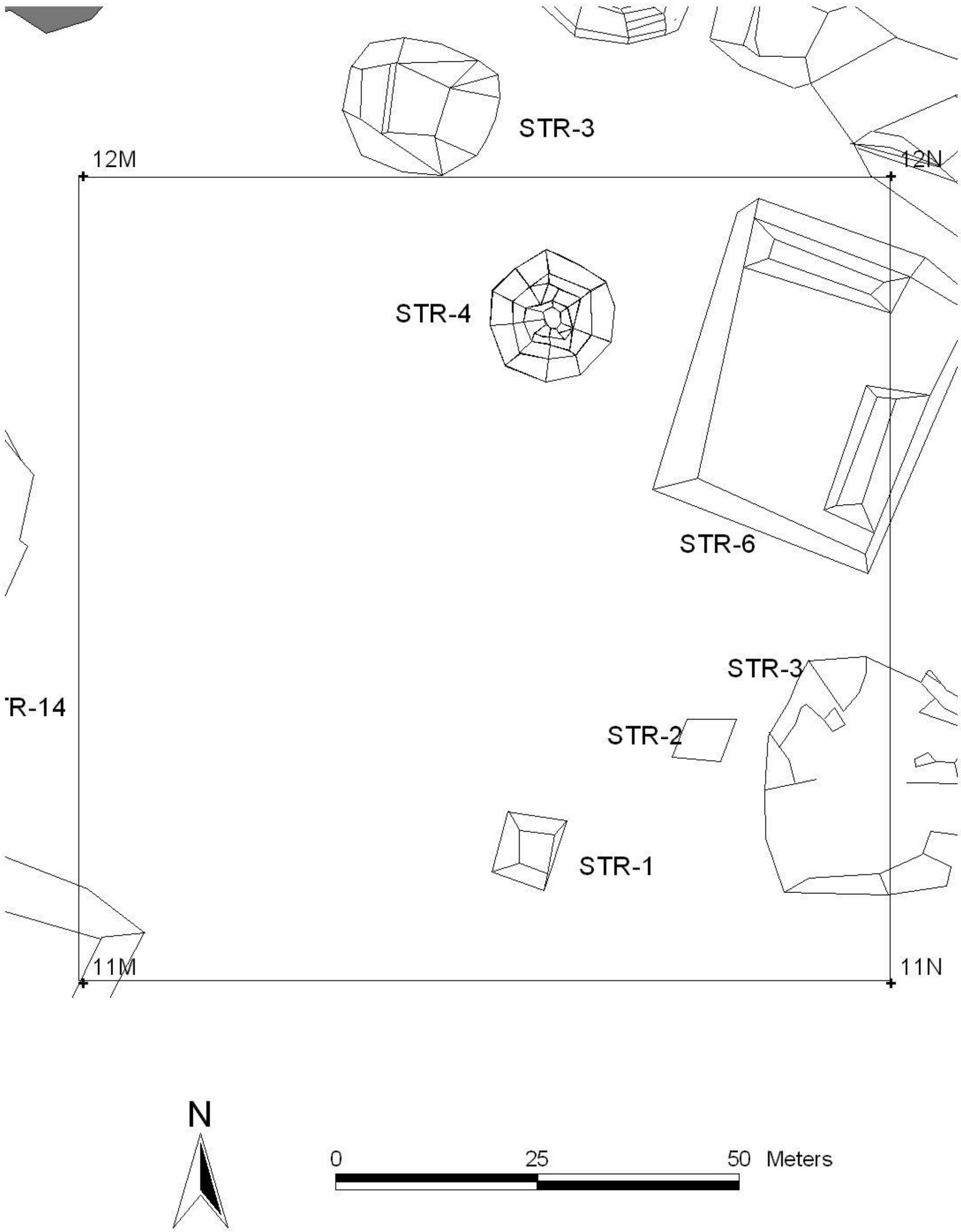


Figure B.47. Map of Section 11M.

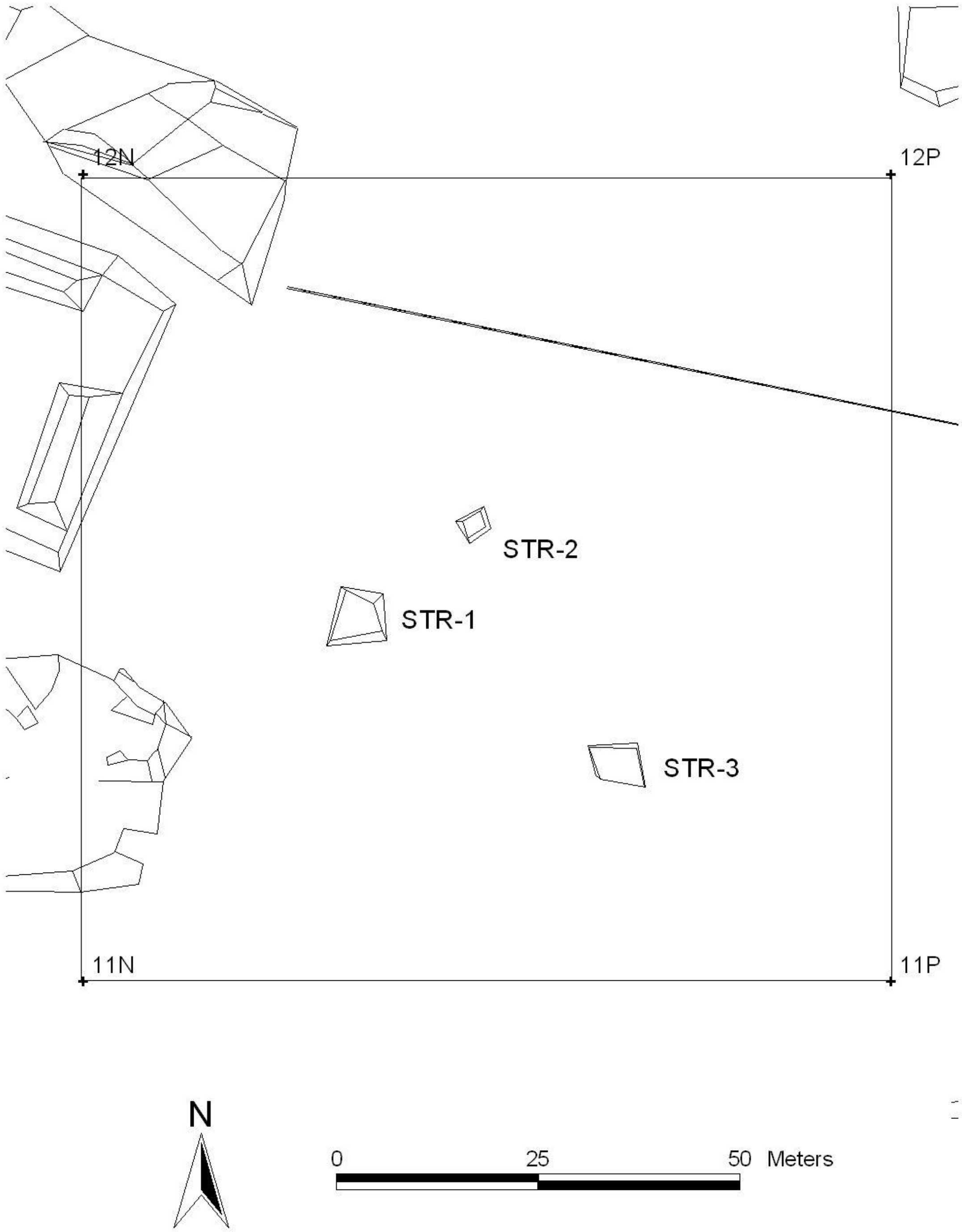


Figure B.48. Map of Section 11N.

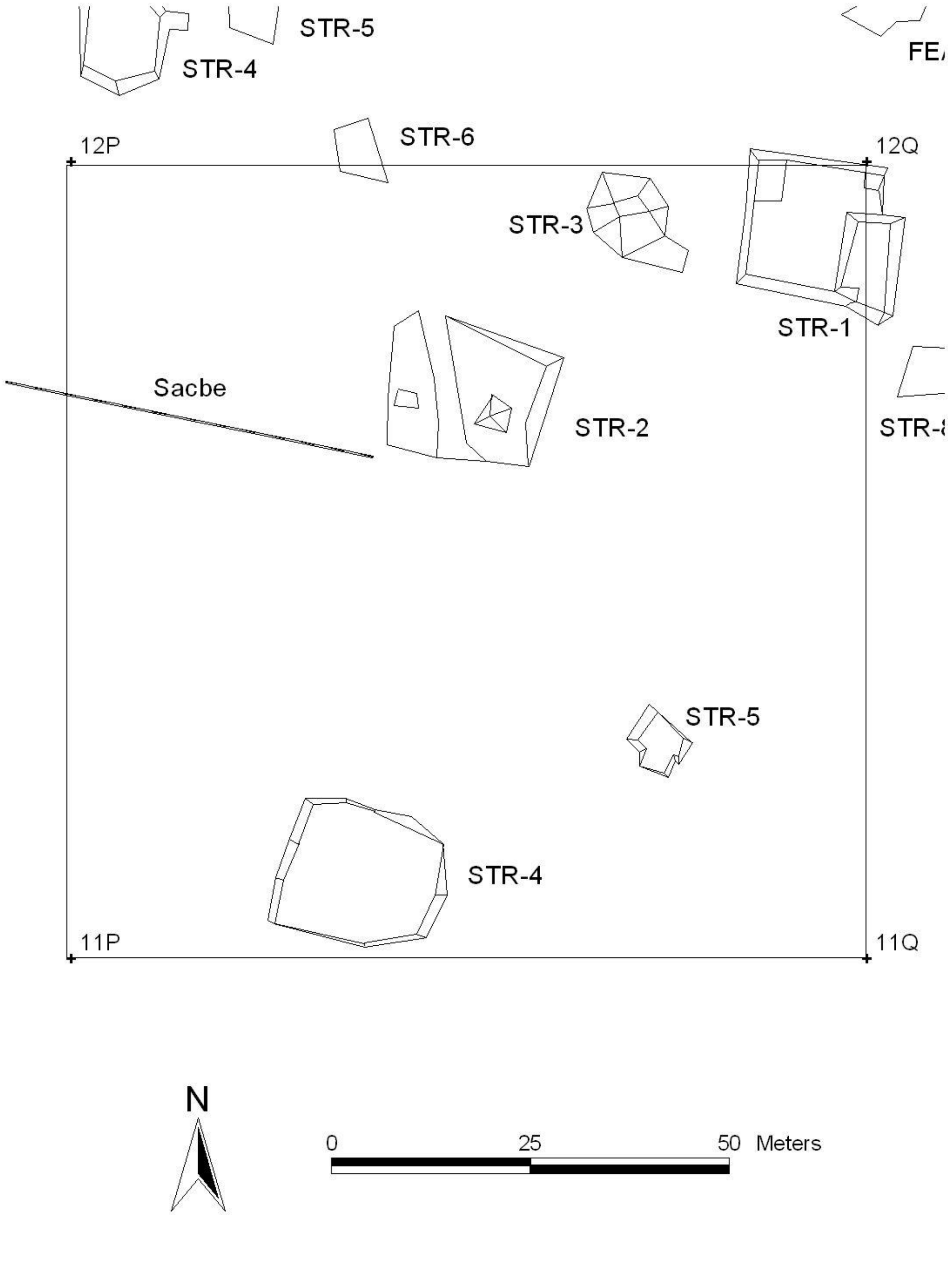


Figure B.49. Map of Section 11P.

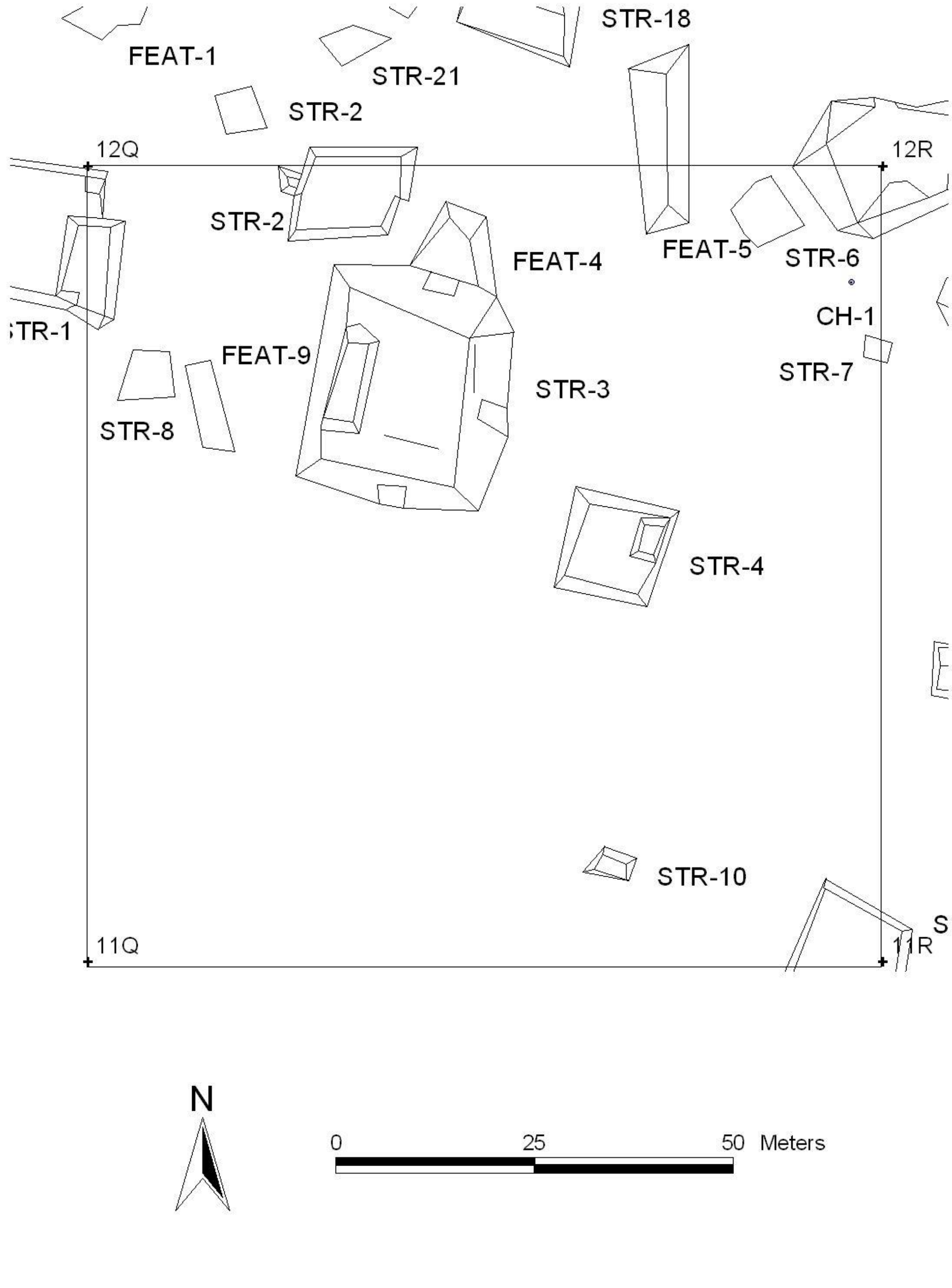


Figure B.50. Map of Section 11Q.

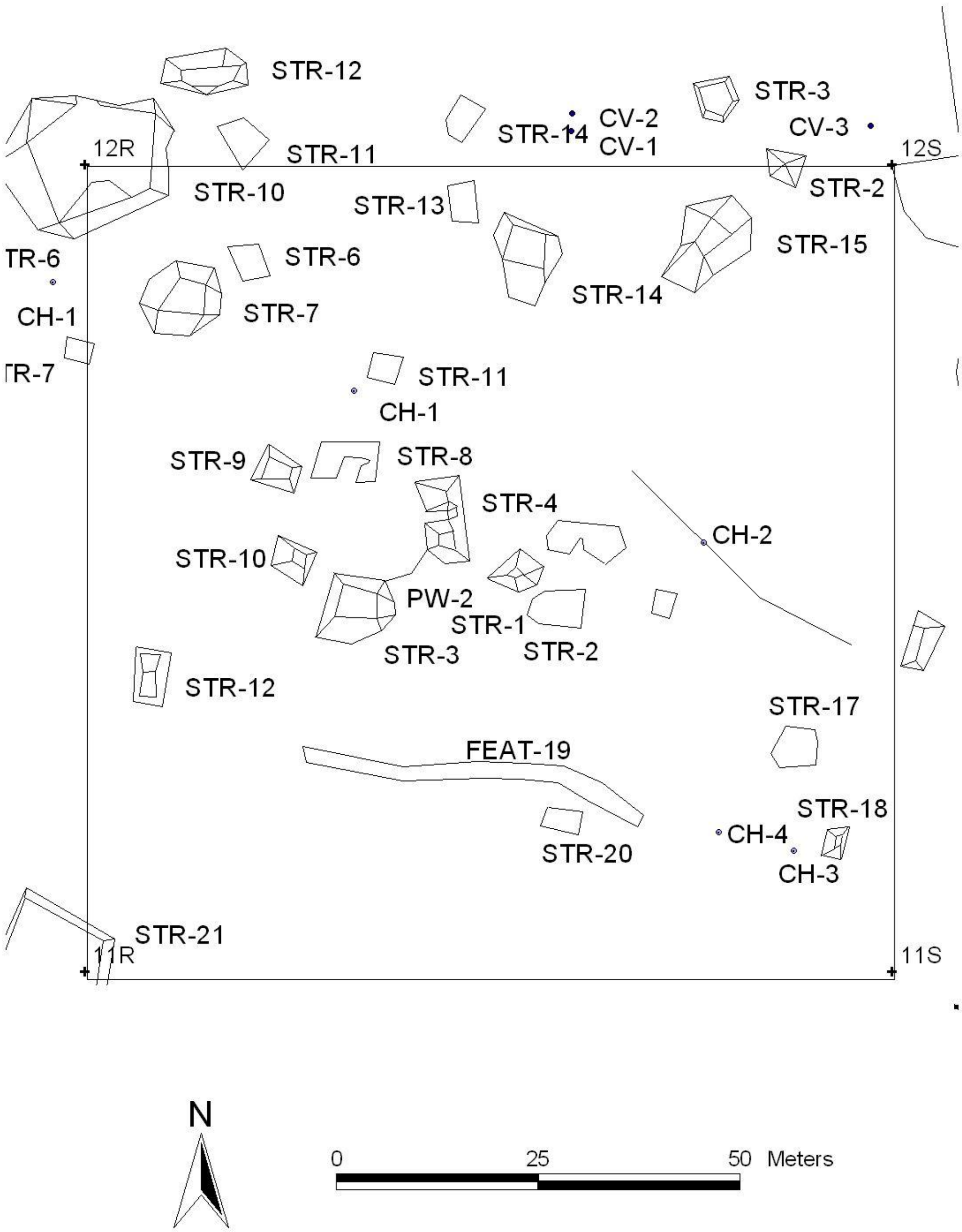


Figure B.51. Map of Section 11R.

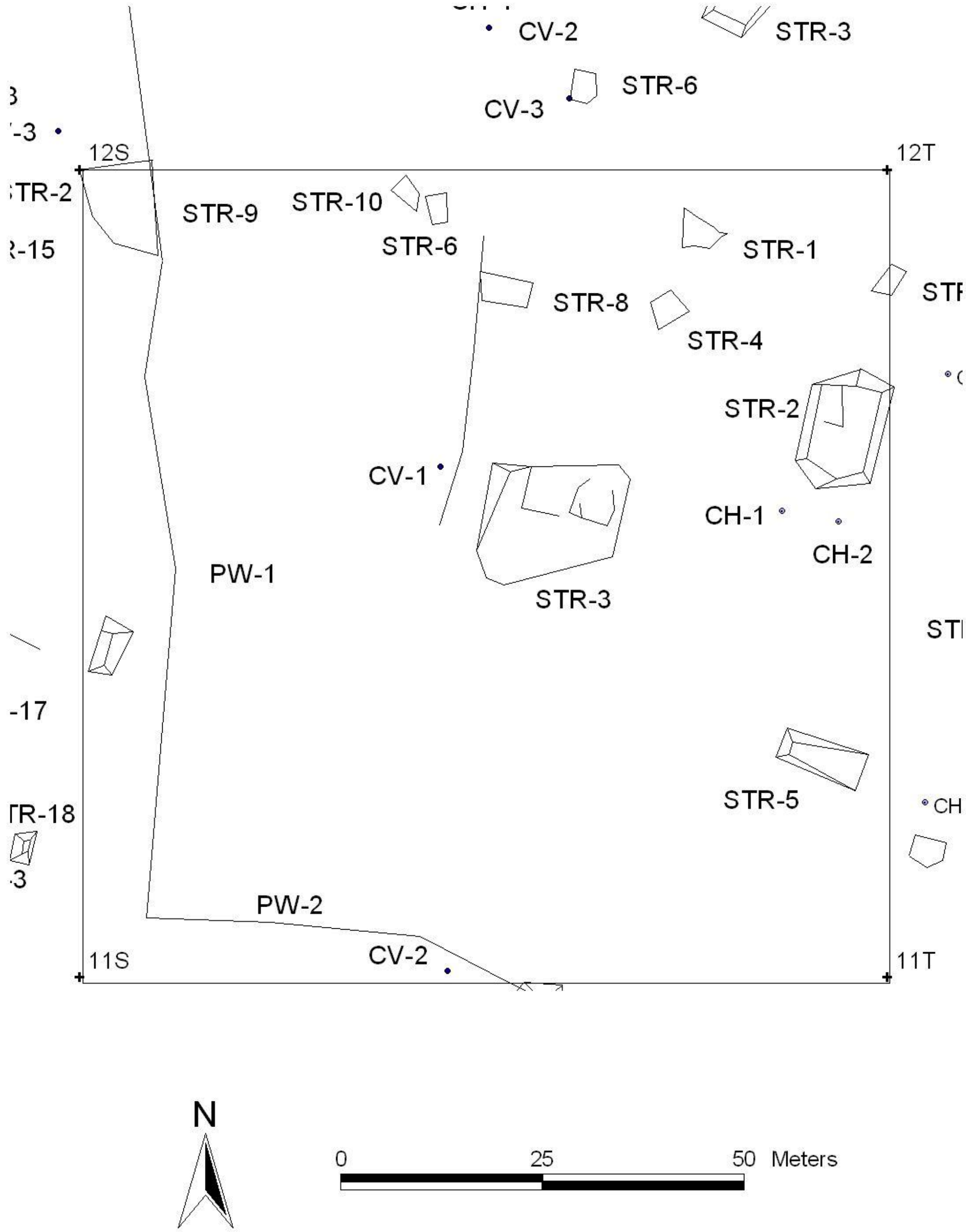


Figure B.52. Map of Section 11S.

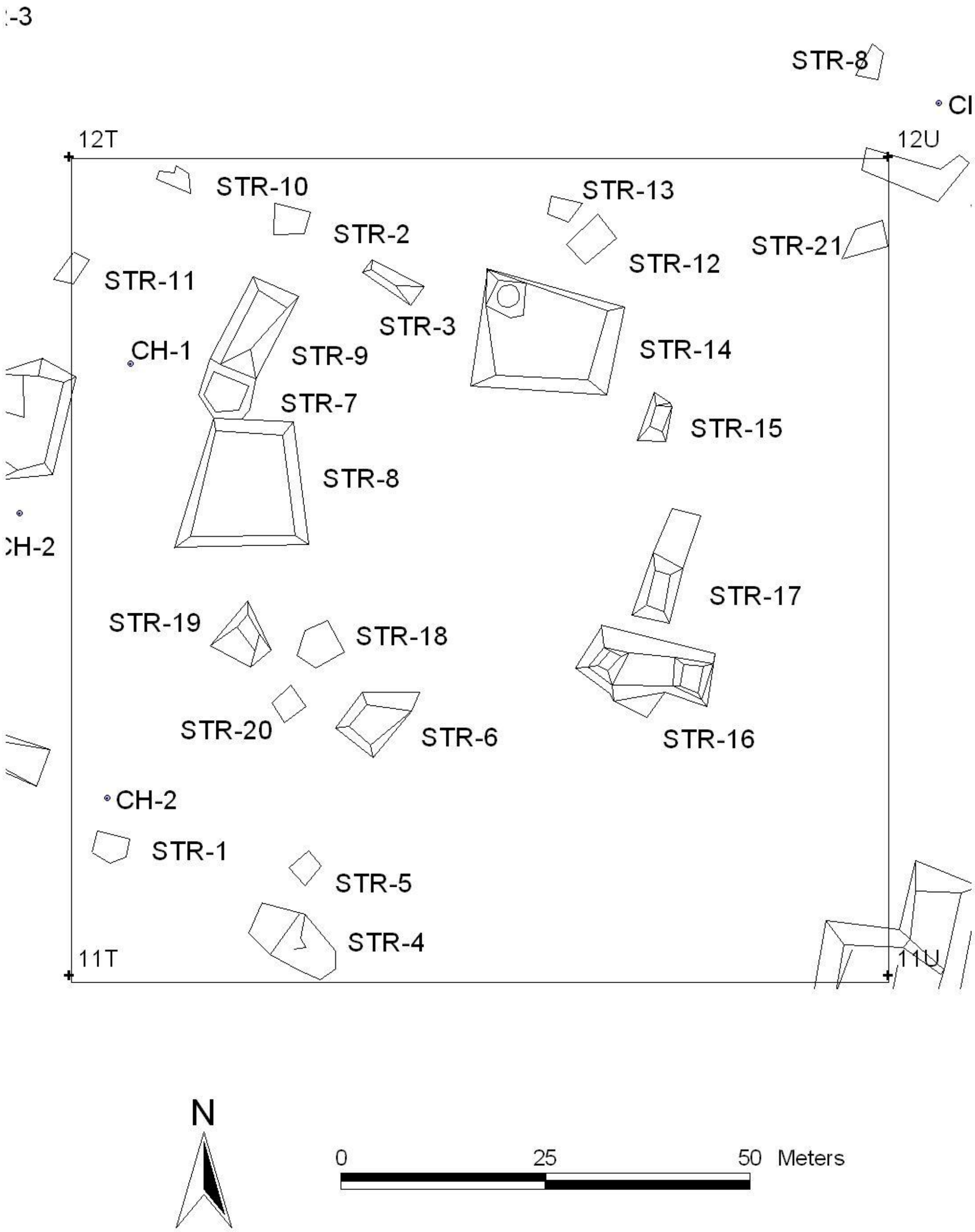


Figure B.53. Map of Section 11T.

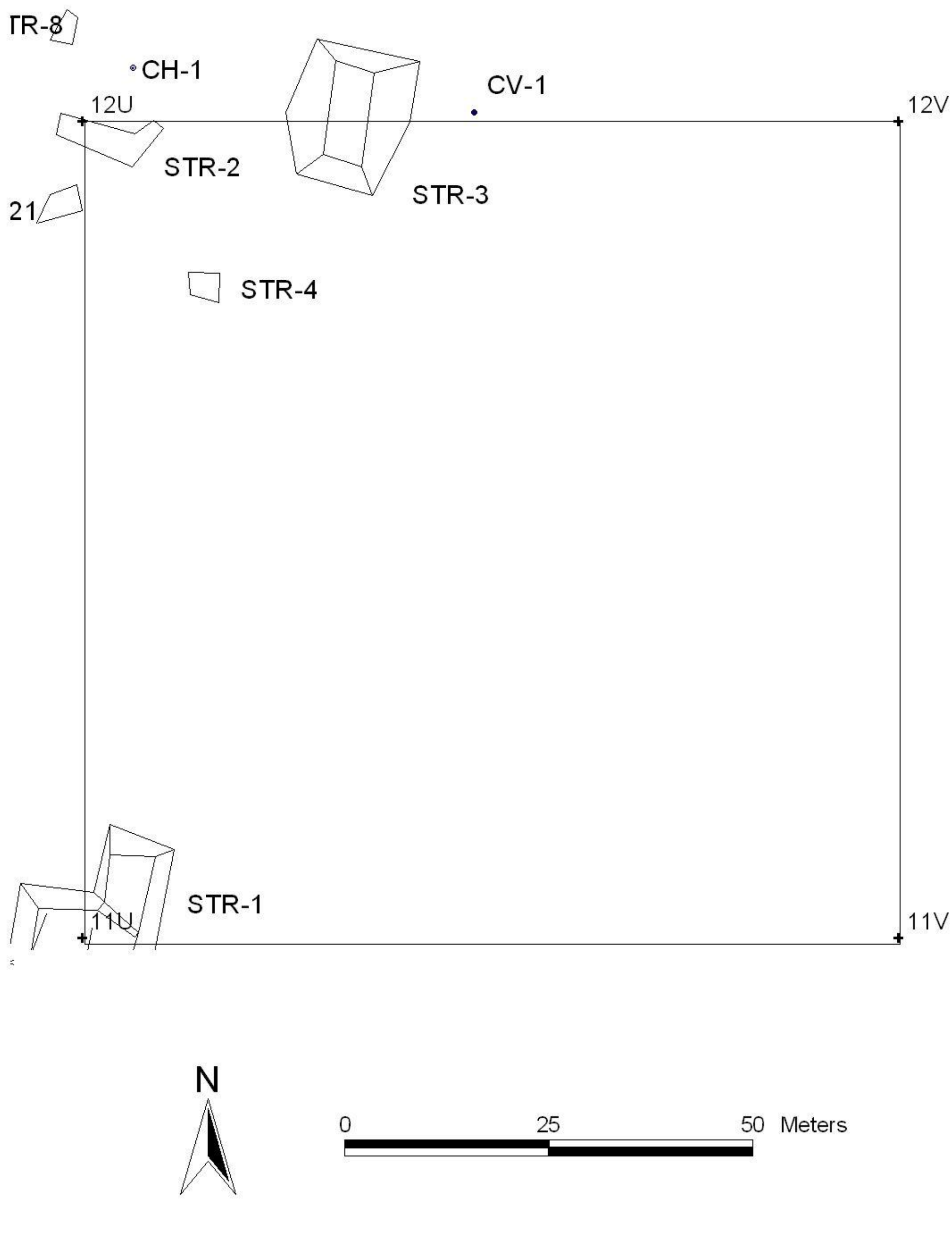


Figure B.54. Map of Section 11U.

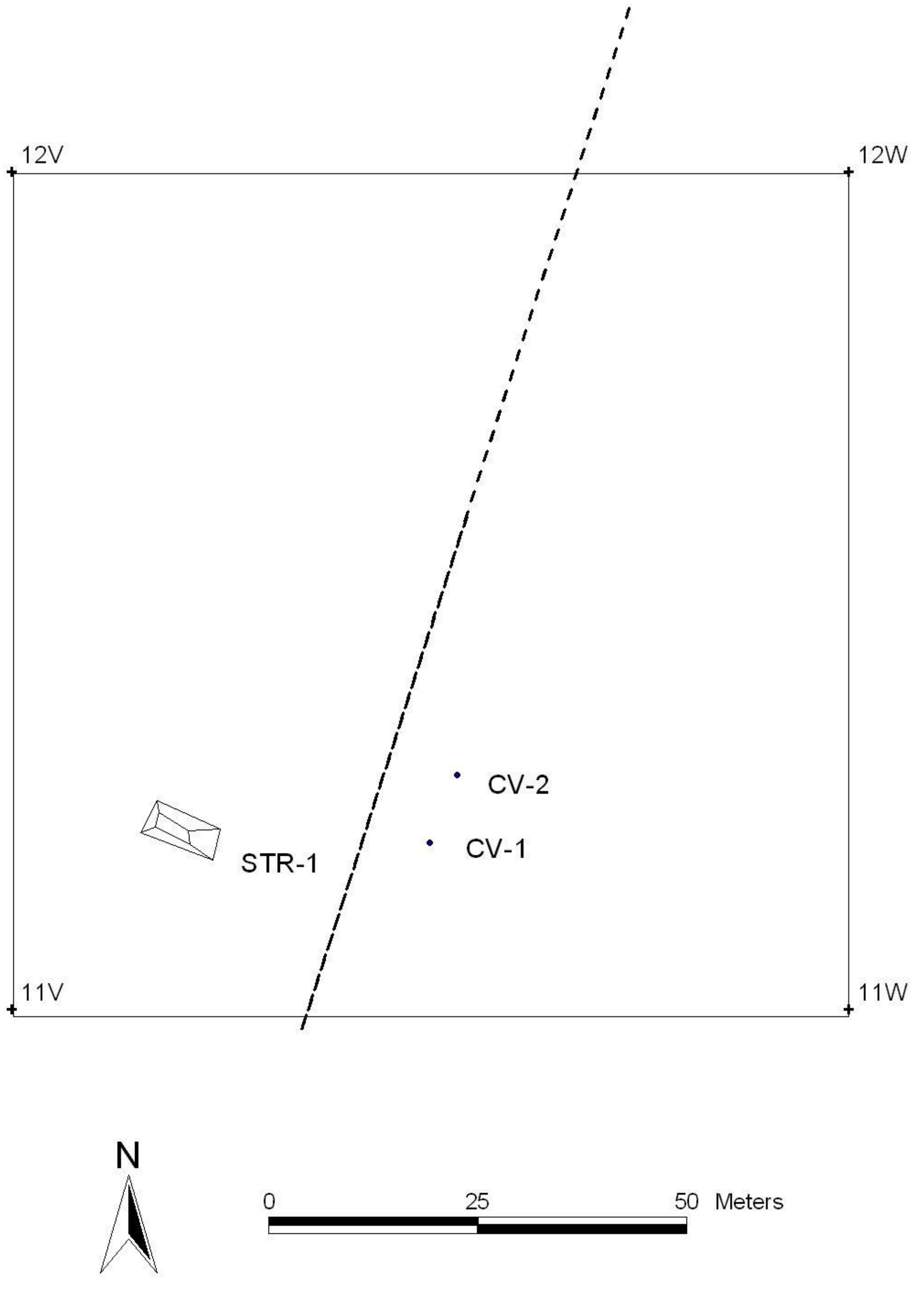


Figure B.55. Map of Section 11V.

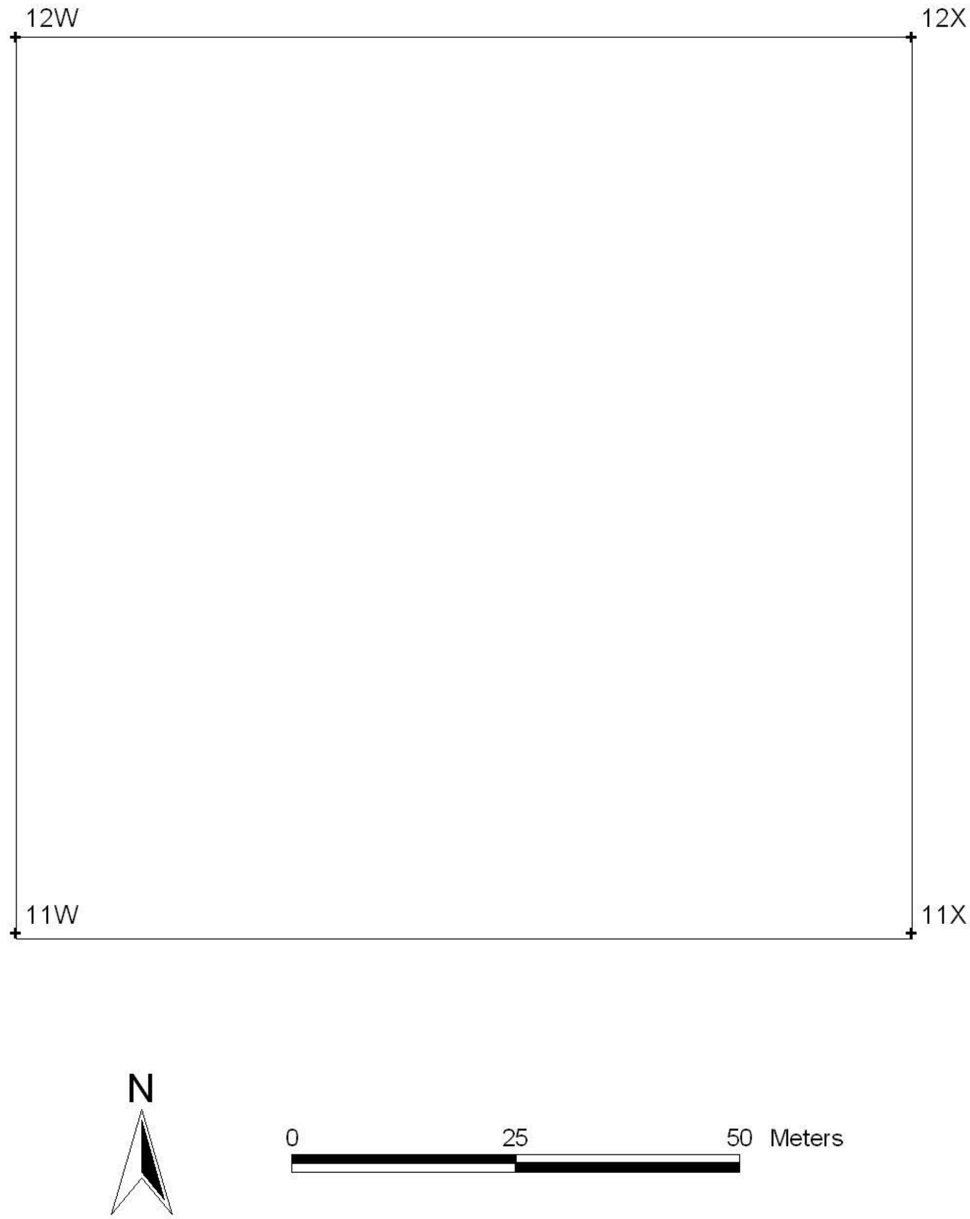


Figure B.56. Map of Section 11W.

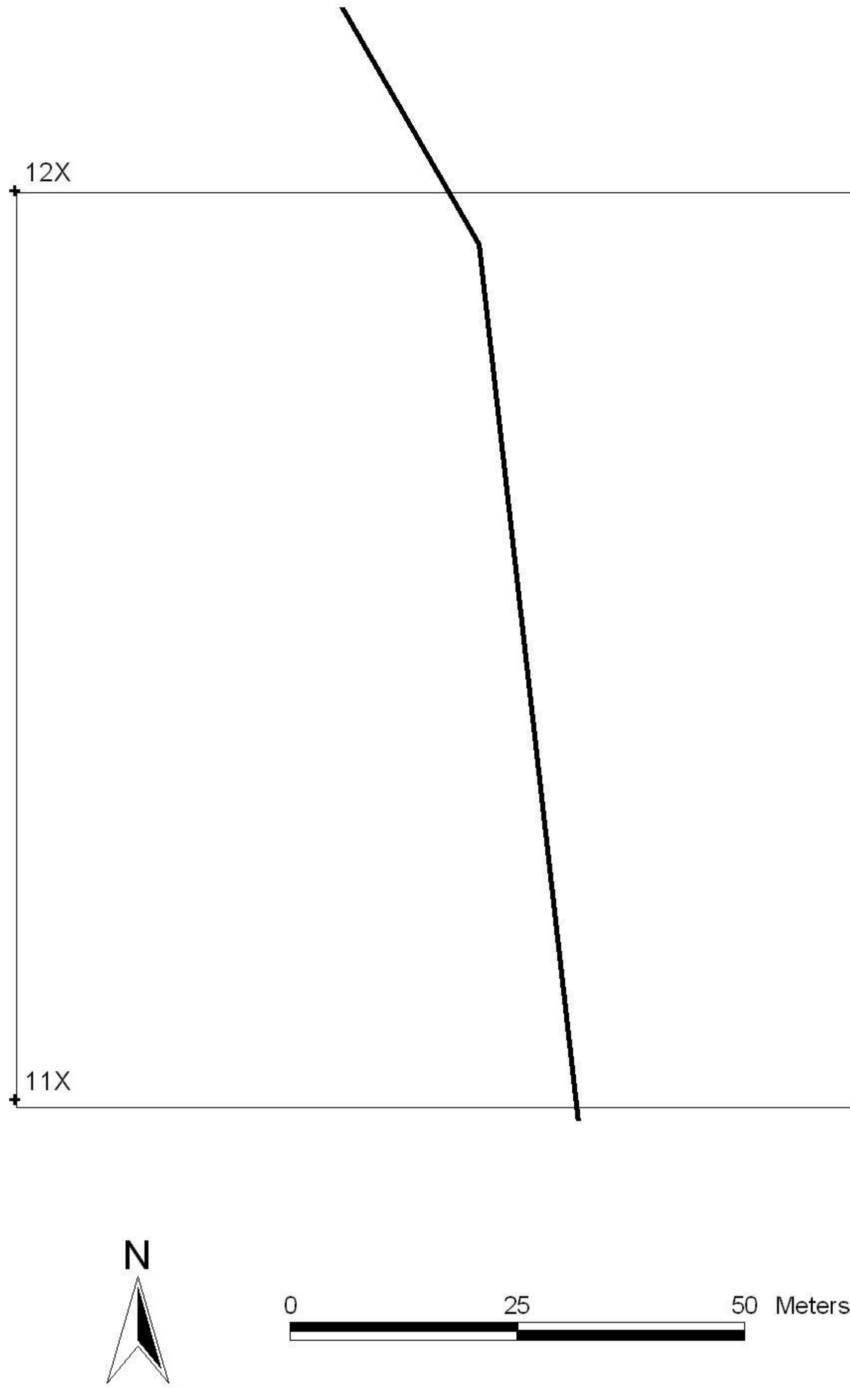


Figure B.57. Map of Section 11X.

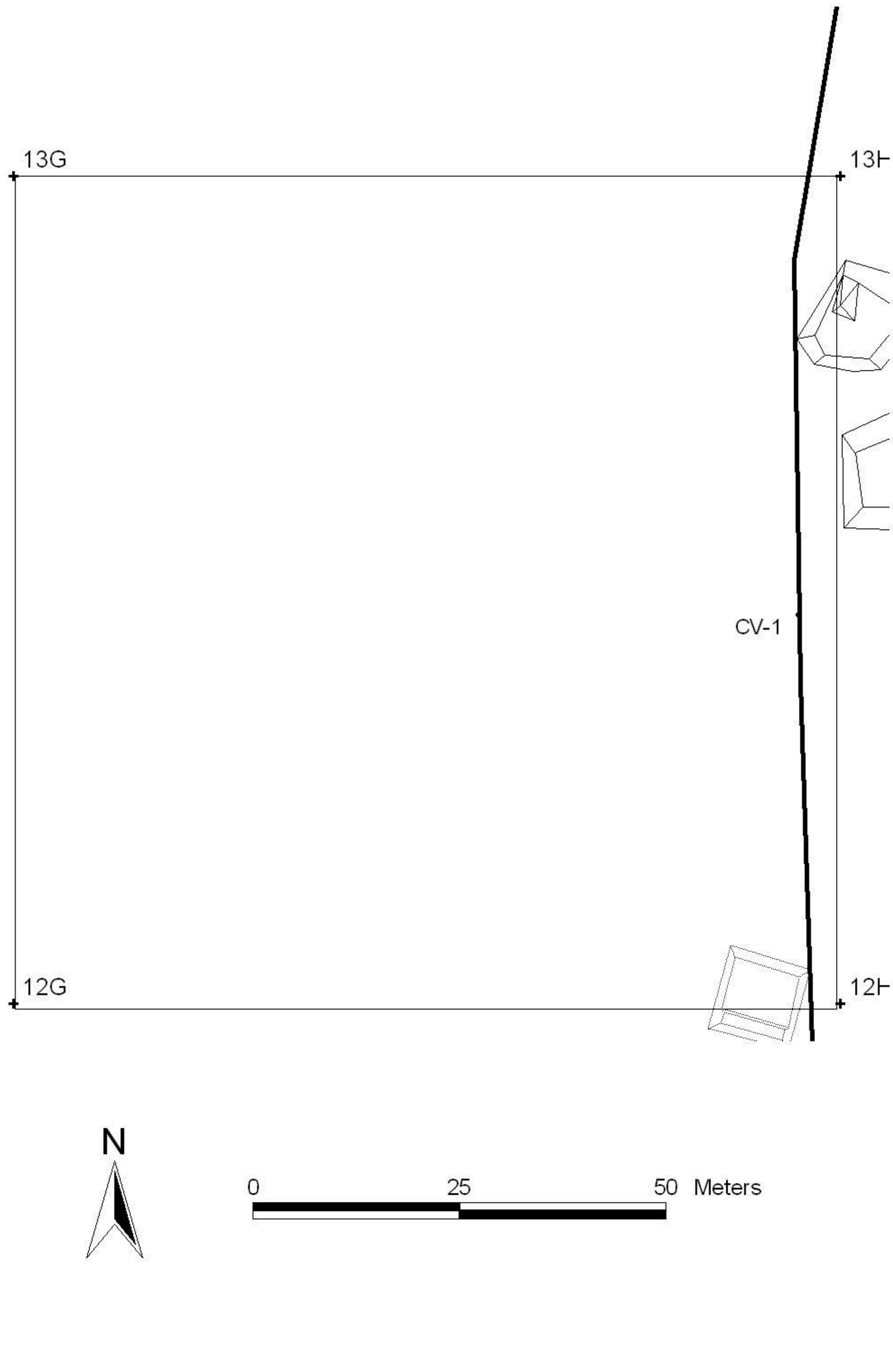


Figure B.58. Map of Section 12G.

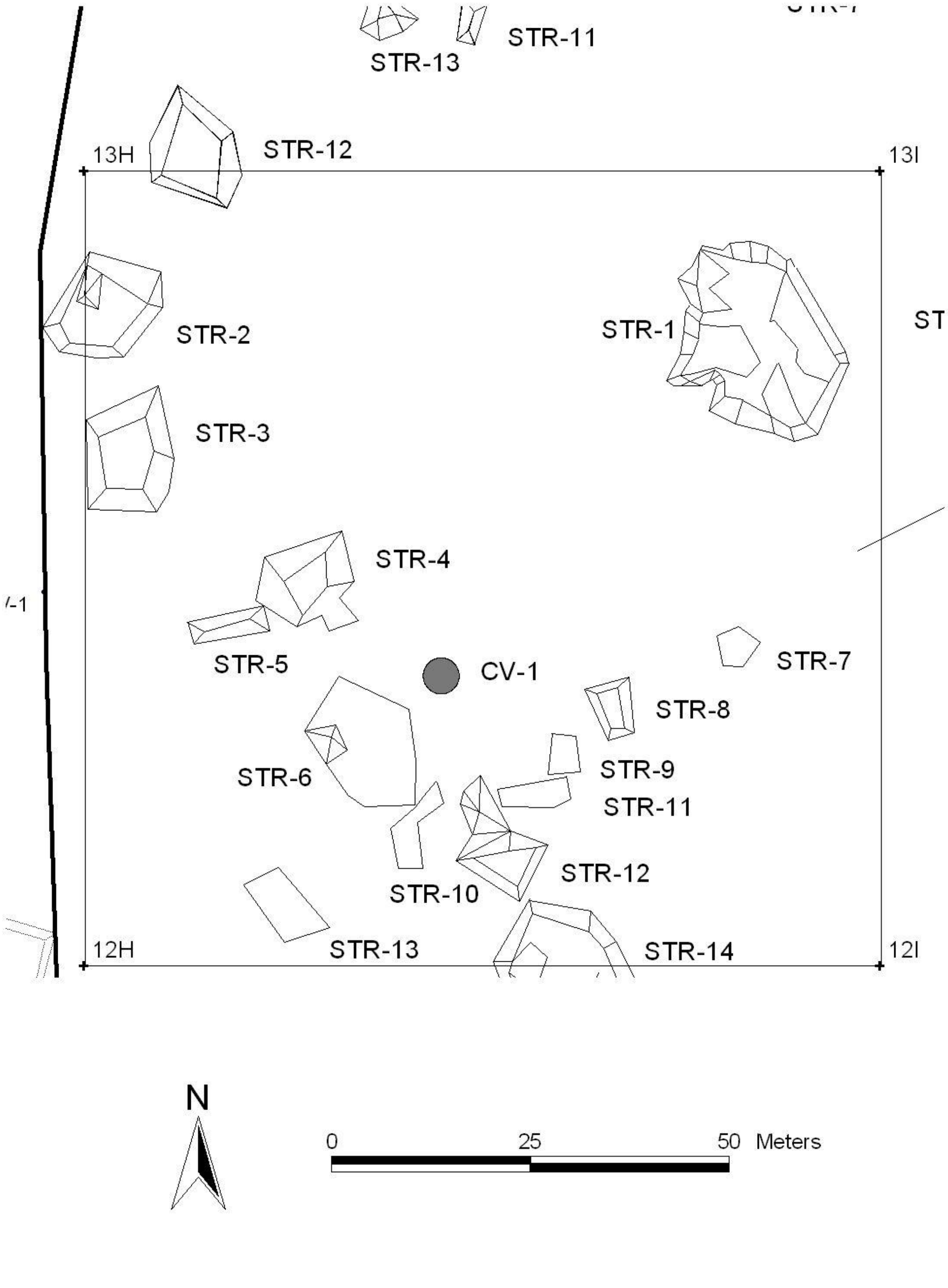


Figure B.59. Map of Section 12H.

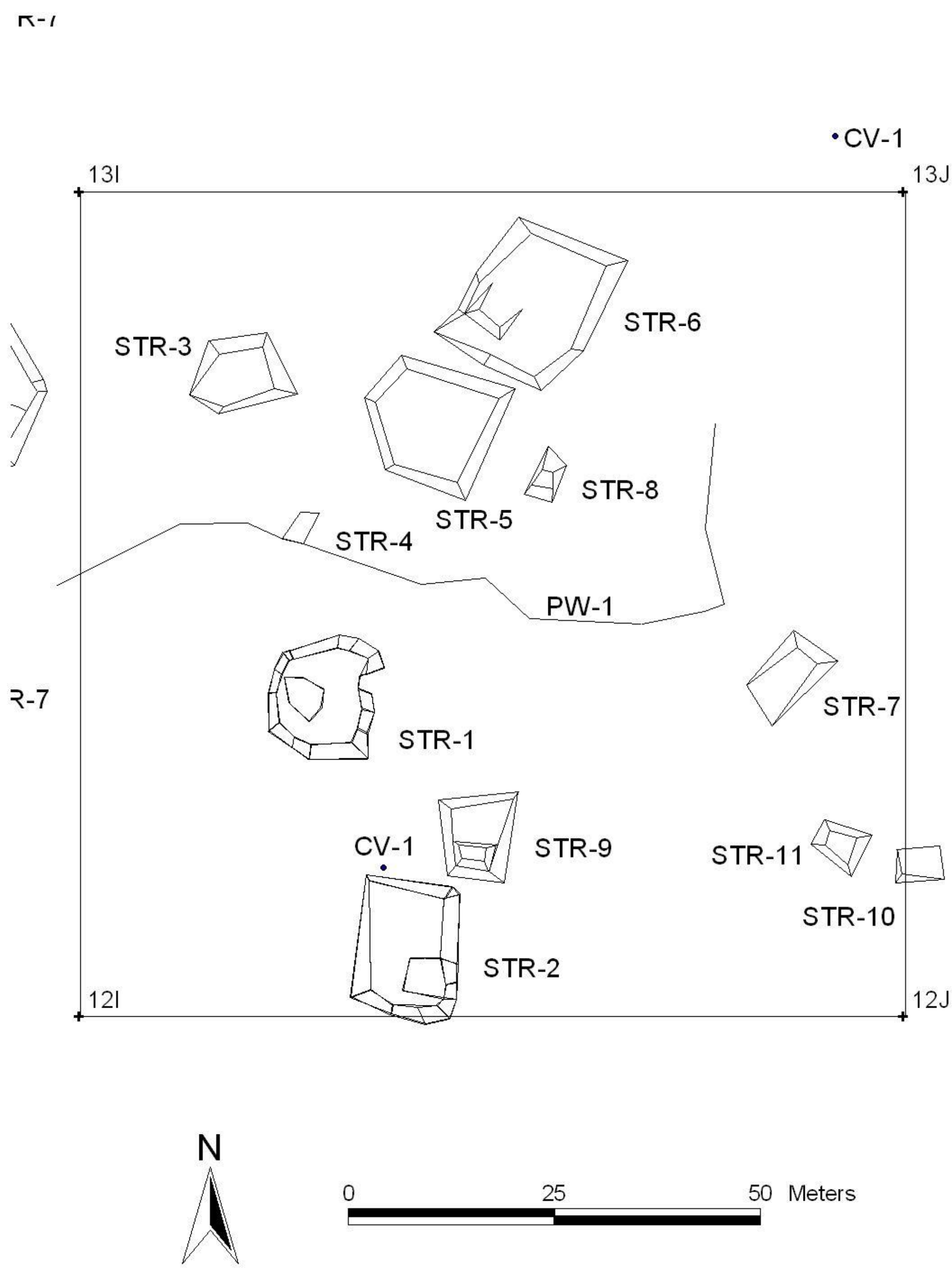


Figure B.60. Map of Section 12I.

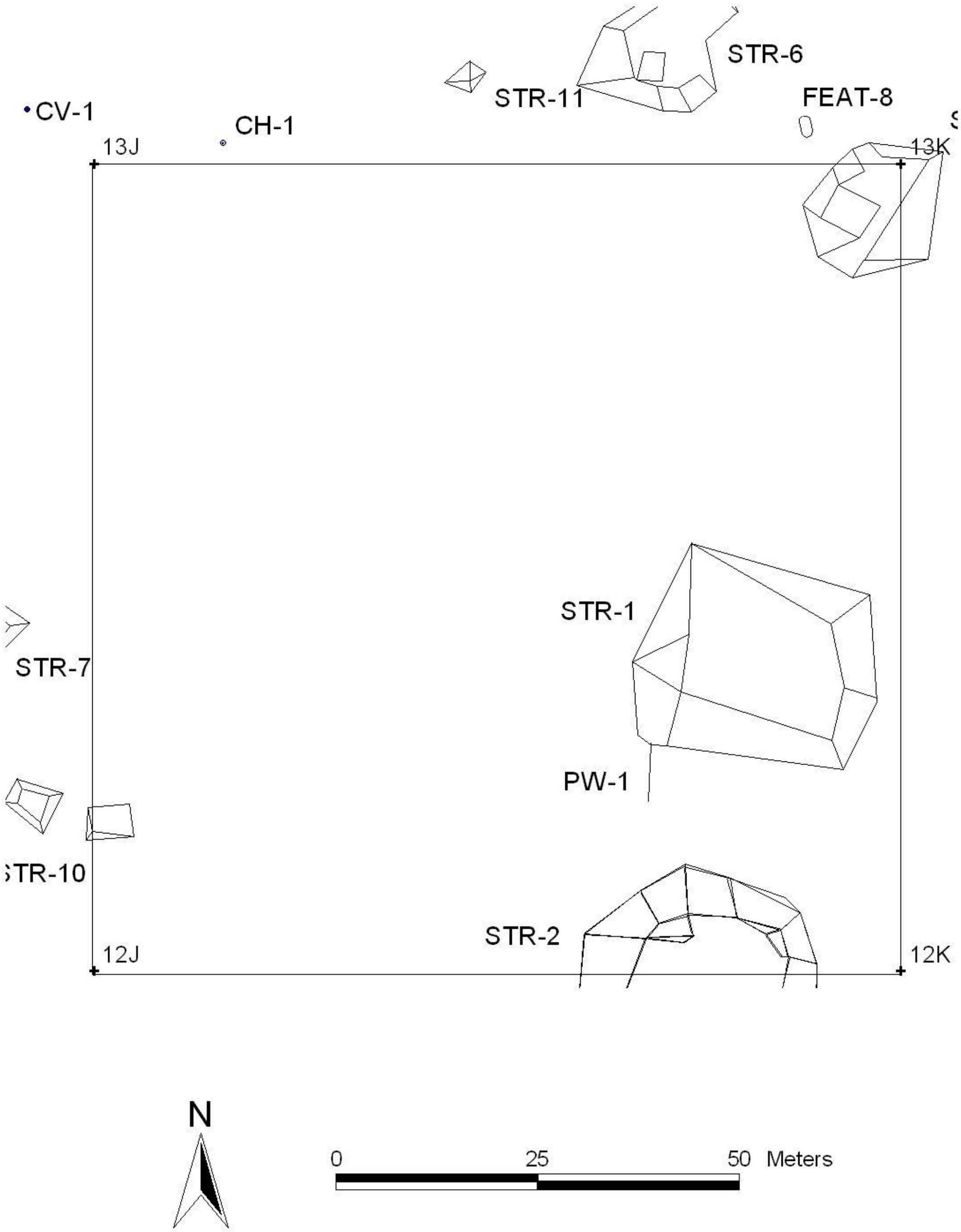


Figure B.61. Map of Section 12J.

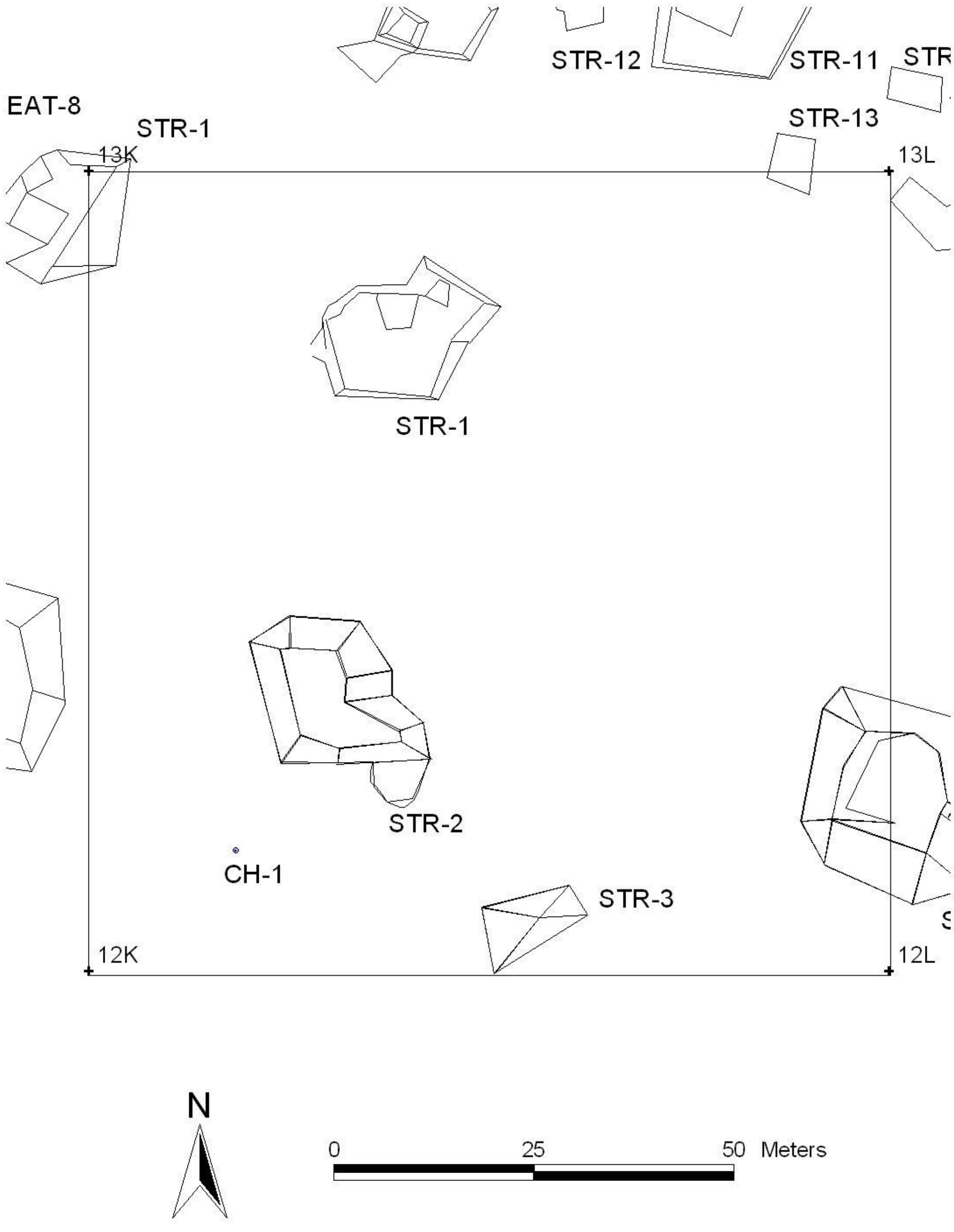
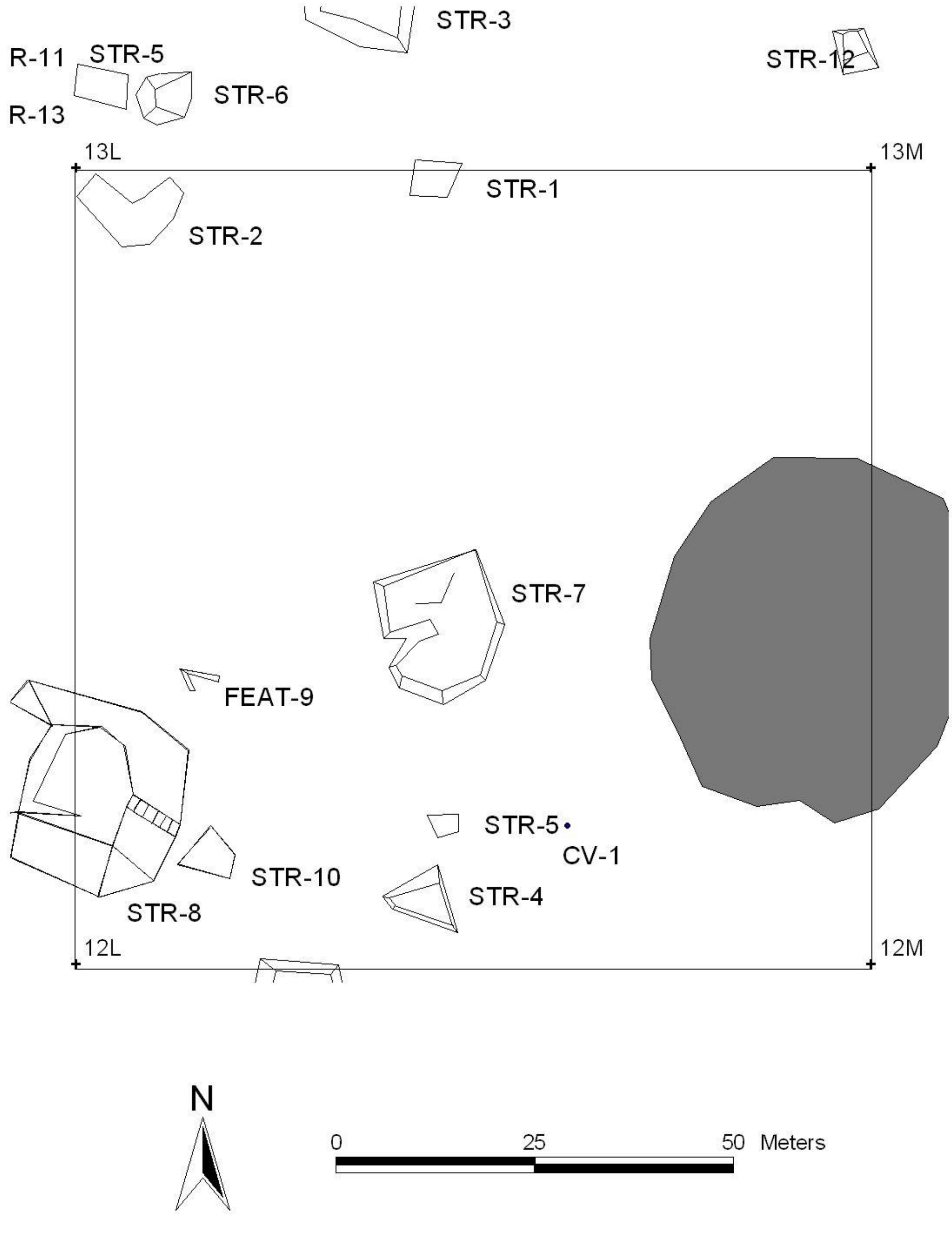


Figure B.62. Map of Section 12K.



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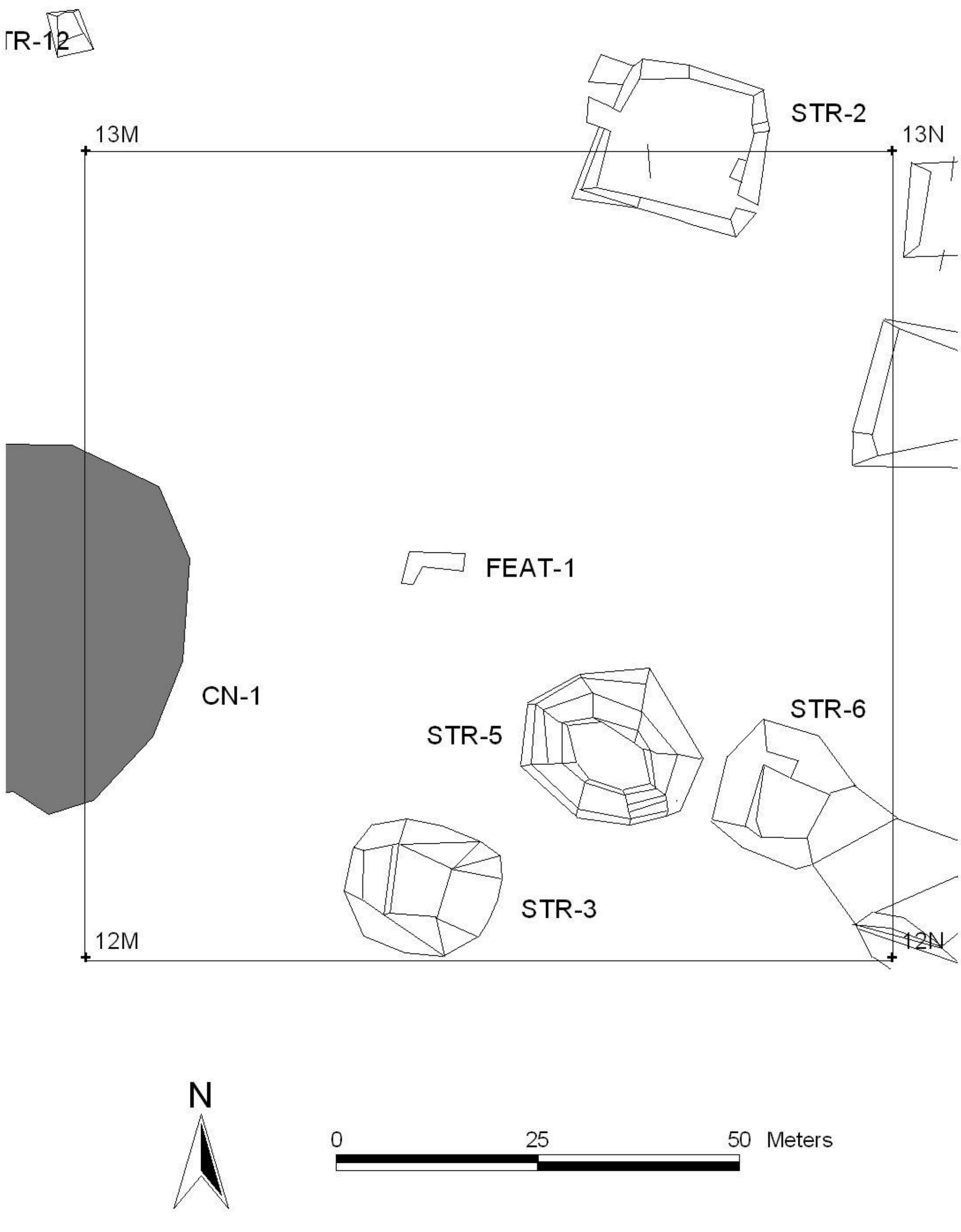

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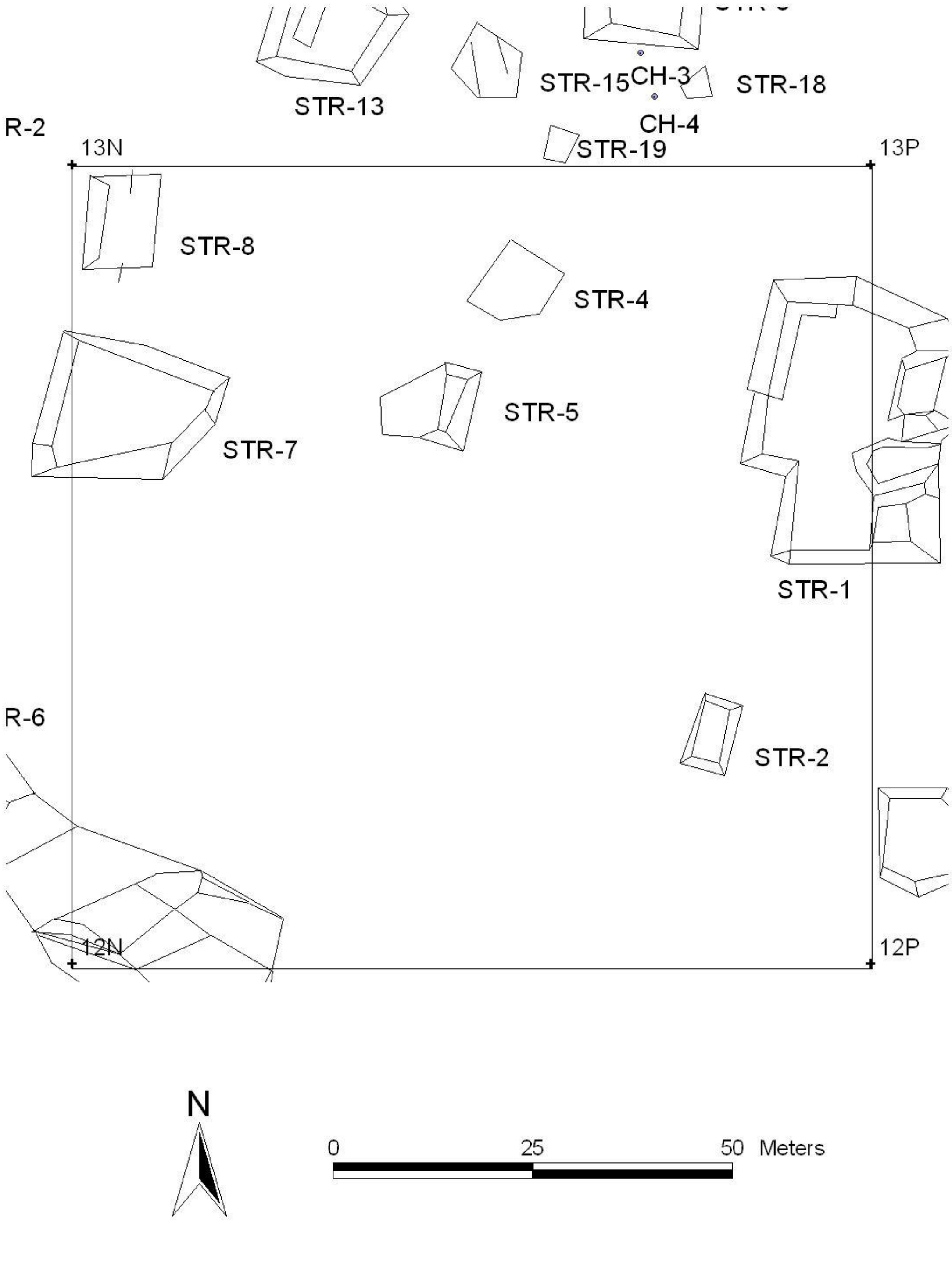

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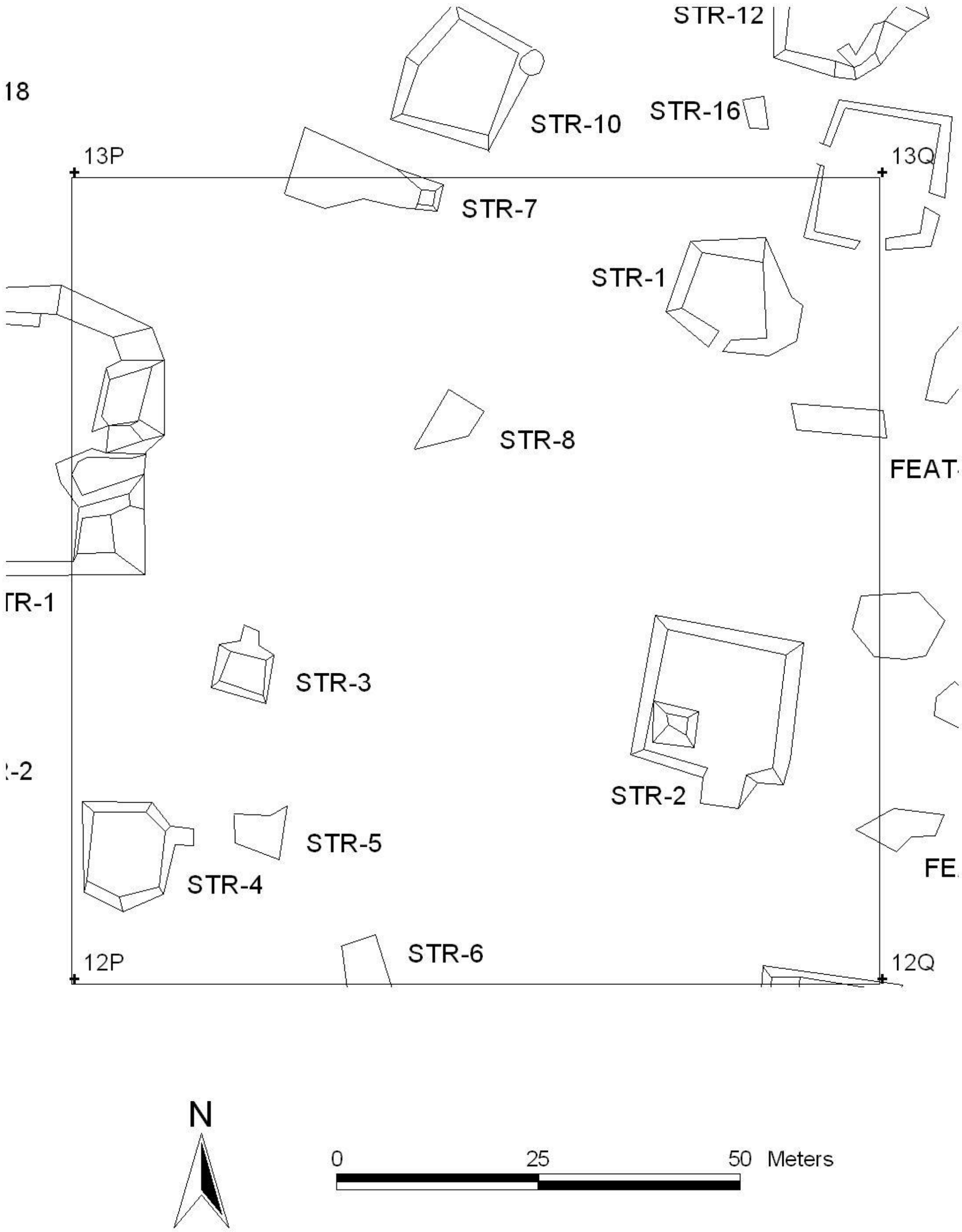

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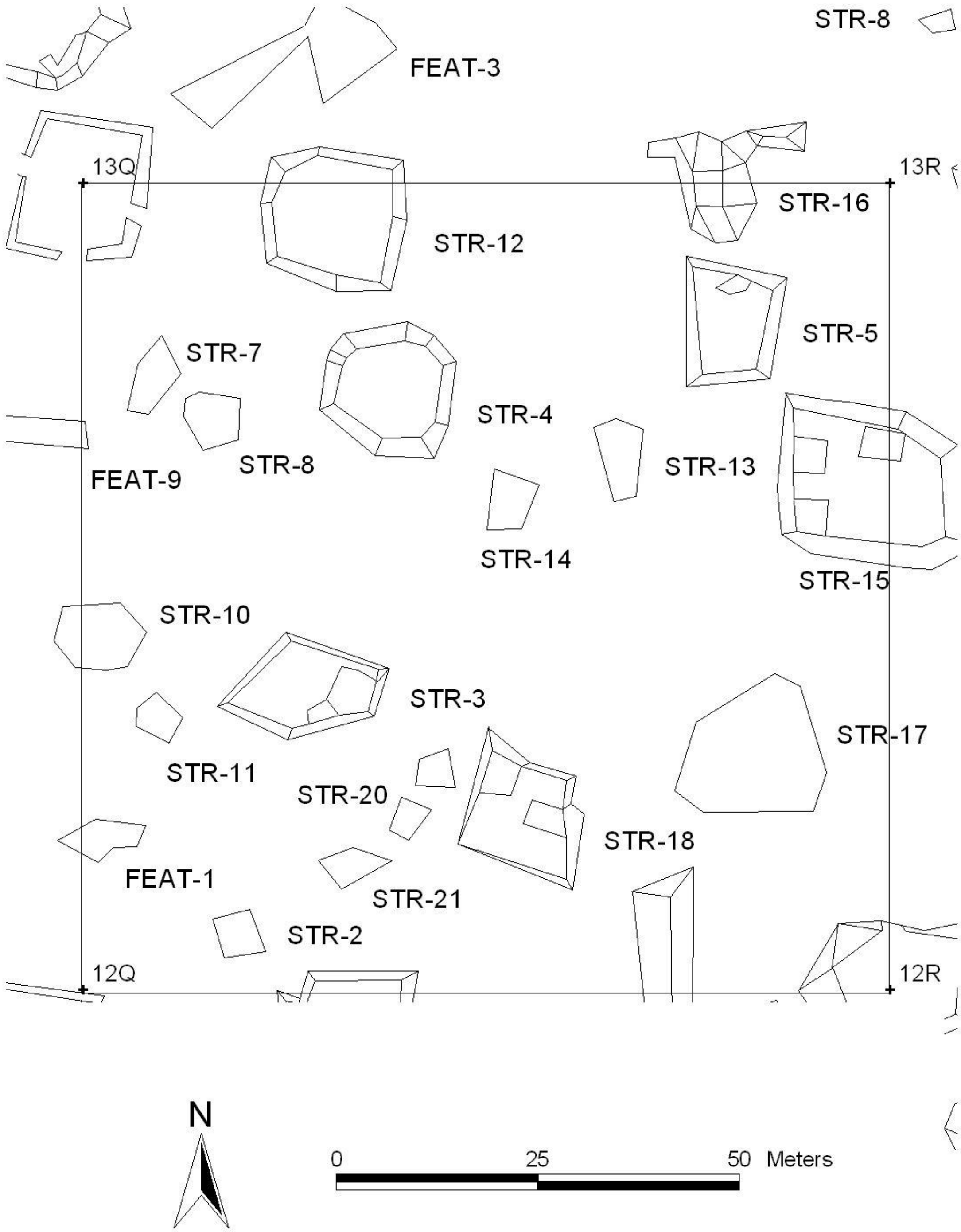

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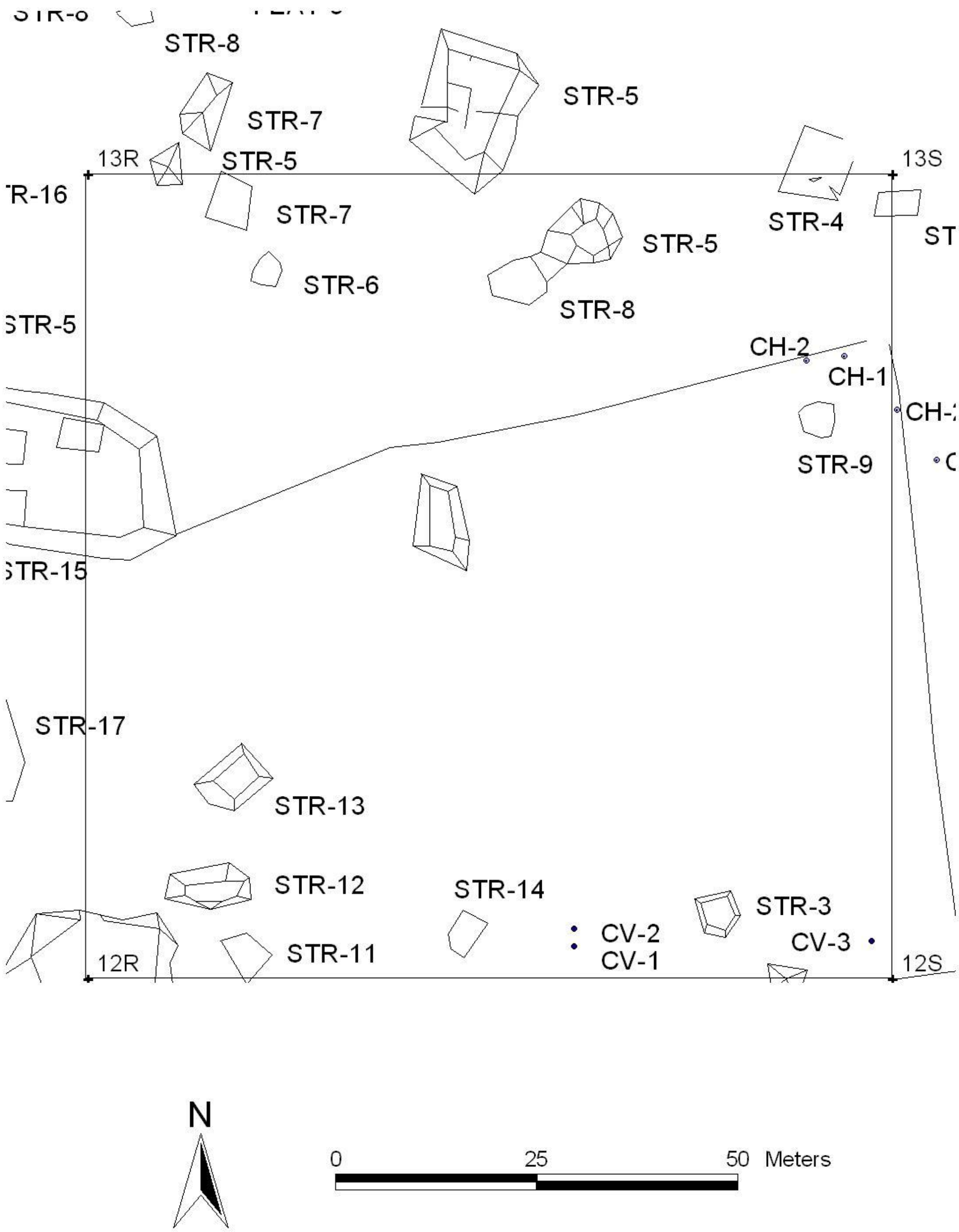

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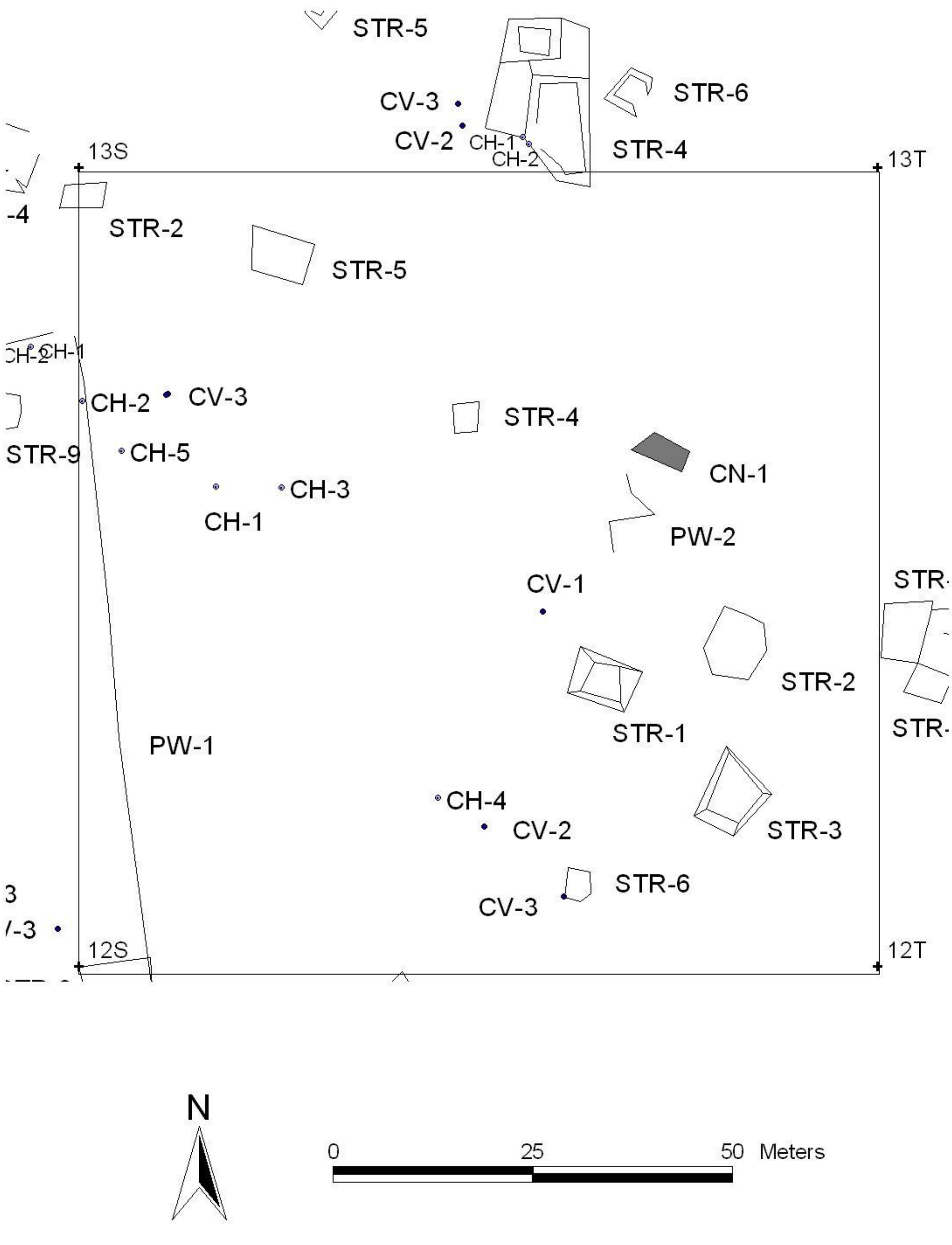

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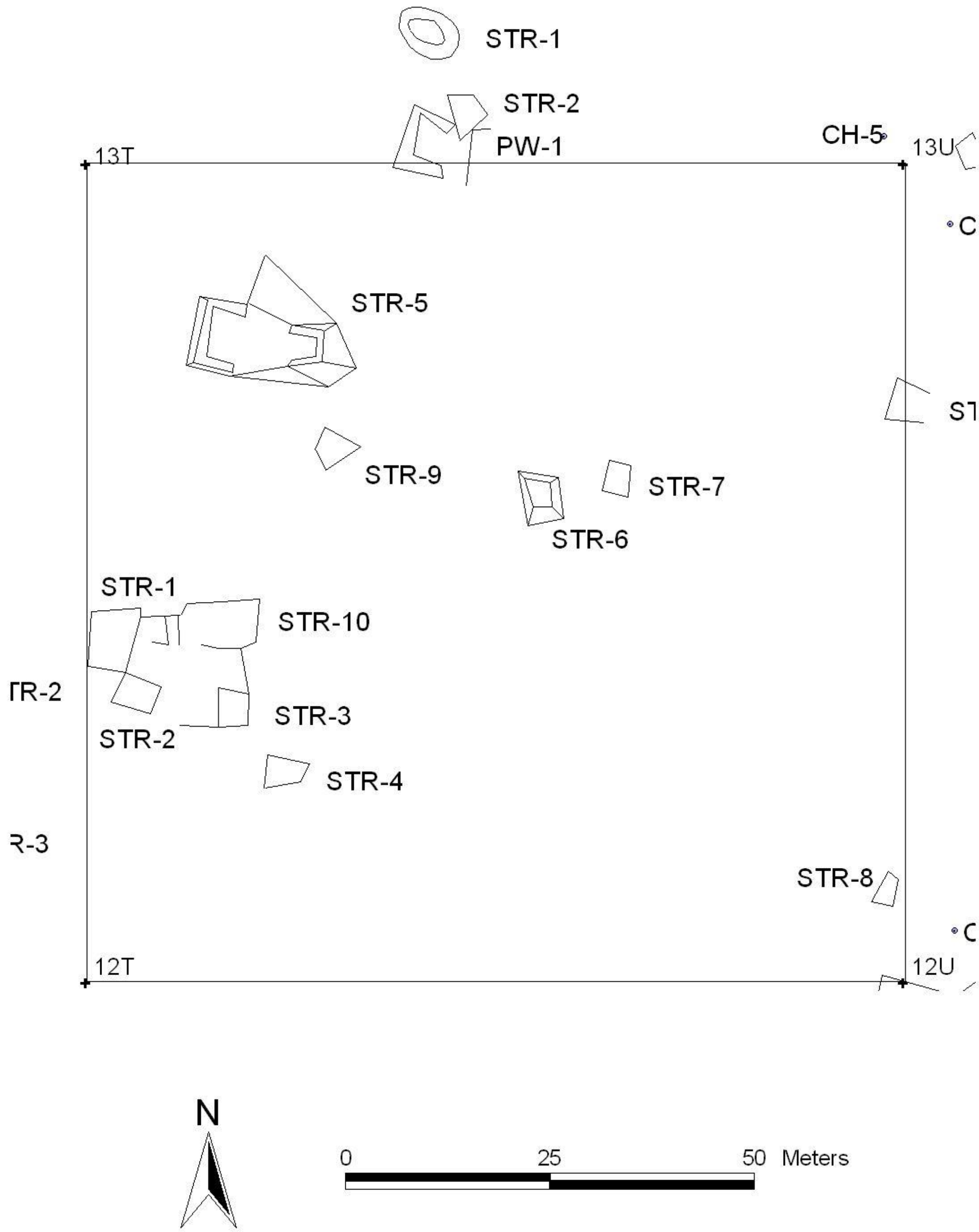

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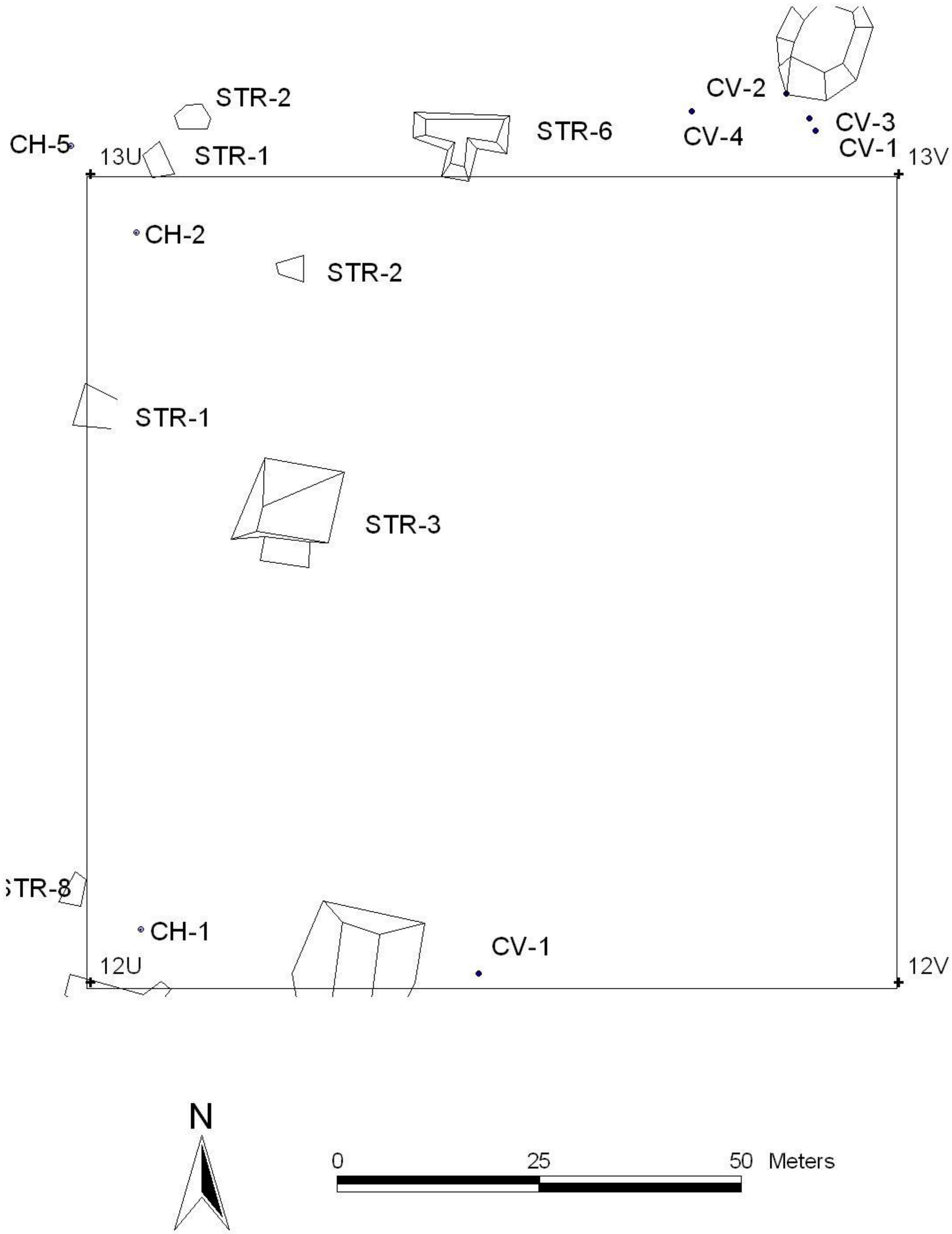

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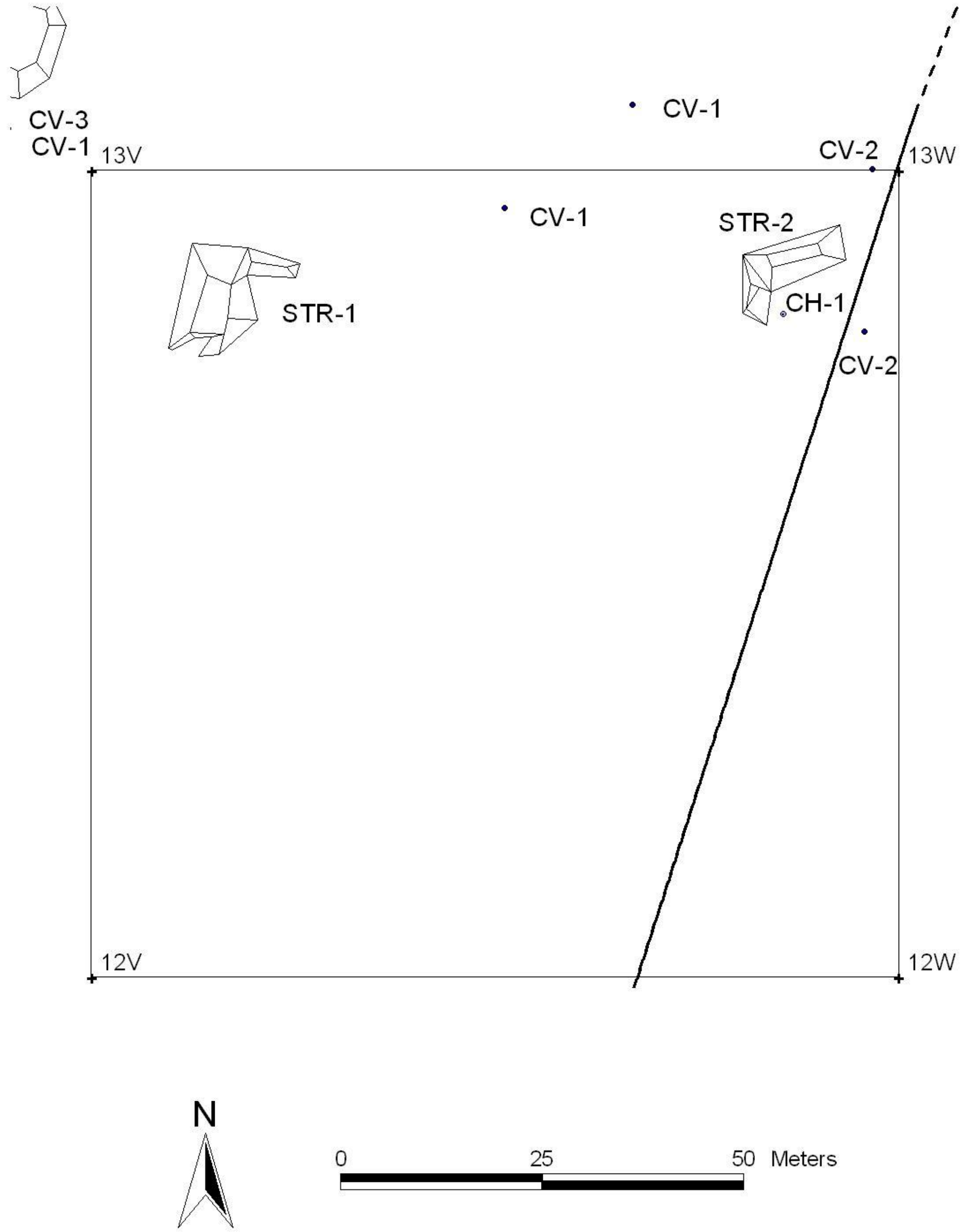

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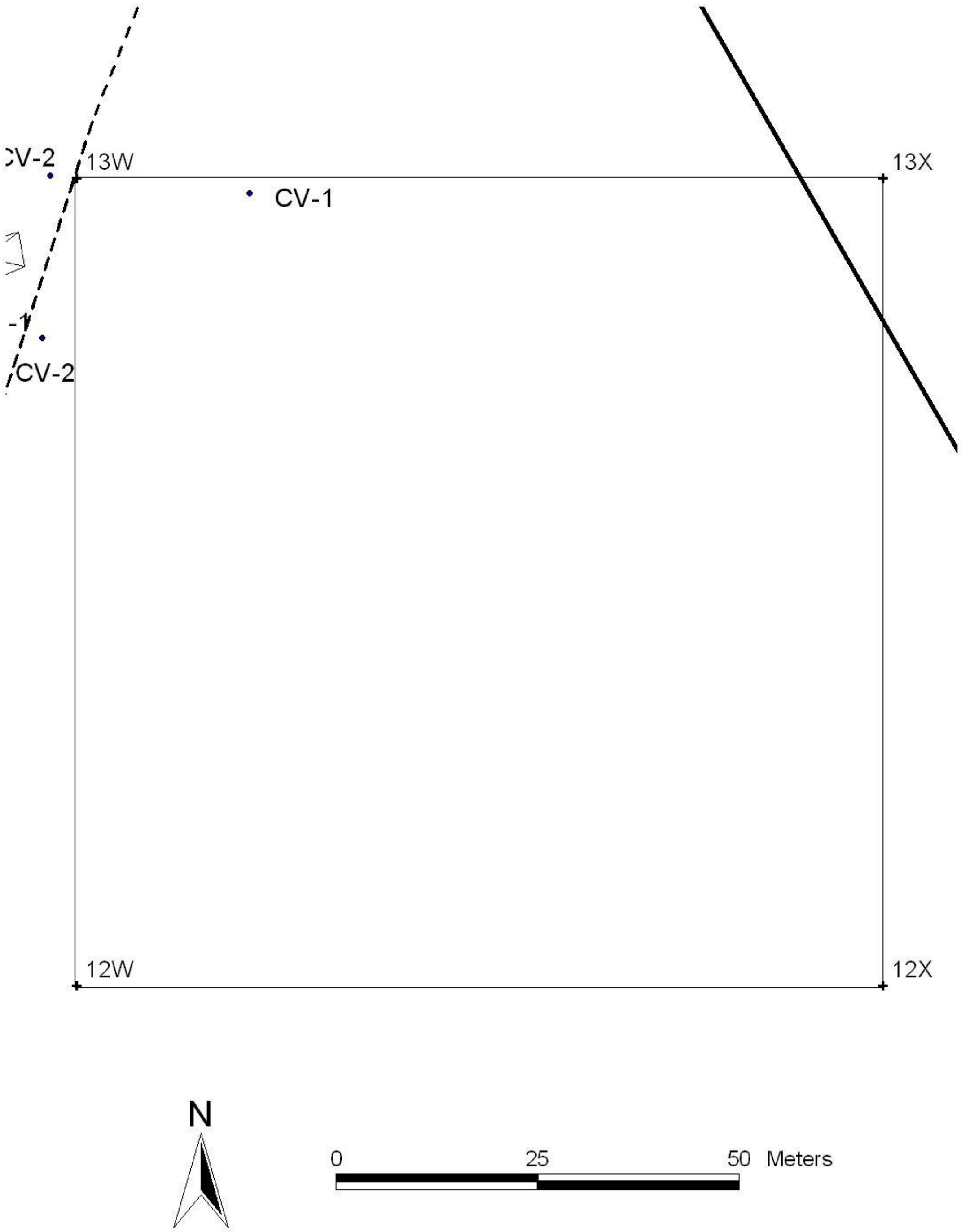

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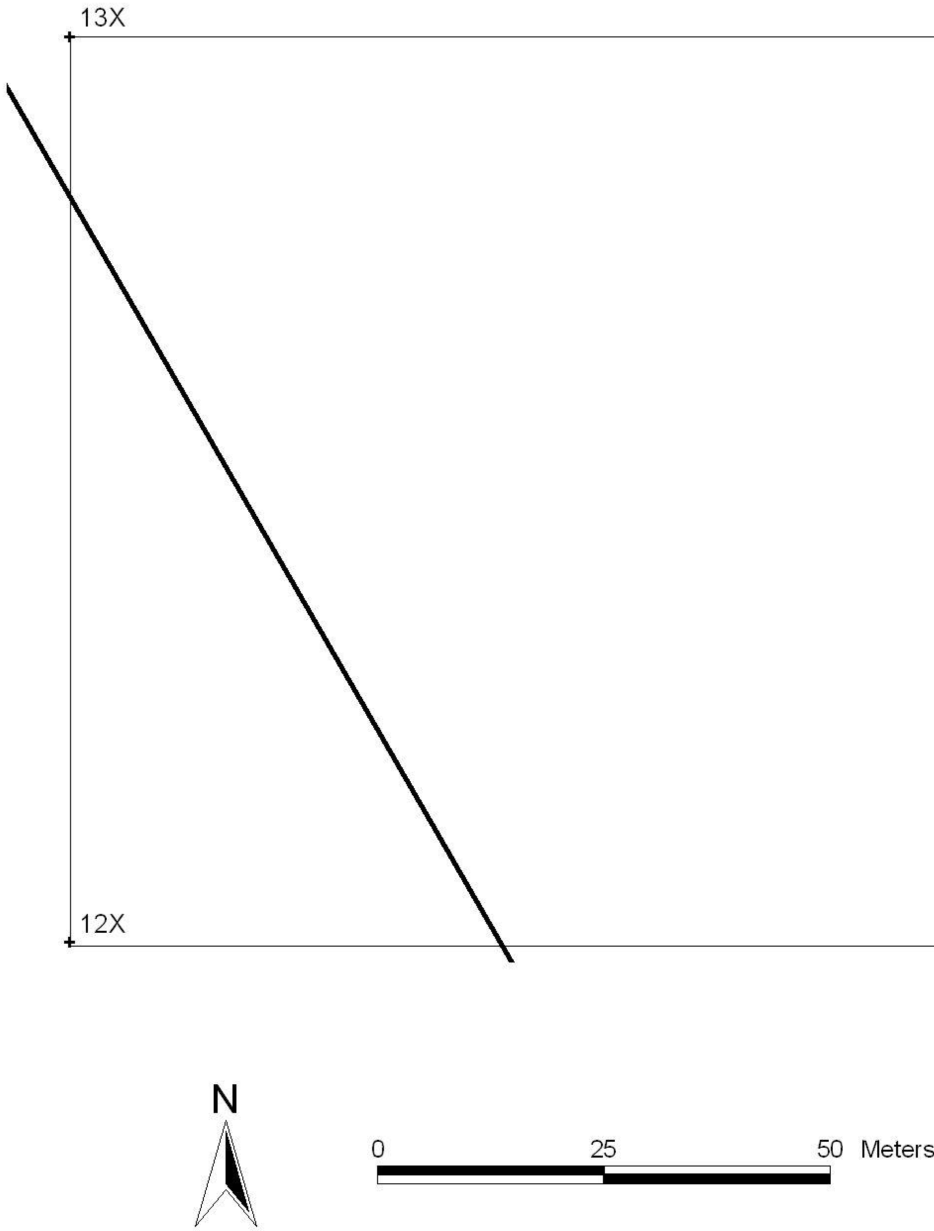

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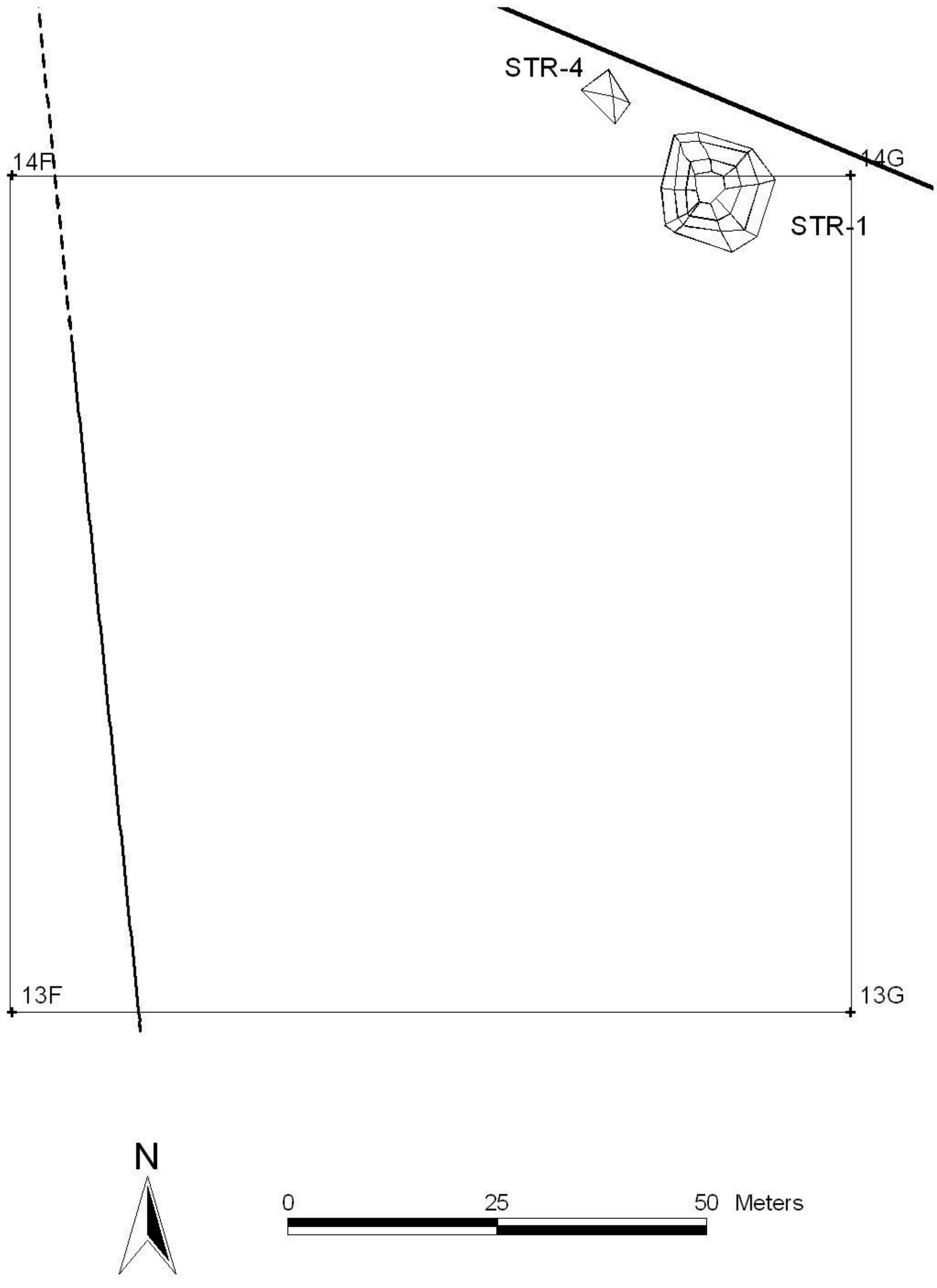


Figure B.74. Map of Section 13F.

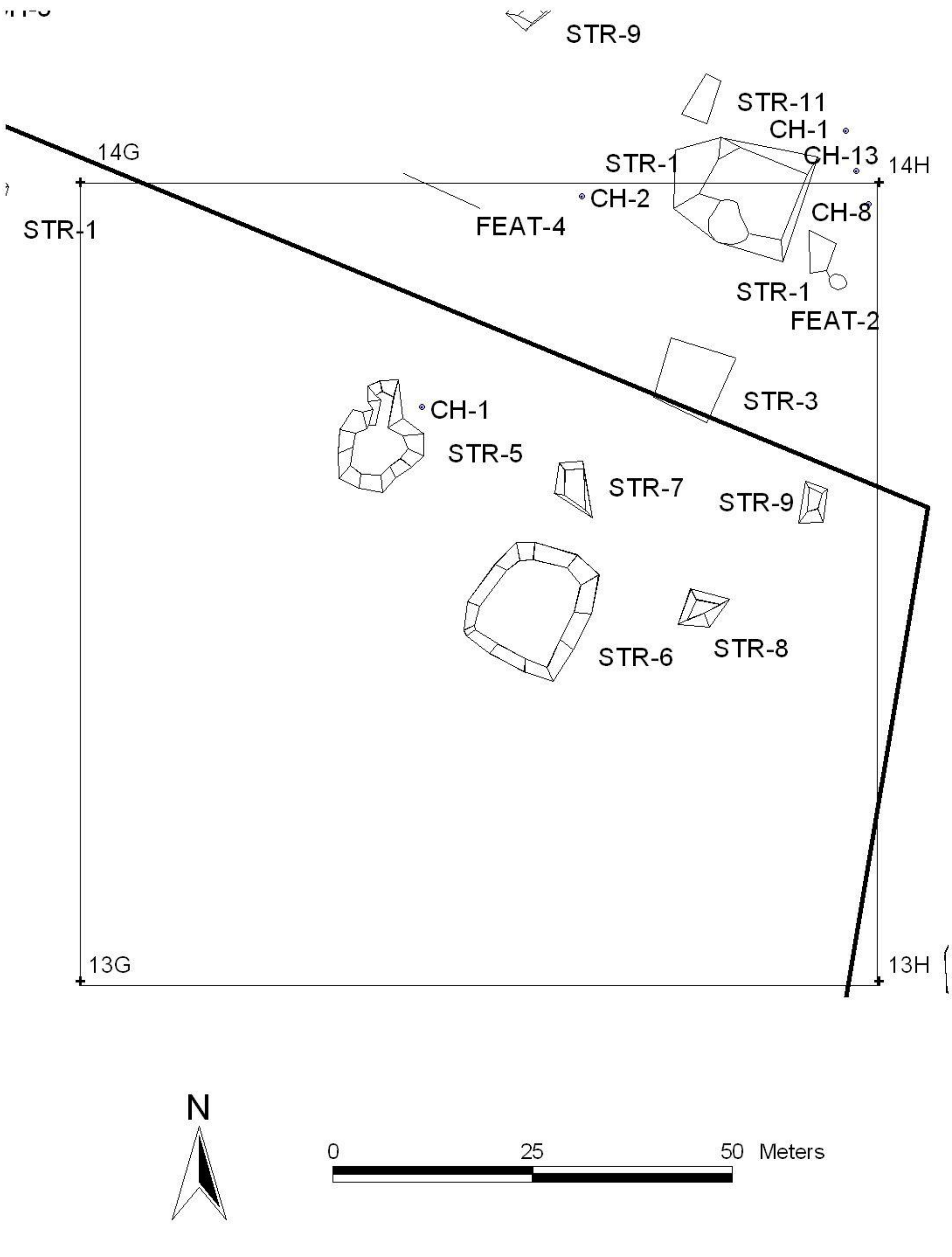


Figure B.75. Map of Section 13G.

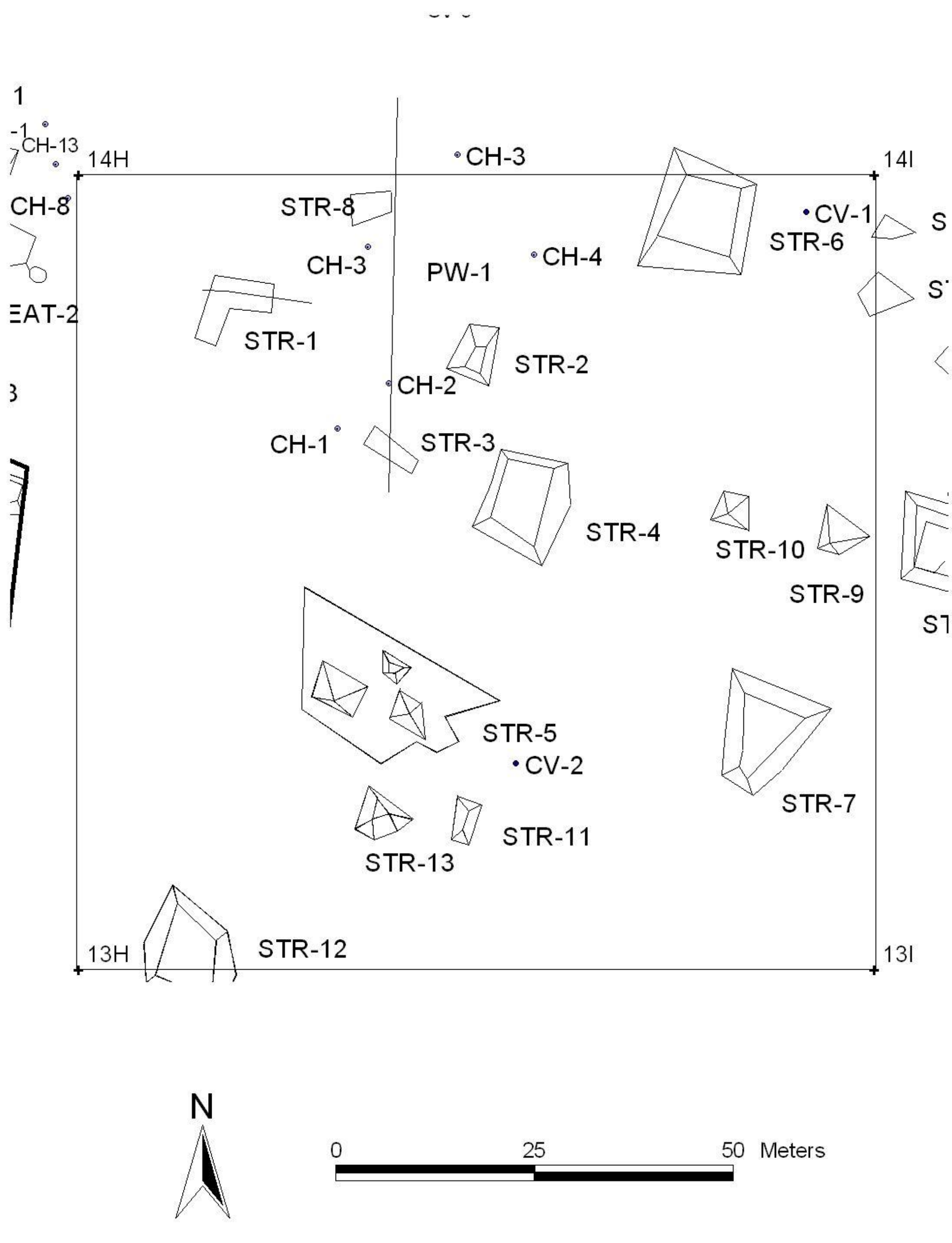
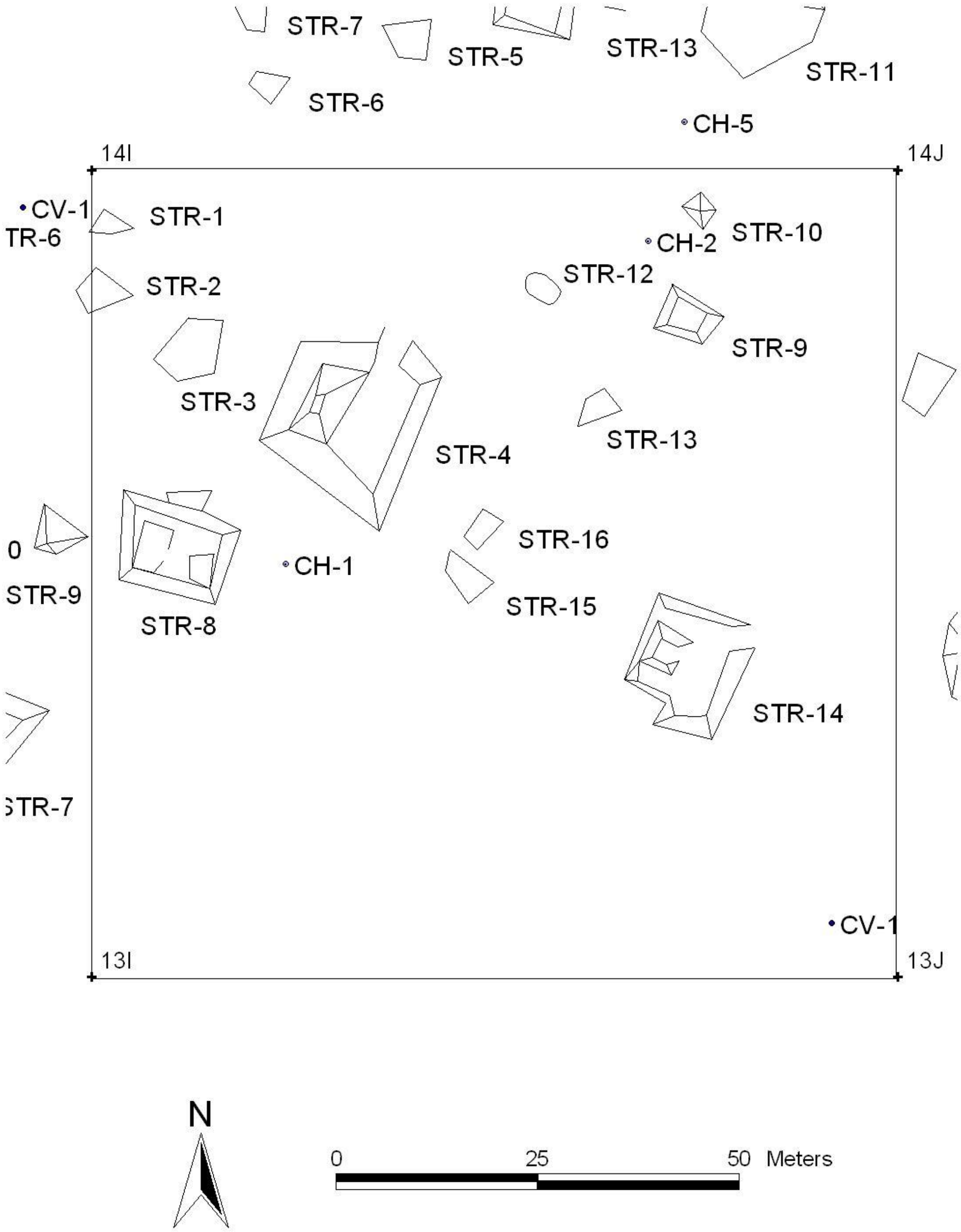


Figure B.76. Map of Section 13H.



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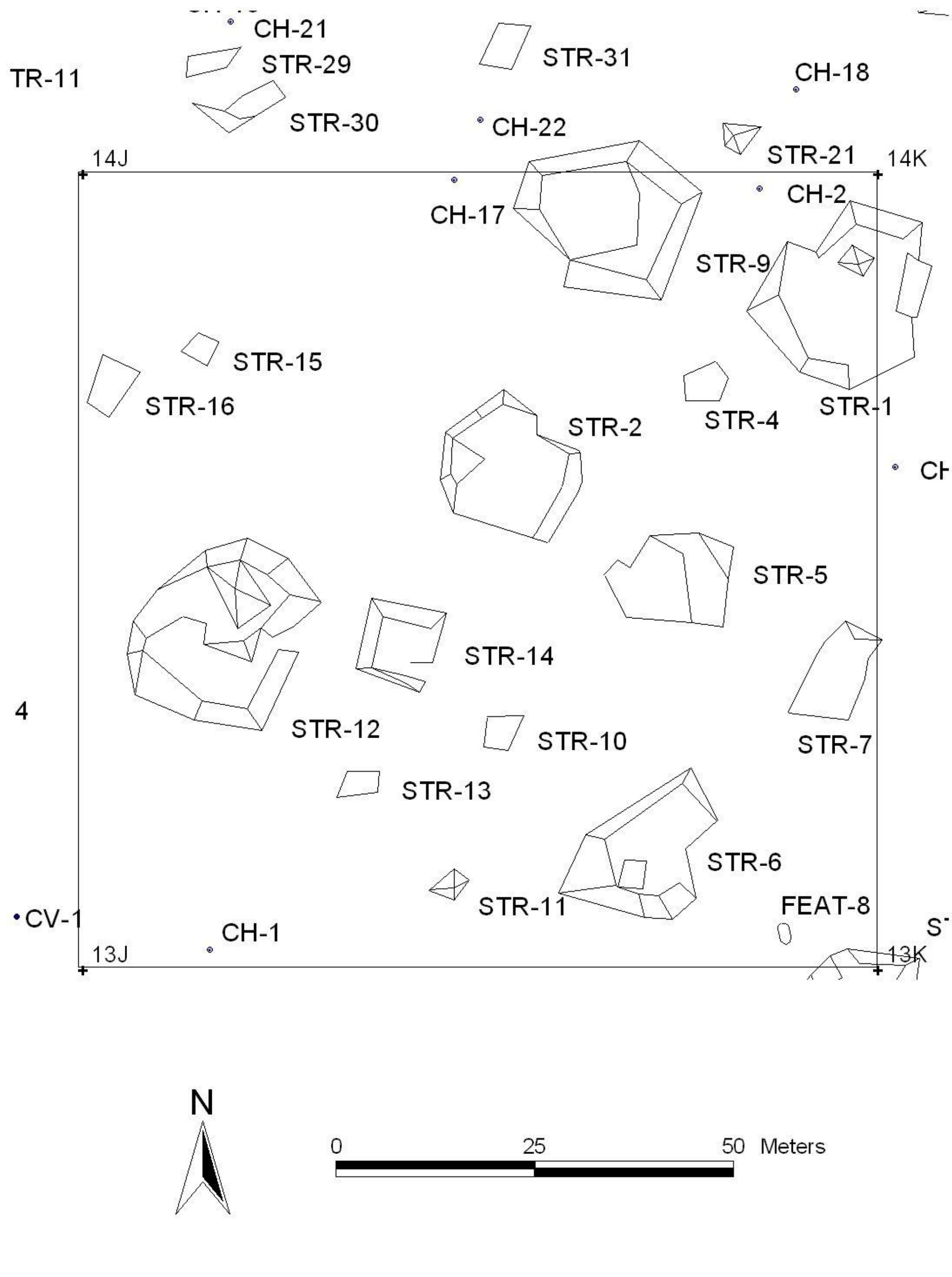

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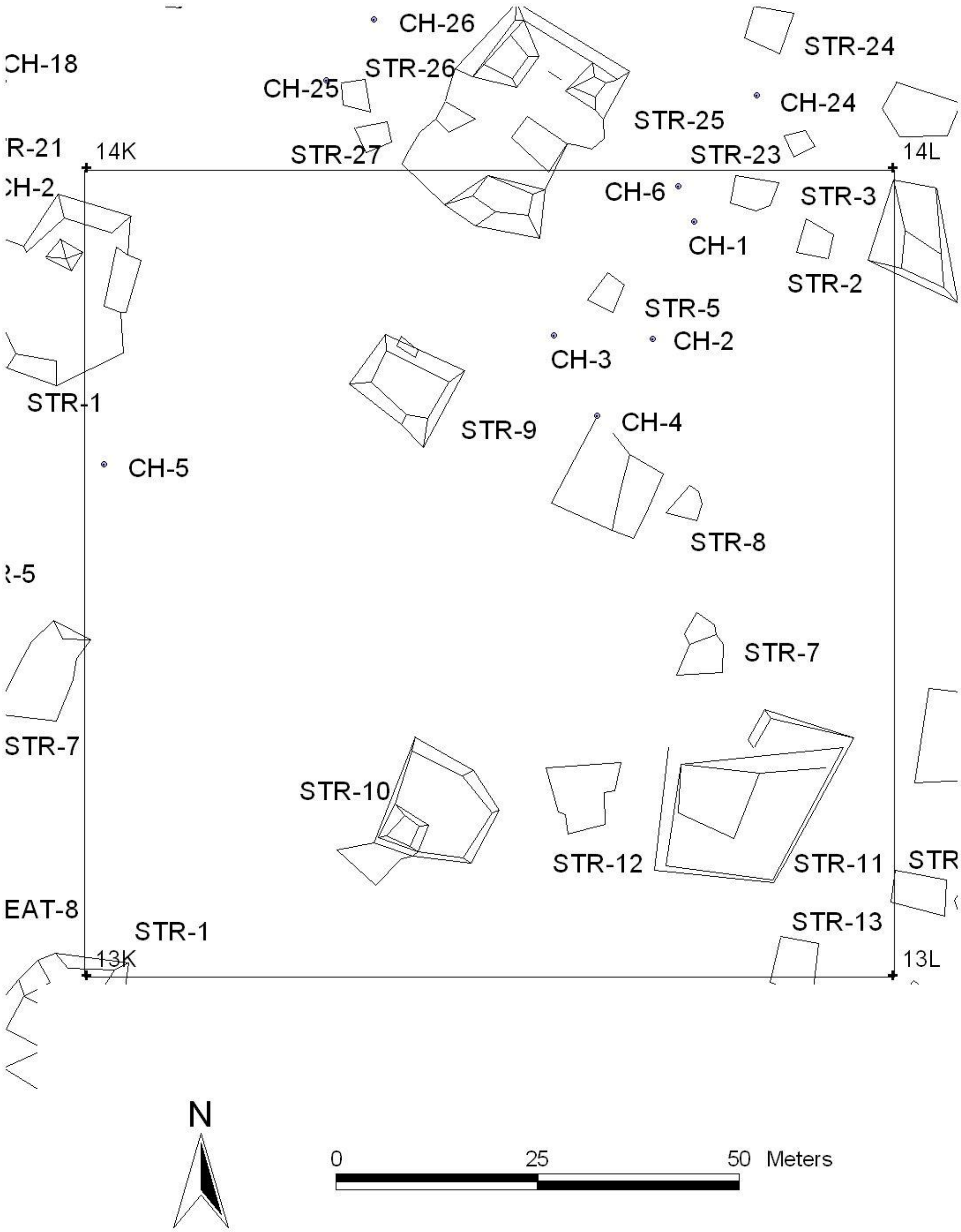

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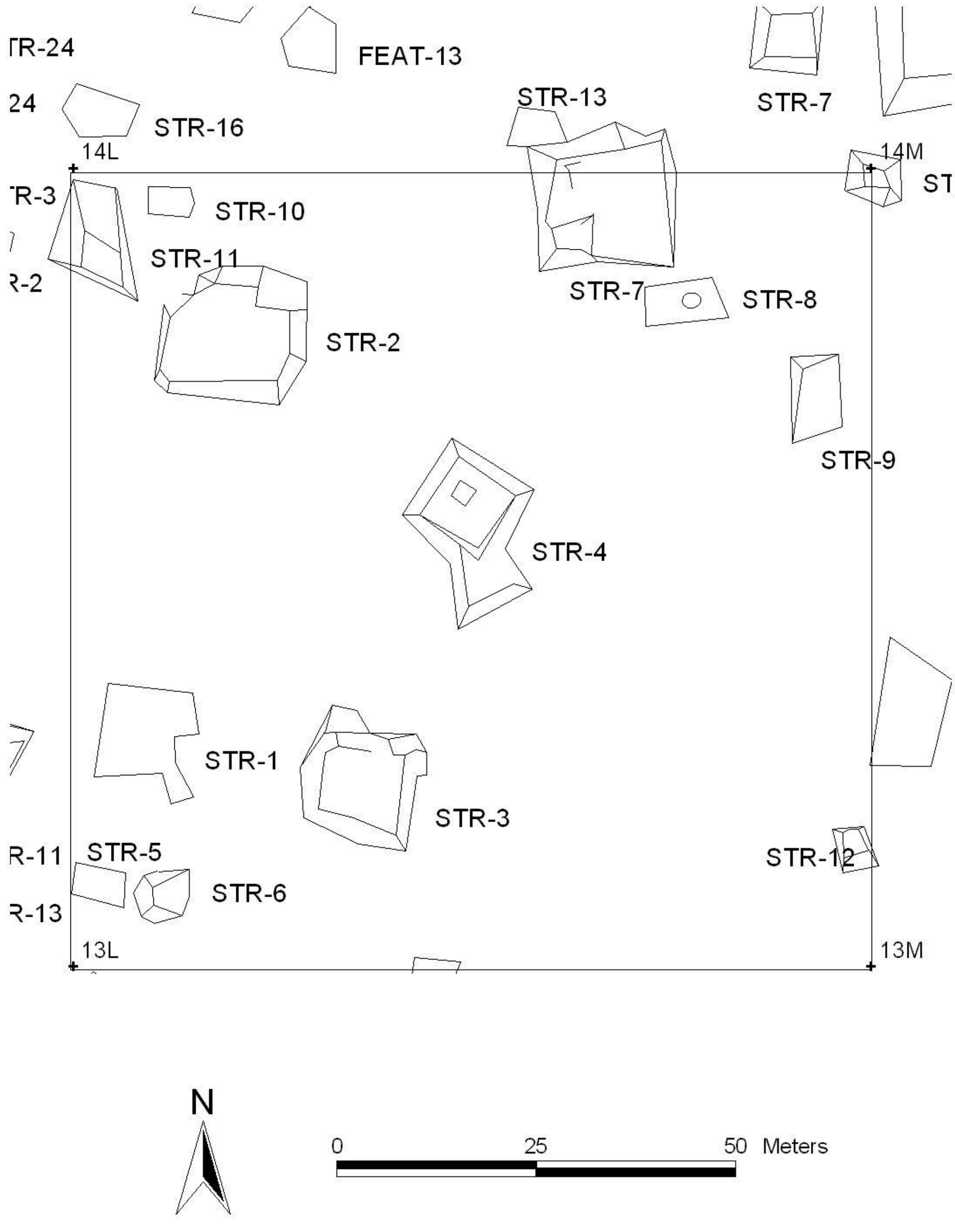

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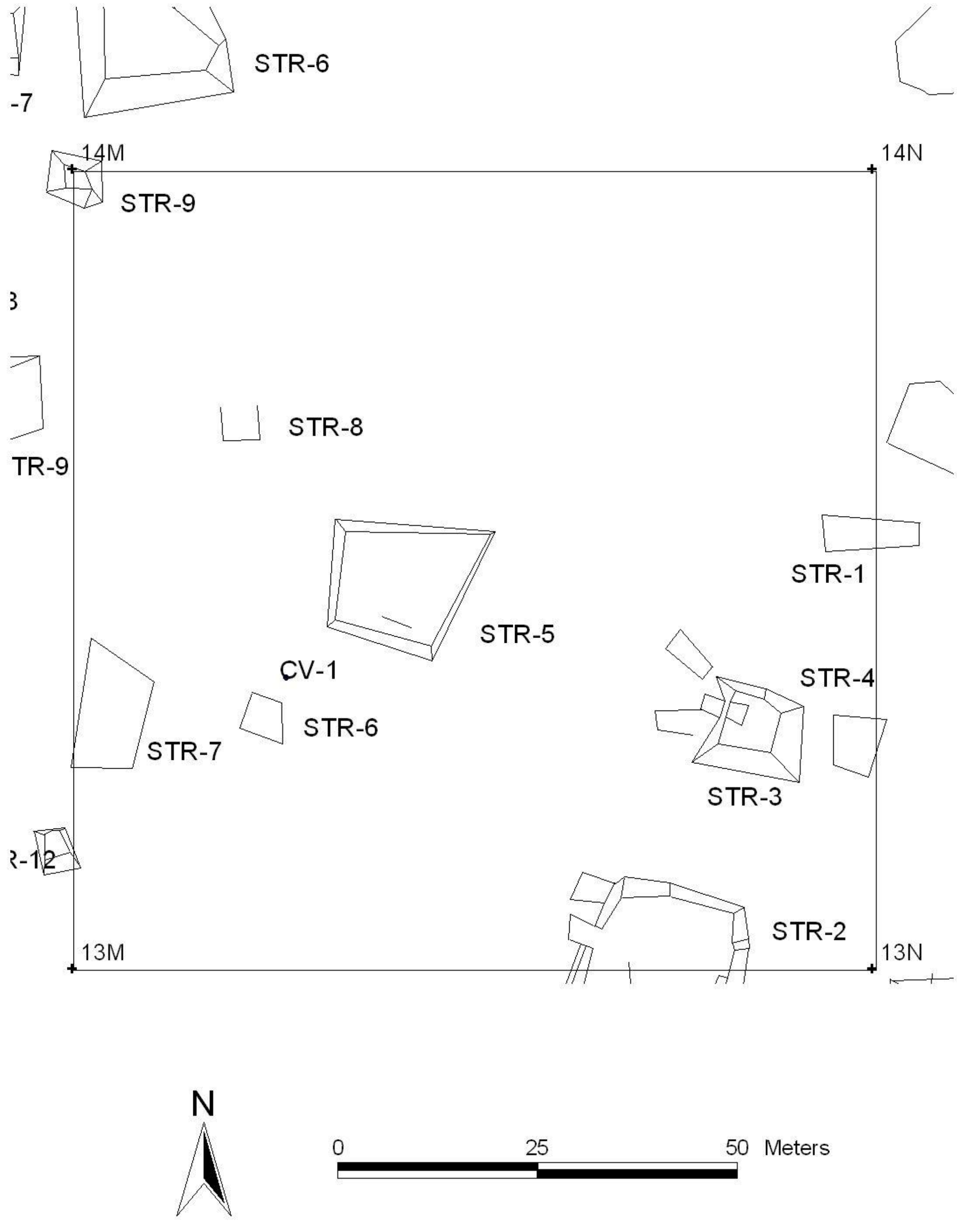
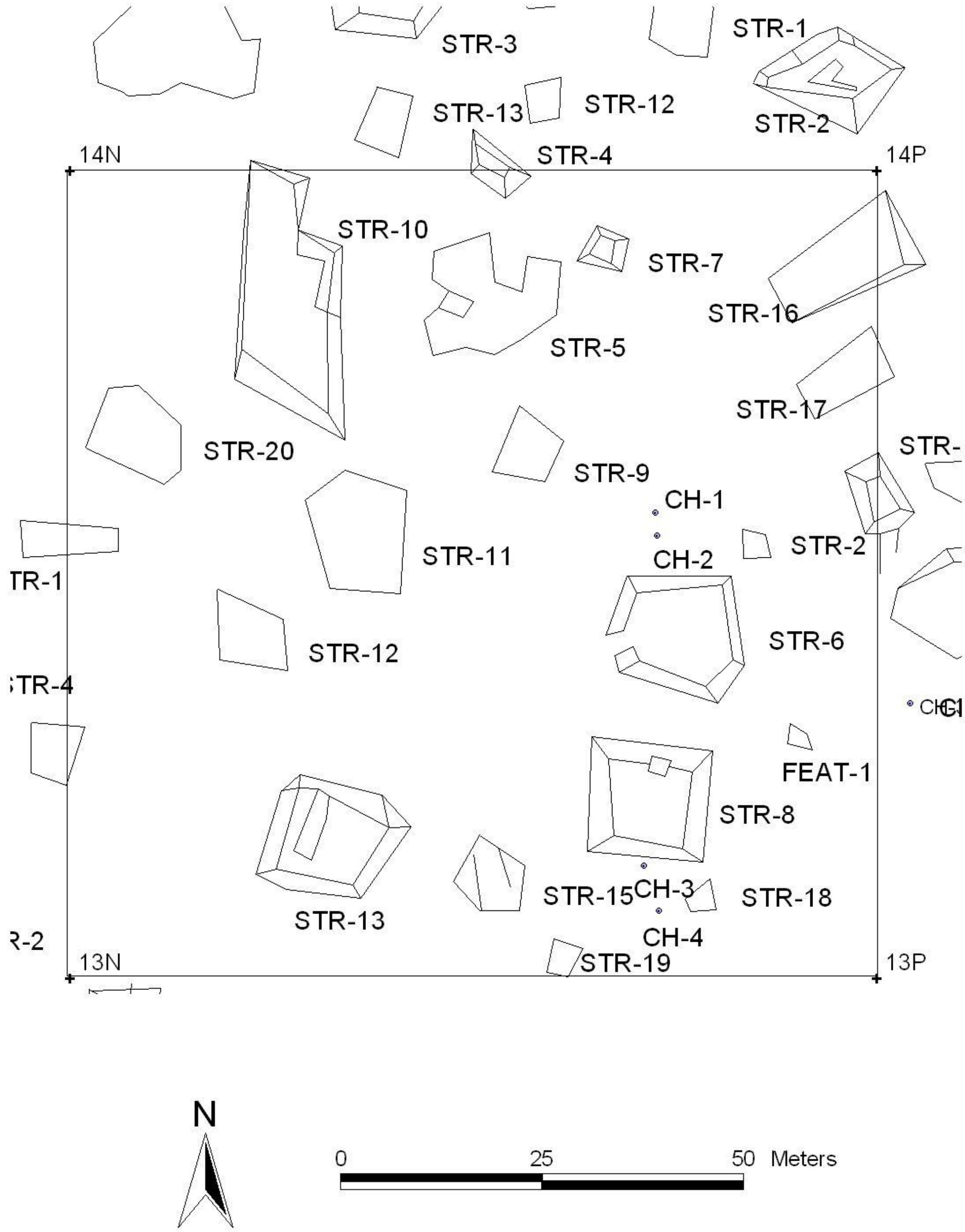


Figure B.81. Map of Section 13M.



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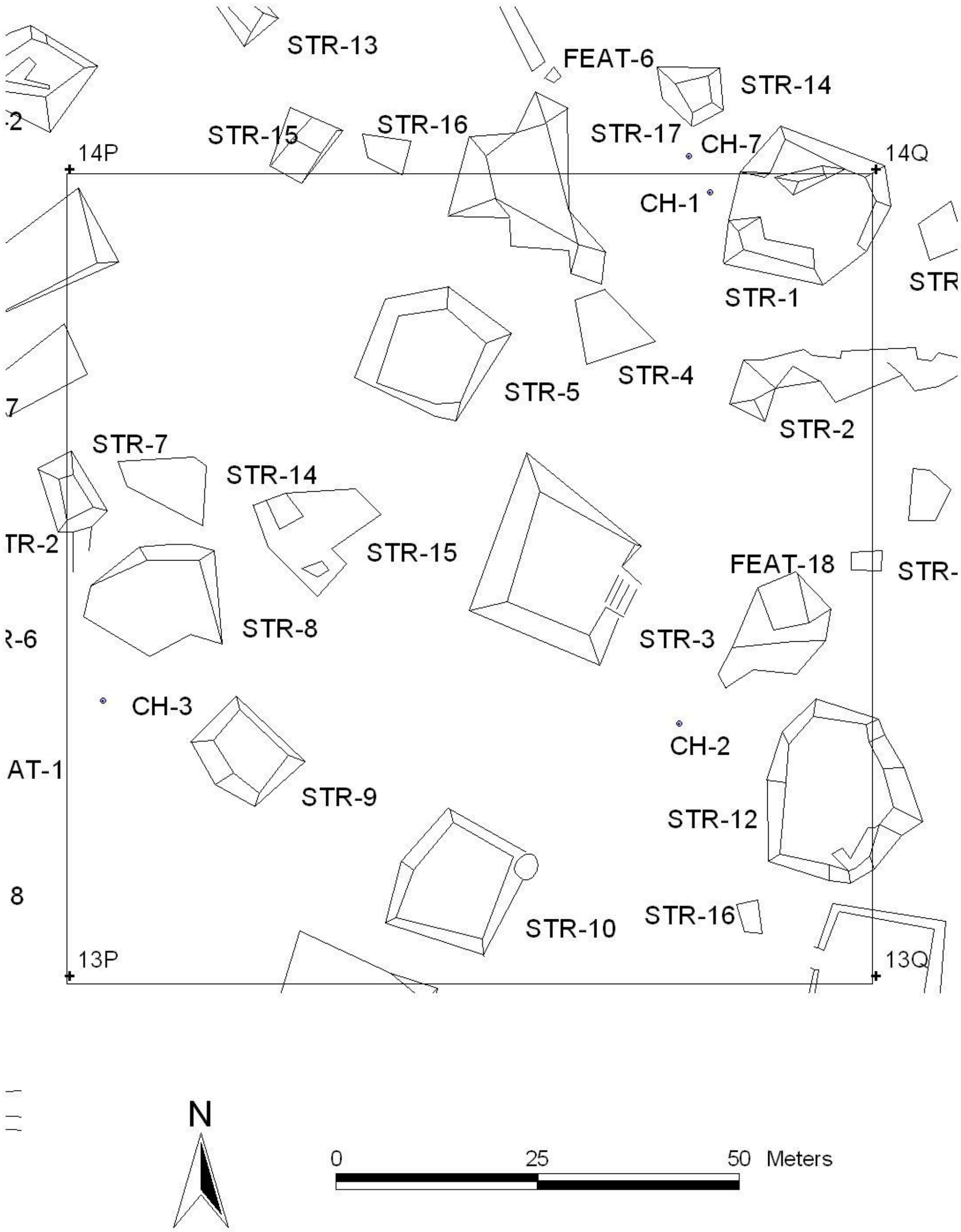

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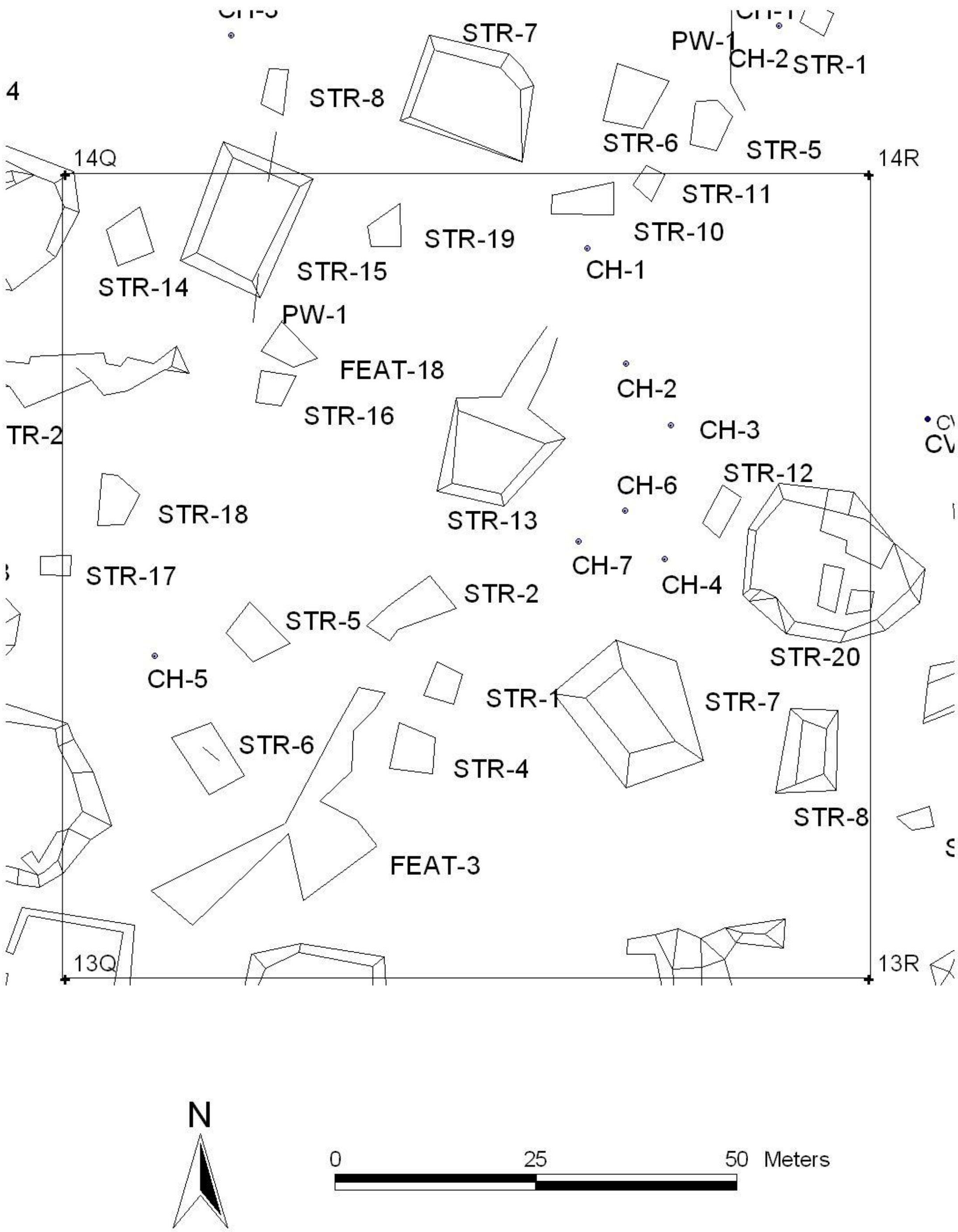

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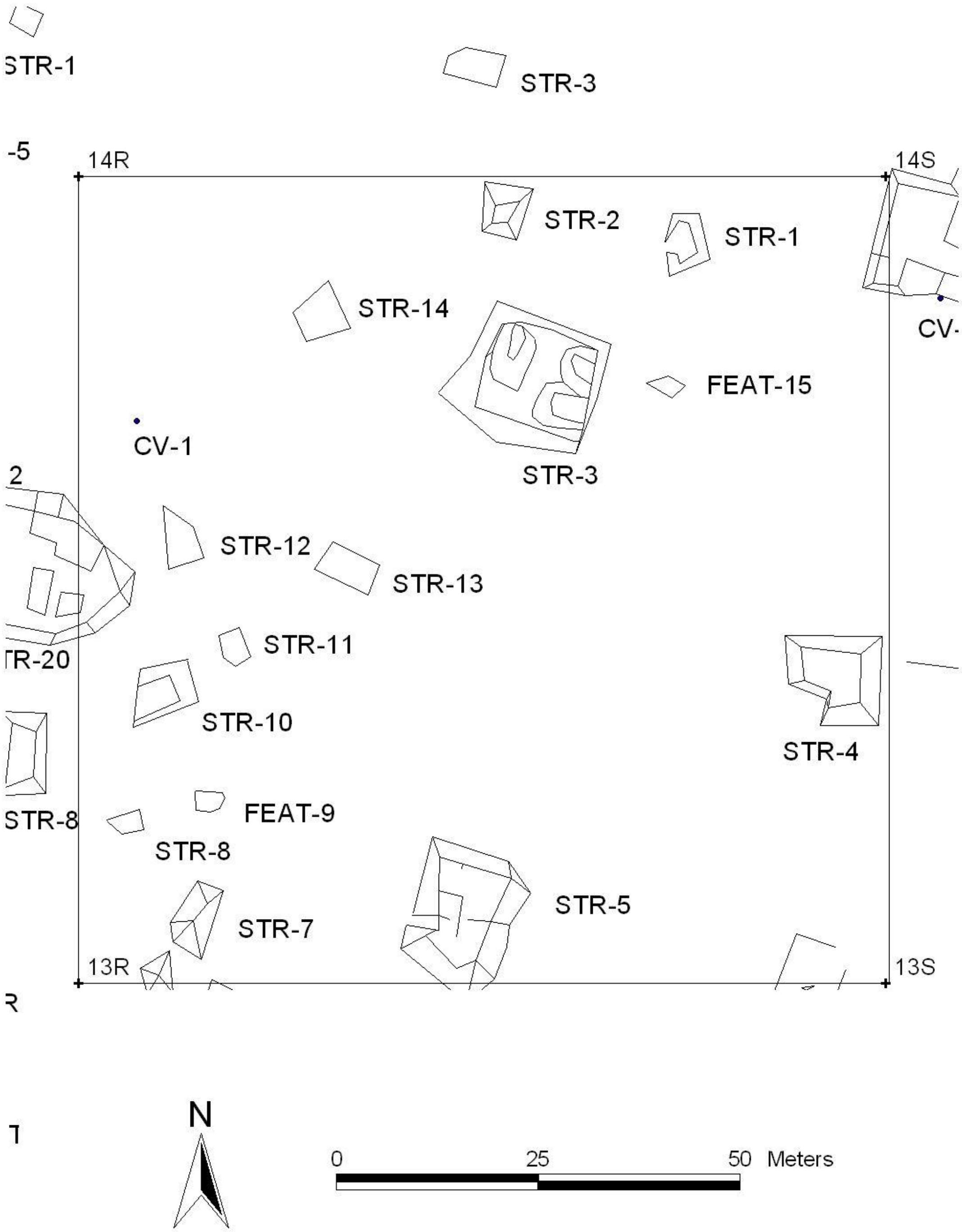

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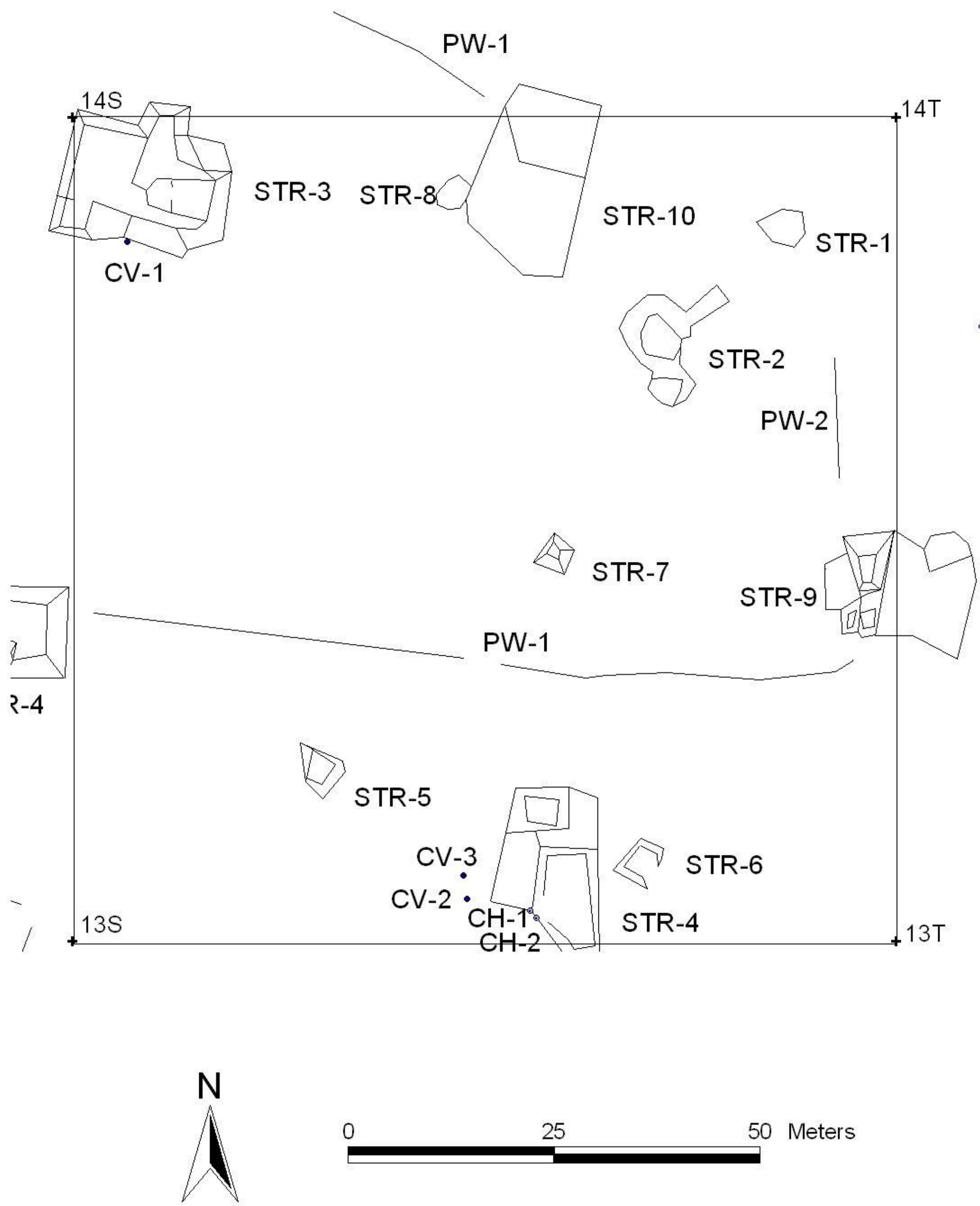

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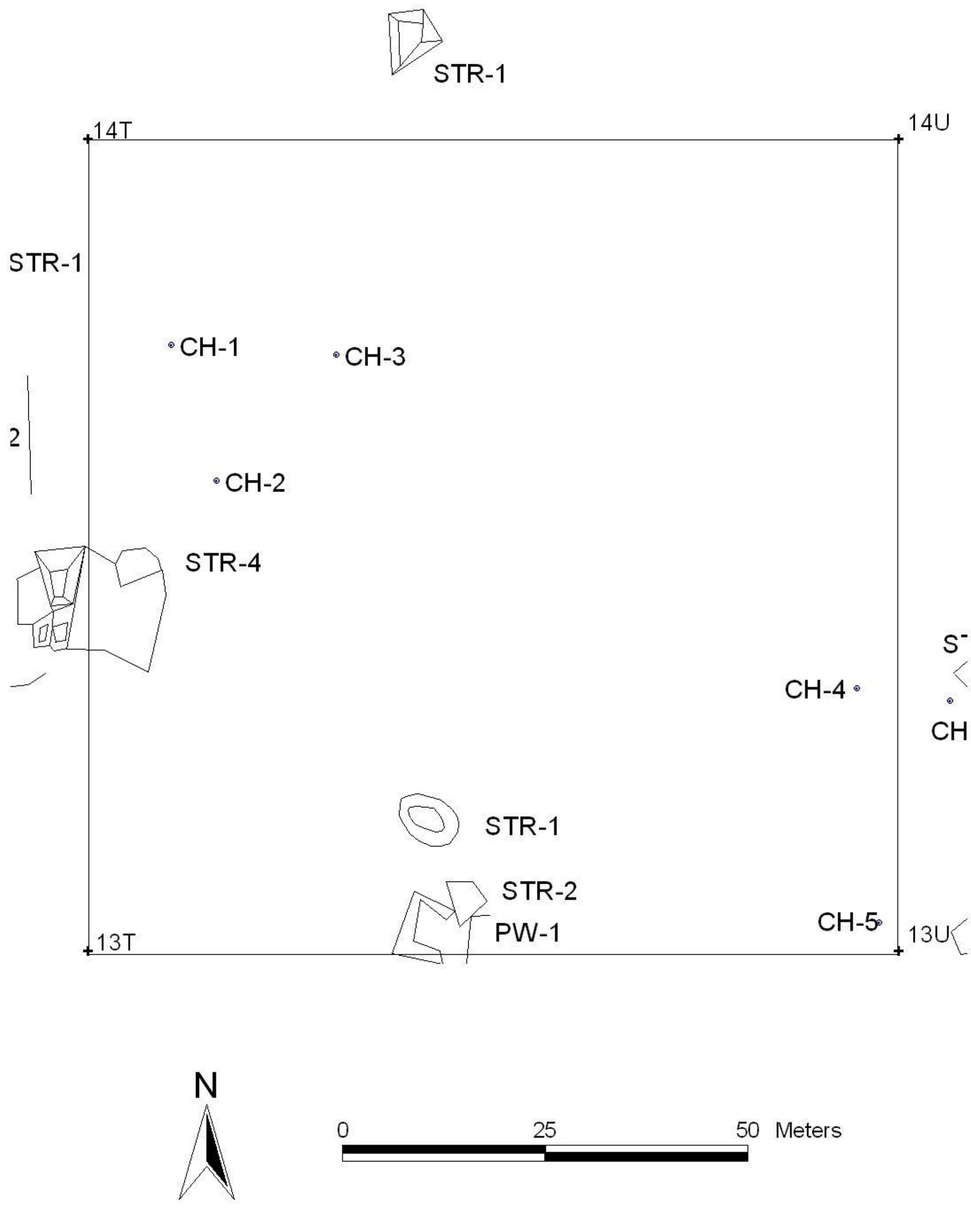

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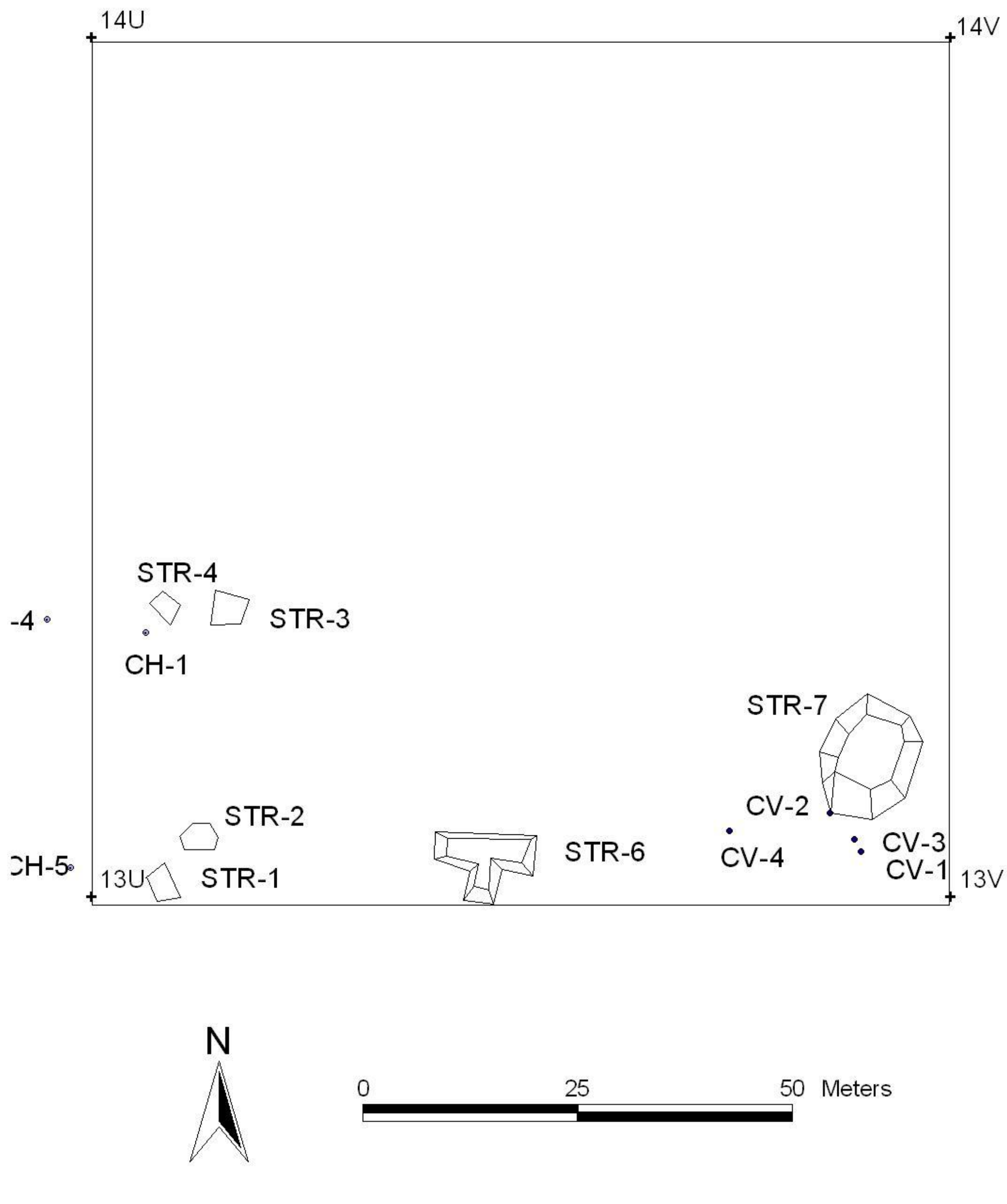

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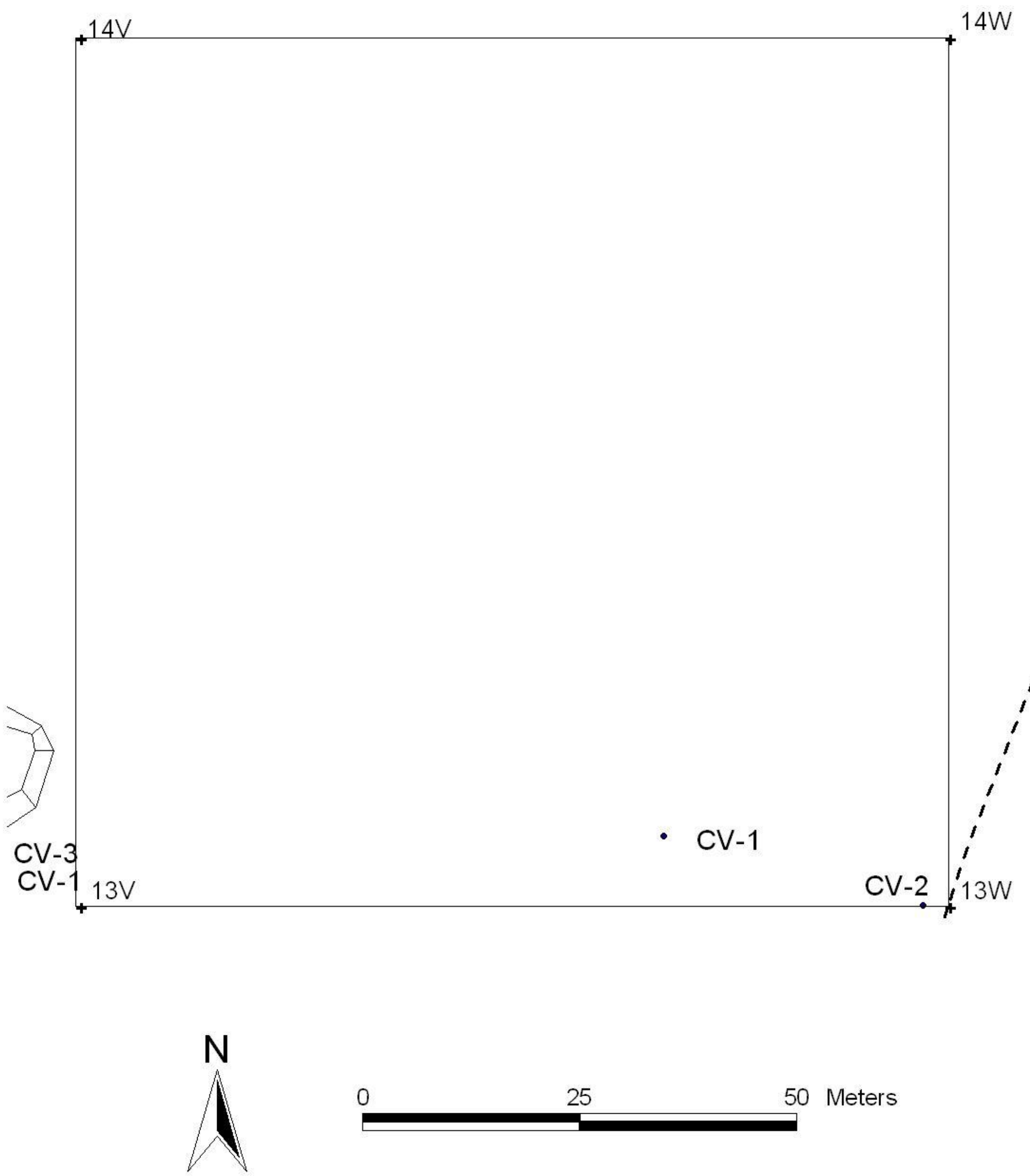

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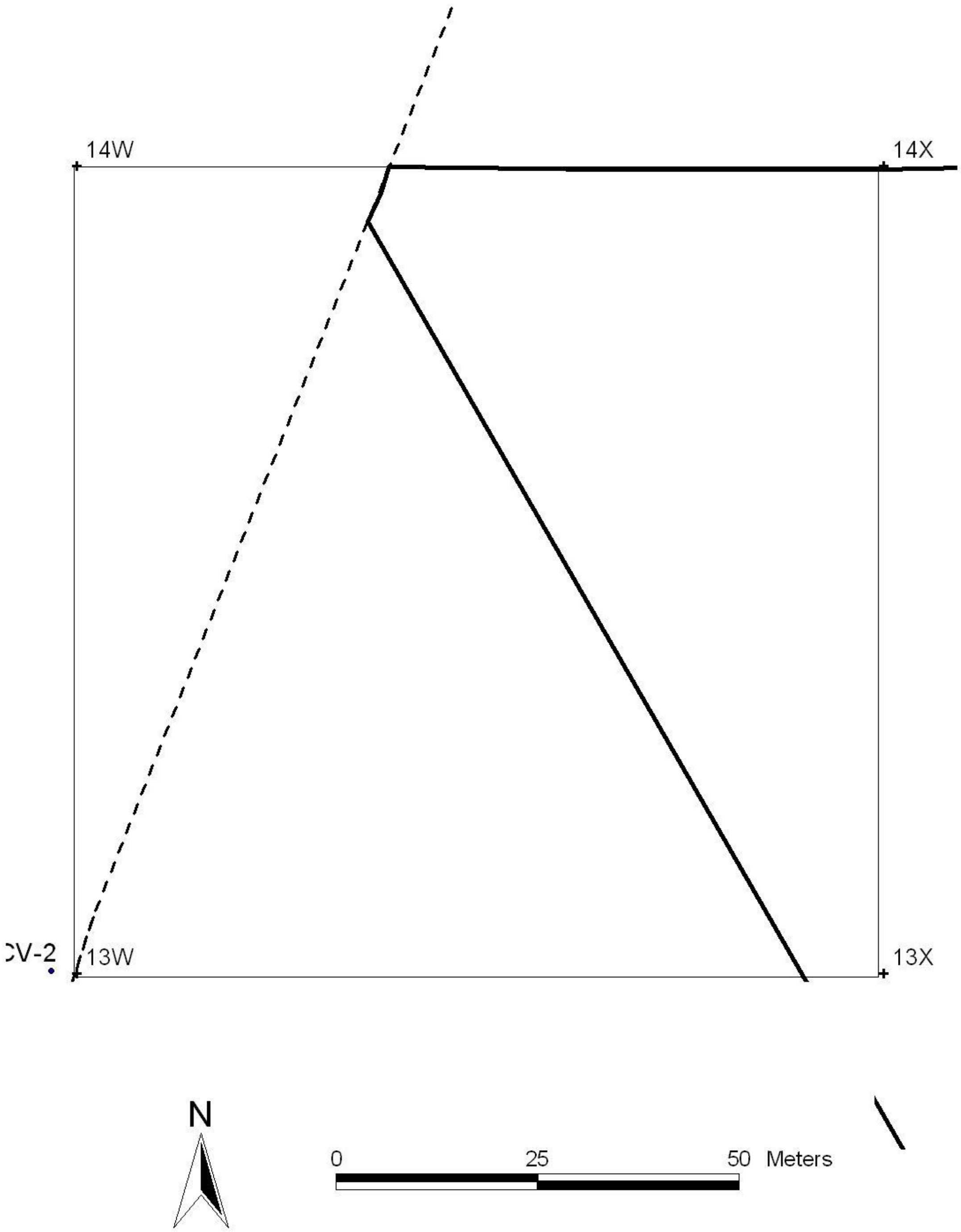

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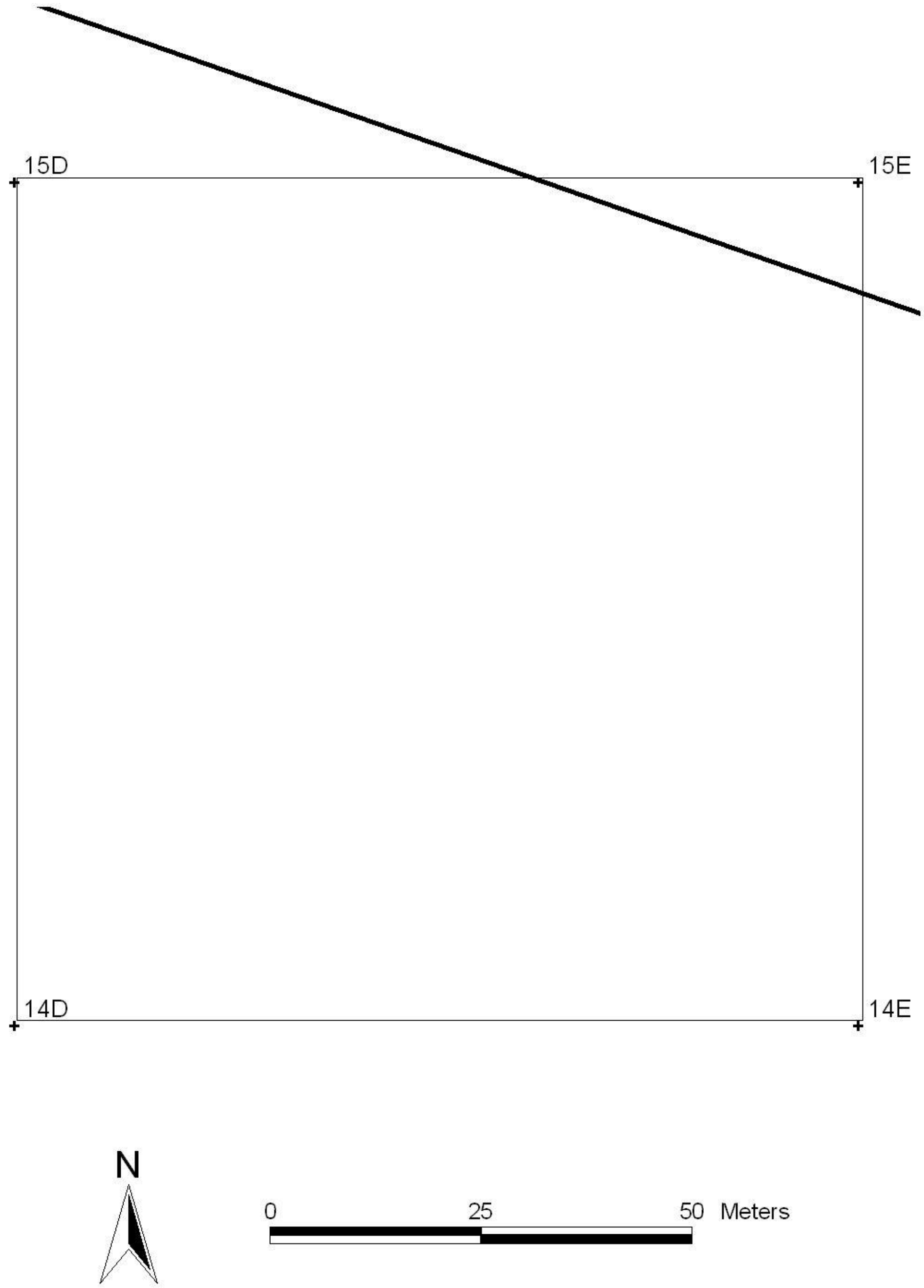
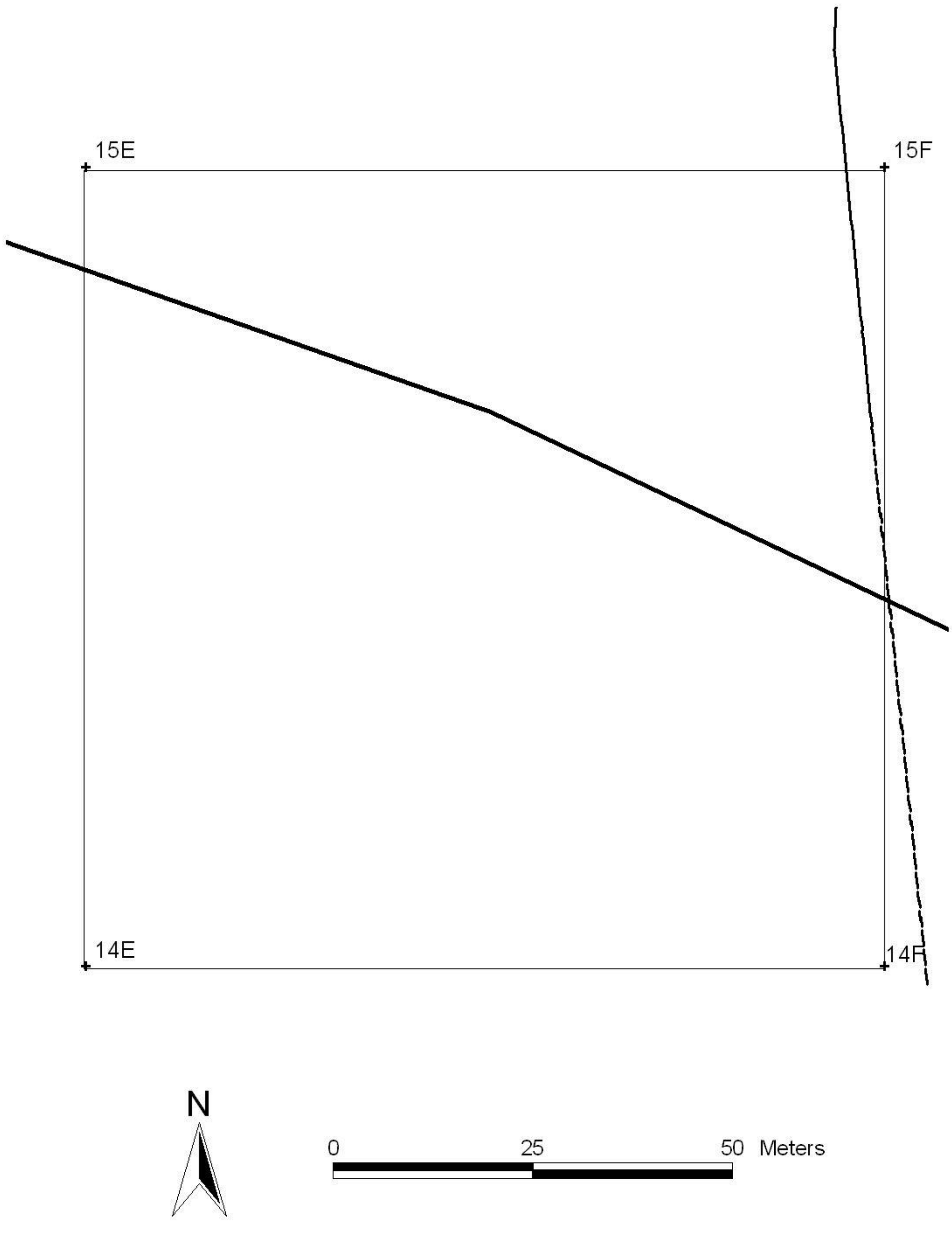


Figure B.91. Map of Section 14D.



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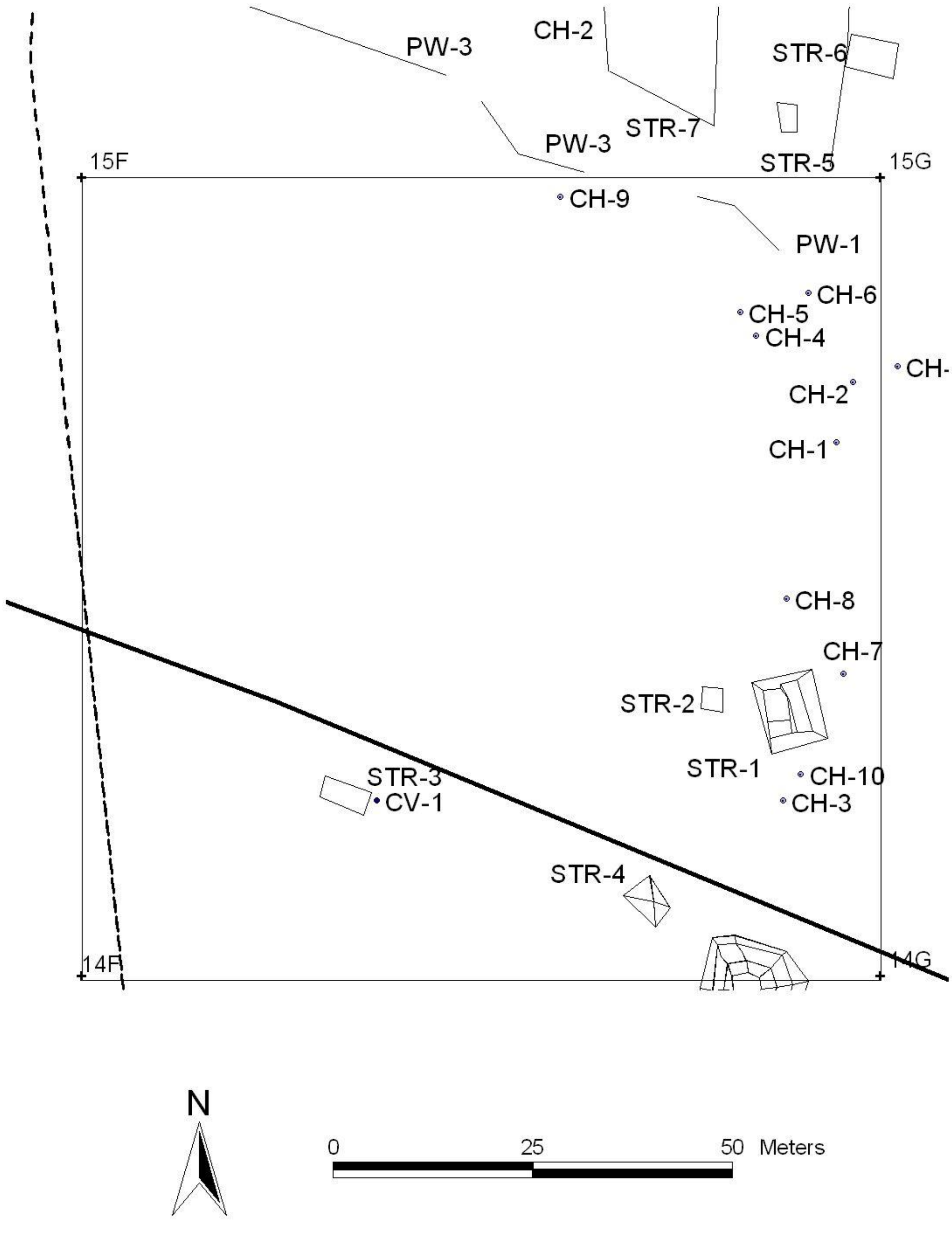
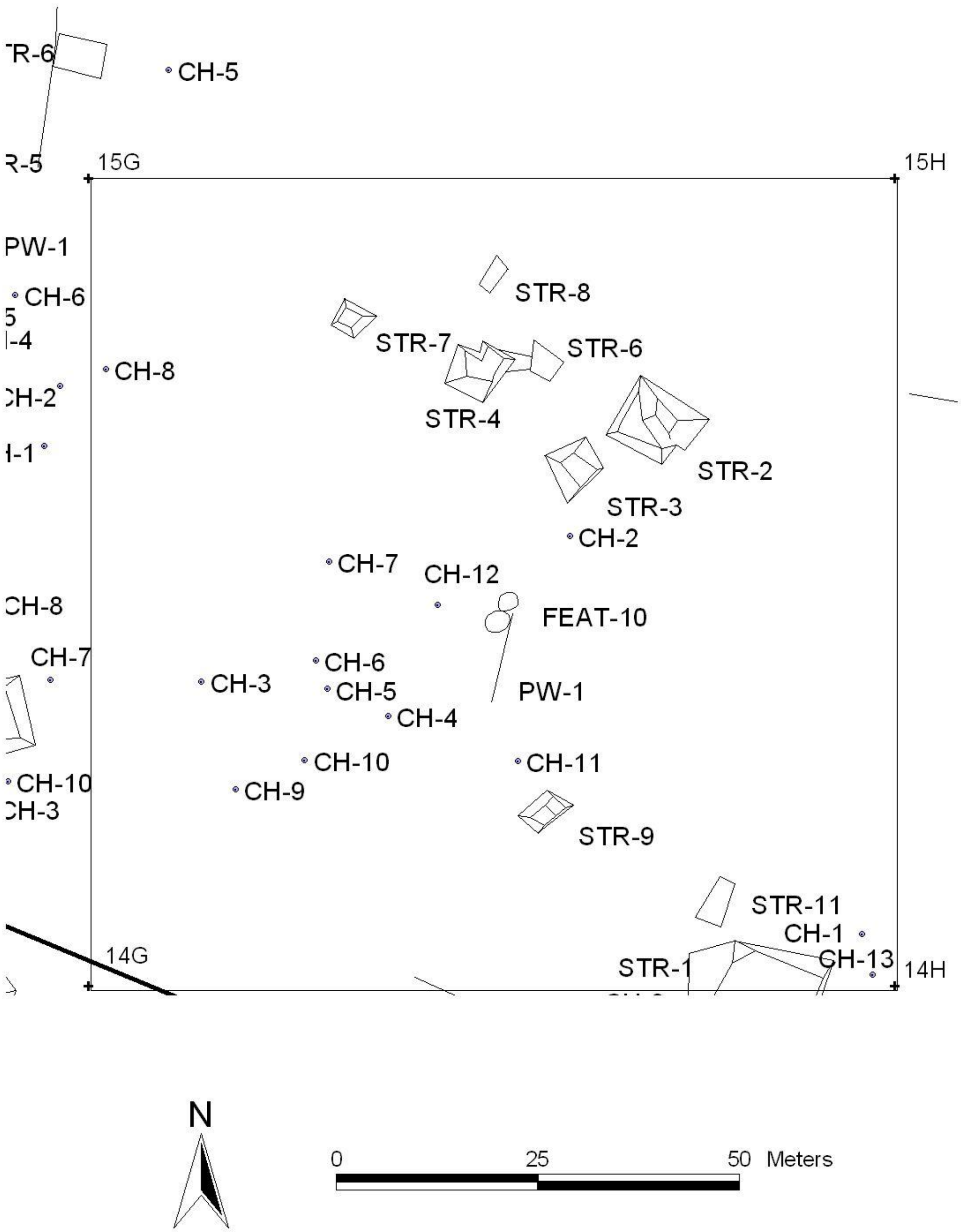


Figure B.93. Map of Section 14F.



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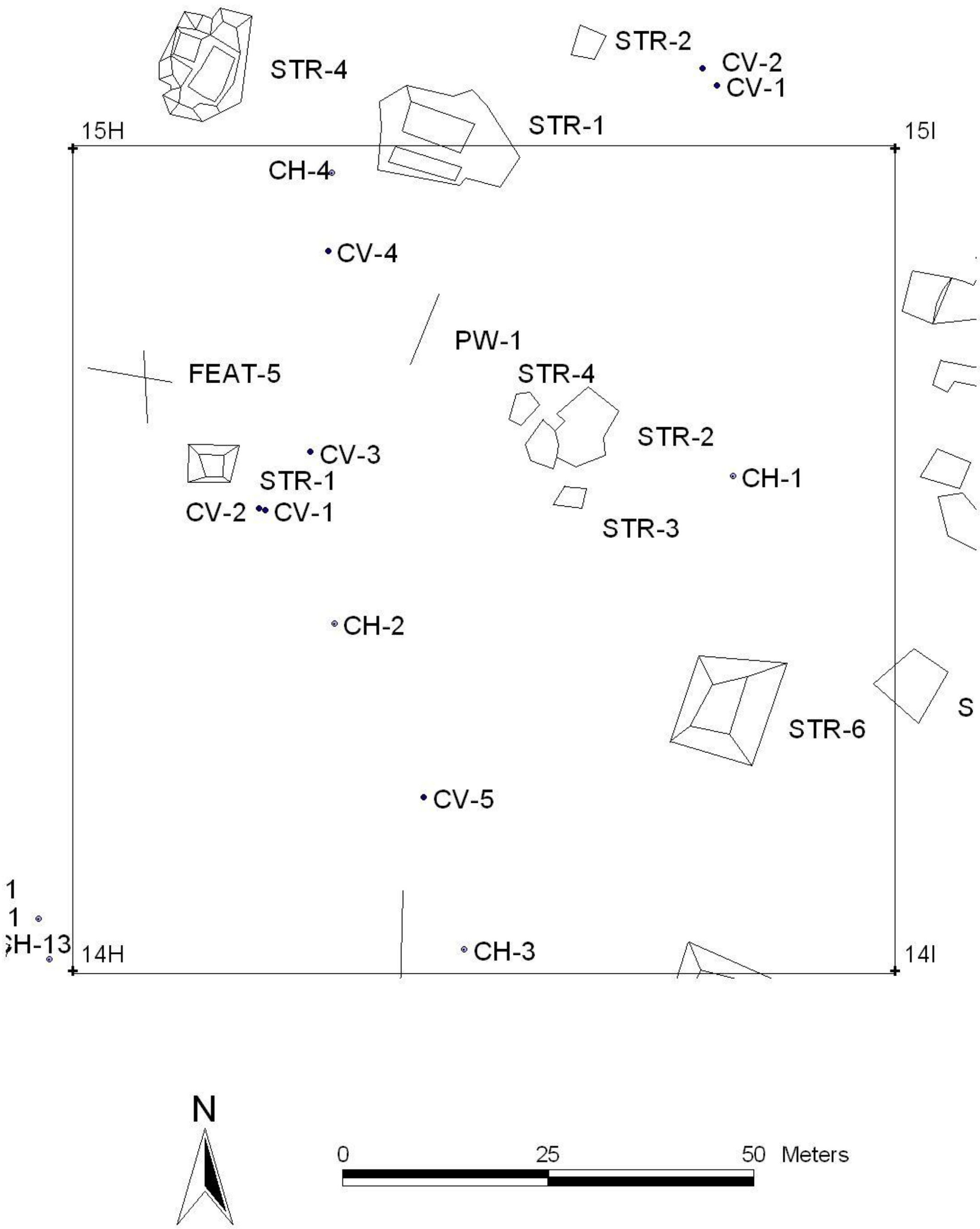

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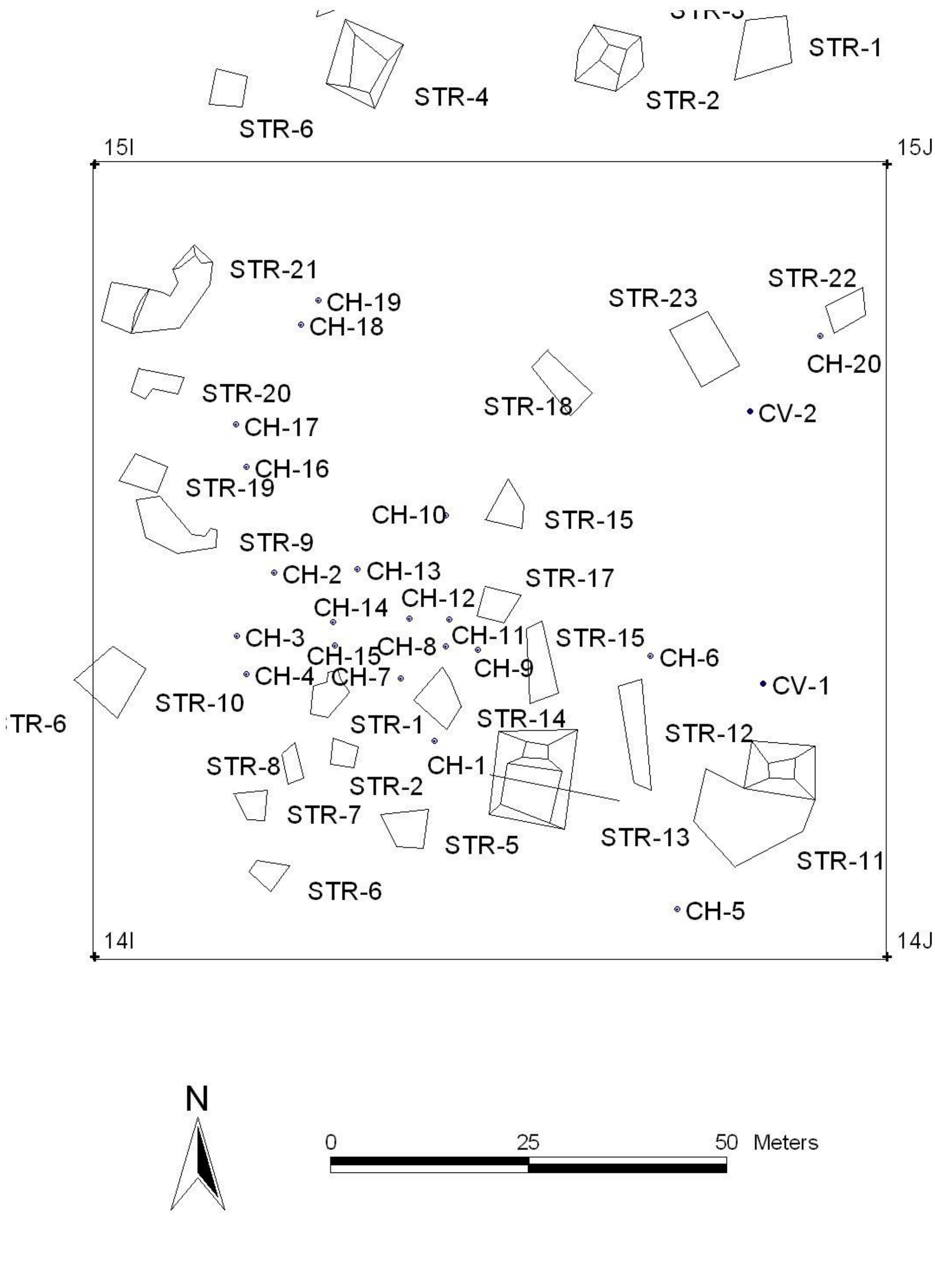

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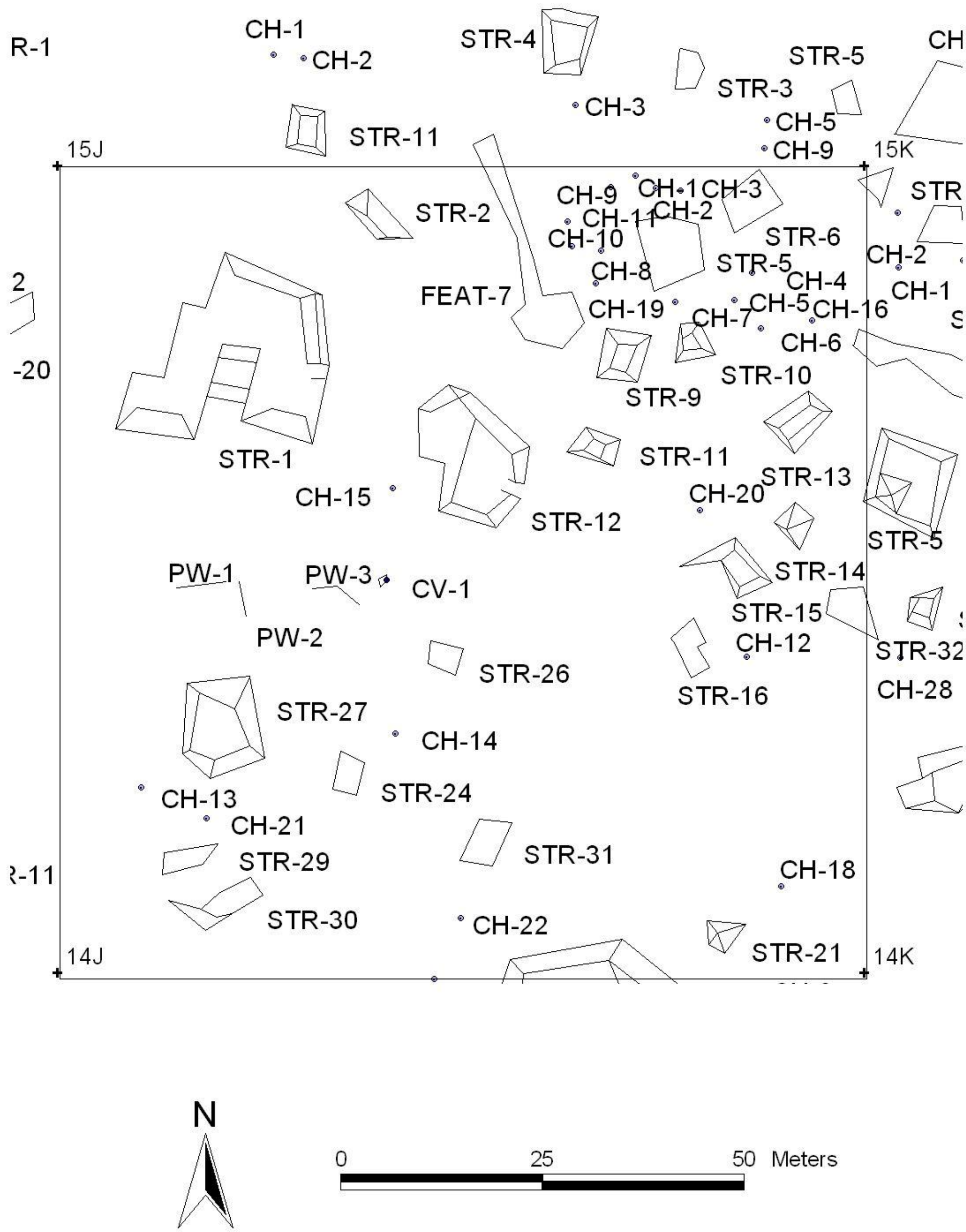

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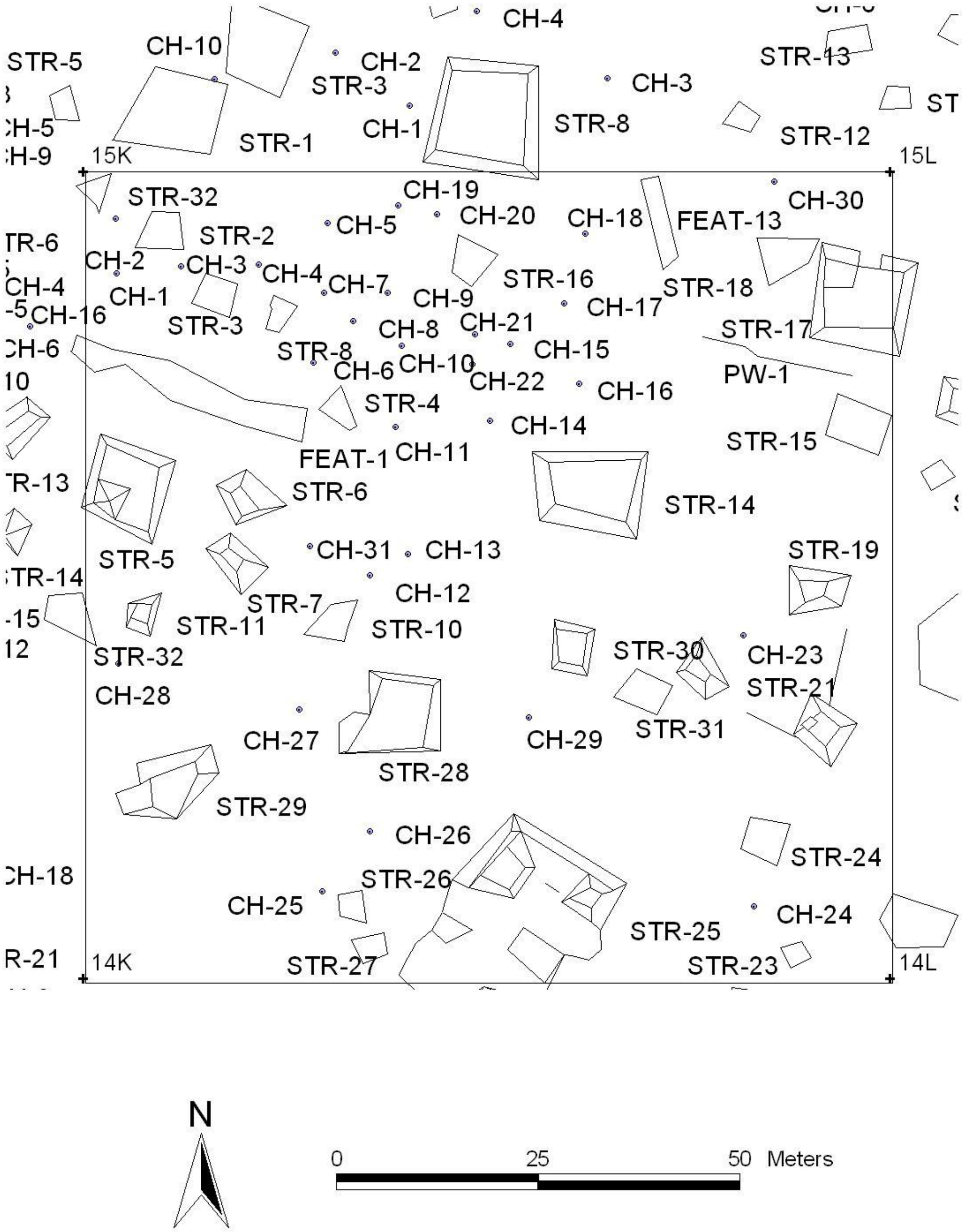

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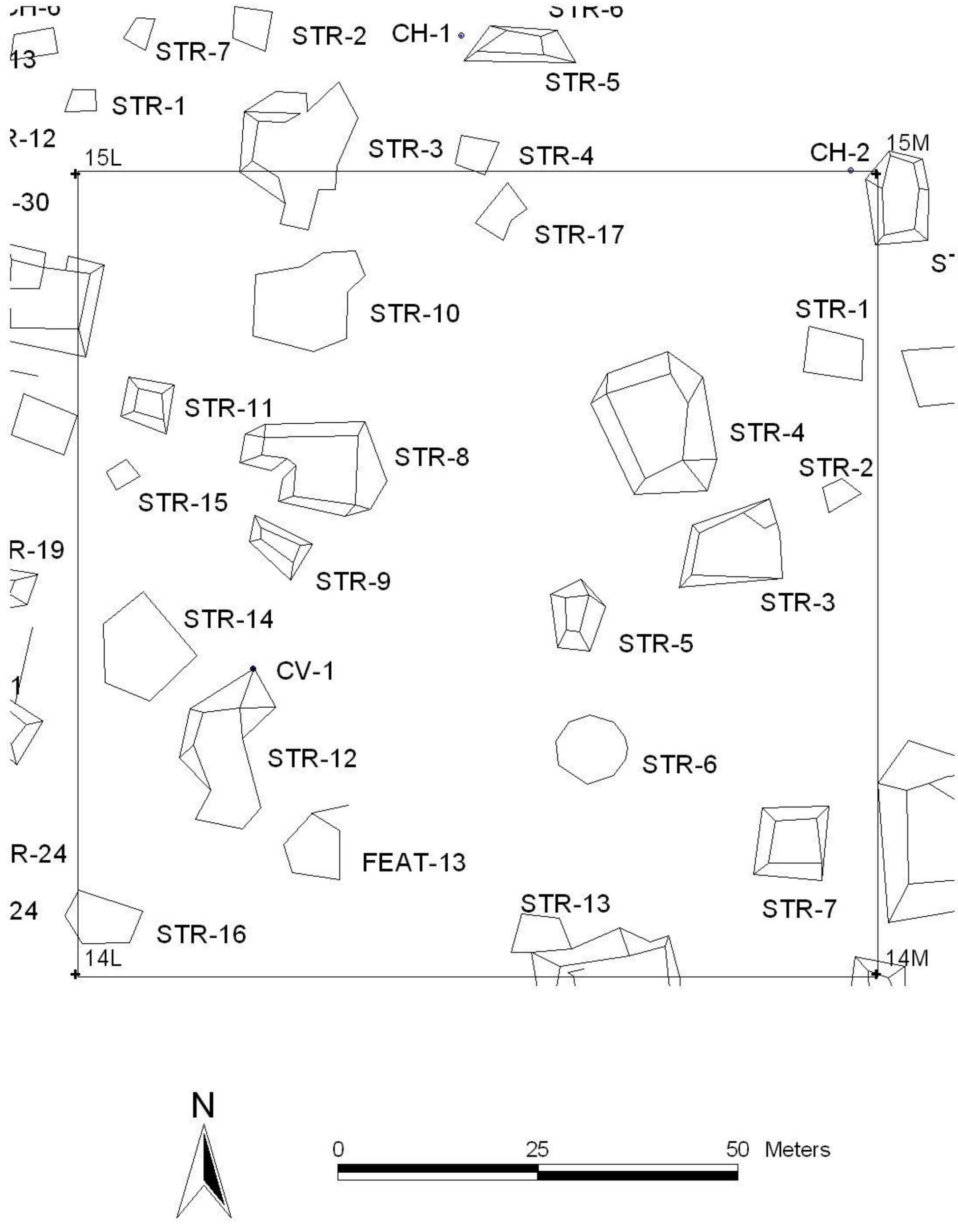

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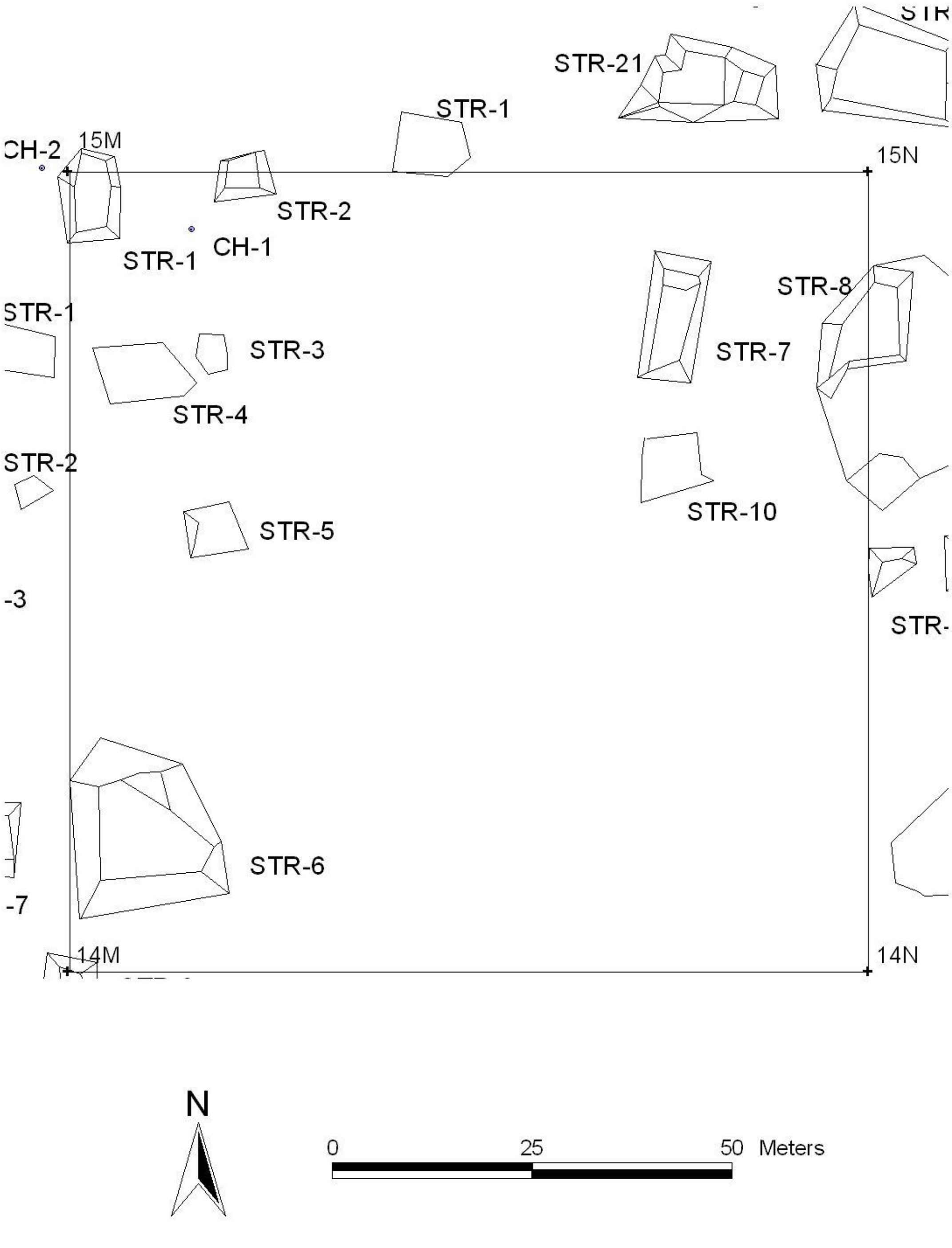


Figure B.100. Map of Section 14M.

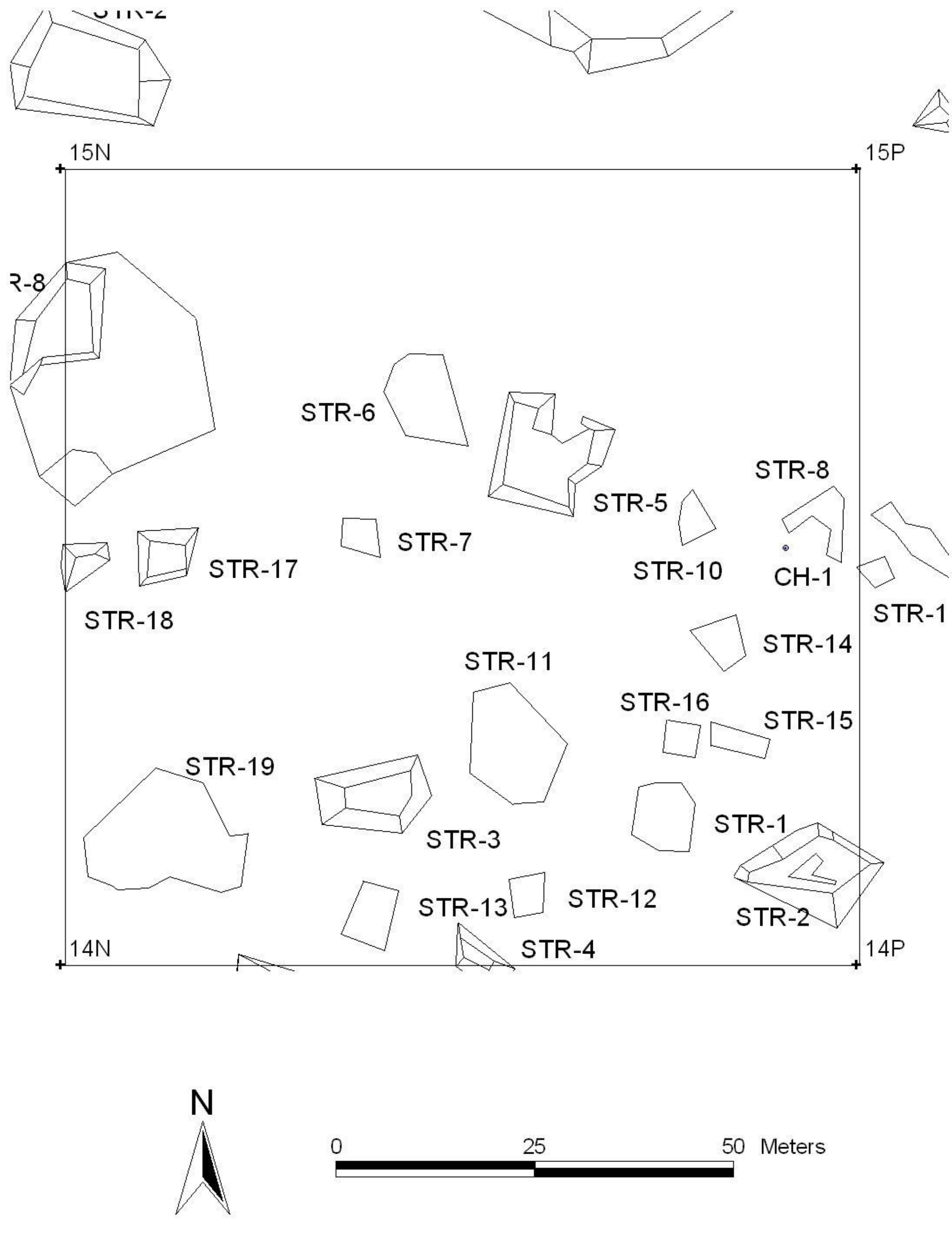


Figure B.101. Map of Section 14N.

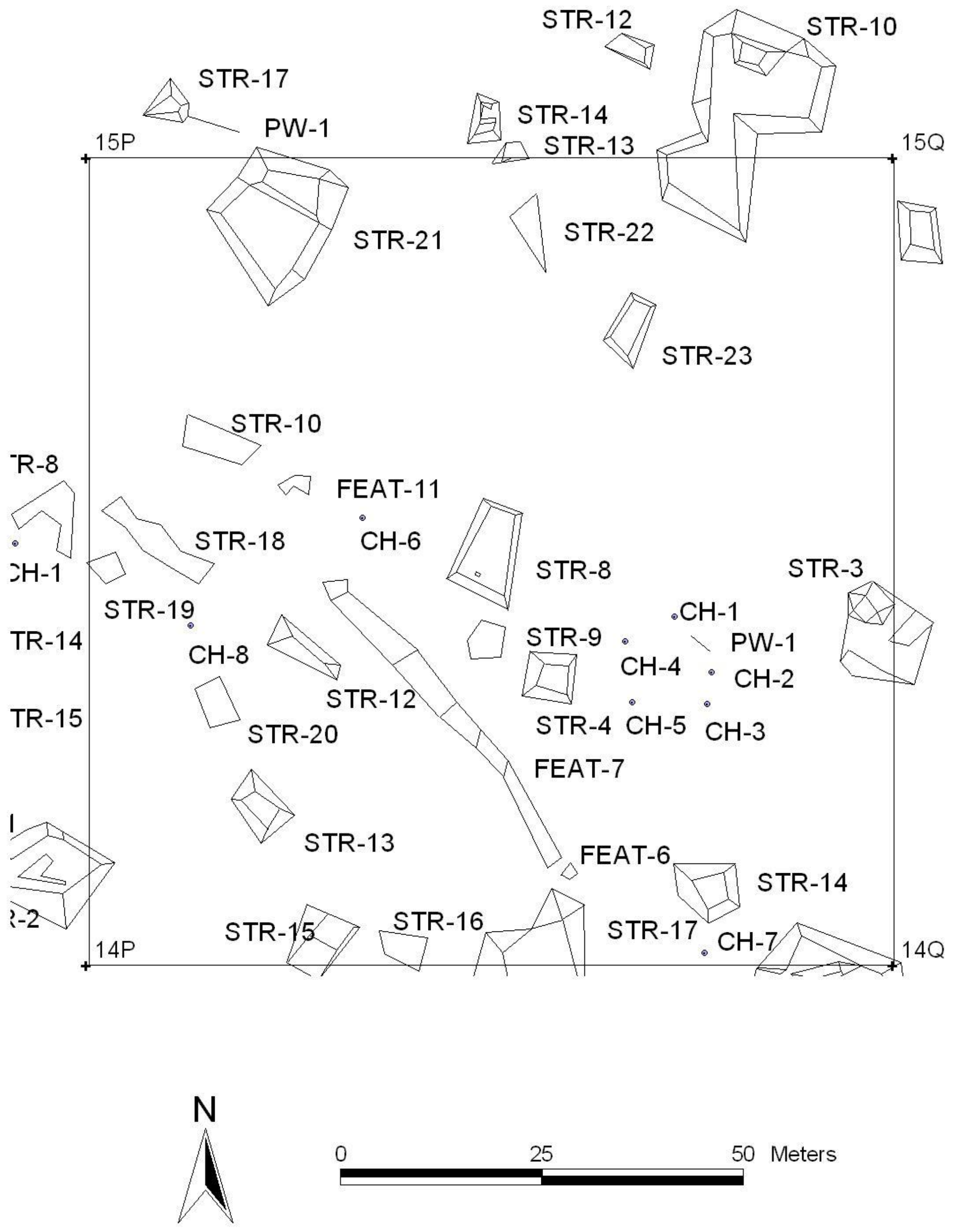
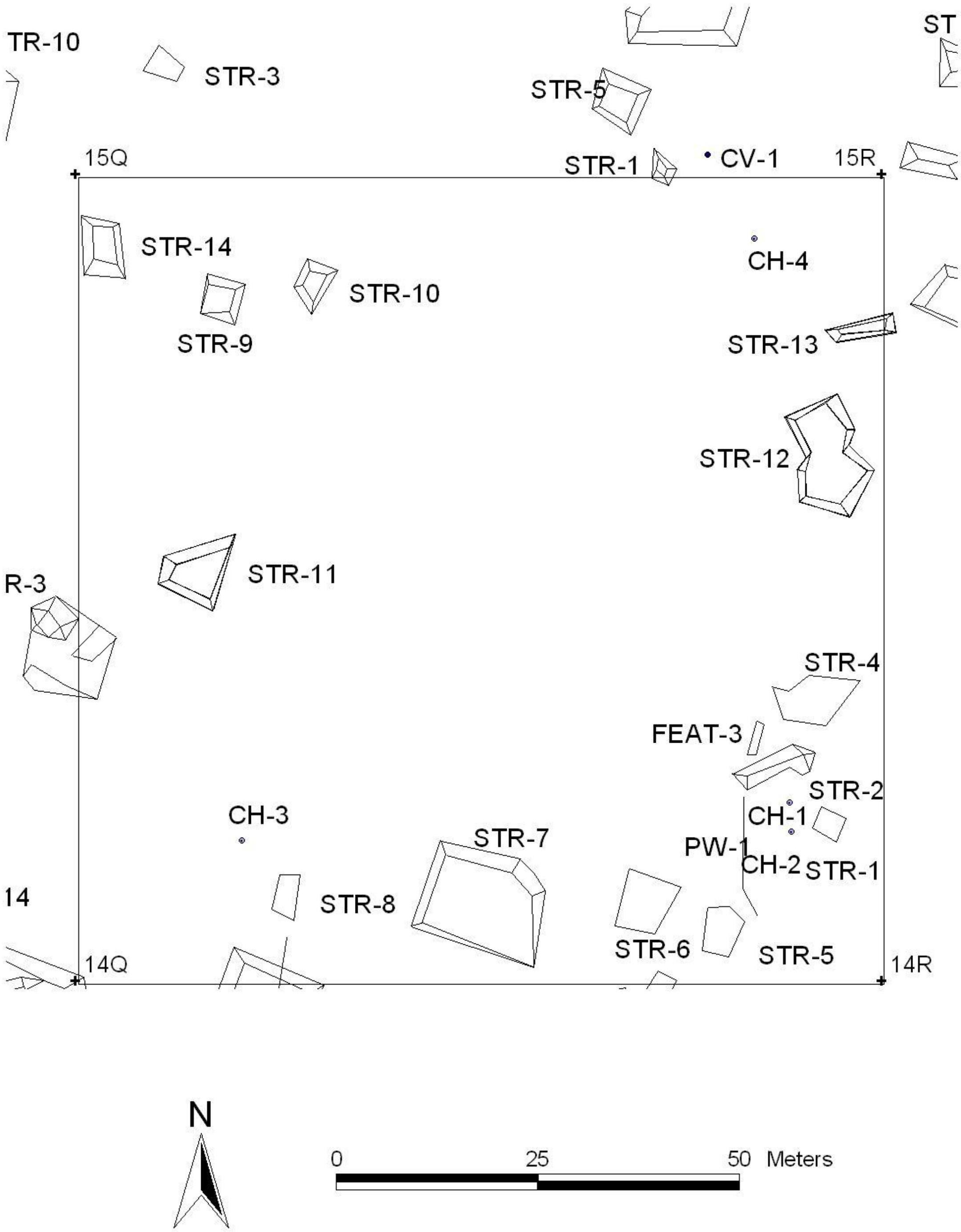


Figure B.102. Map of Section 14P.



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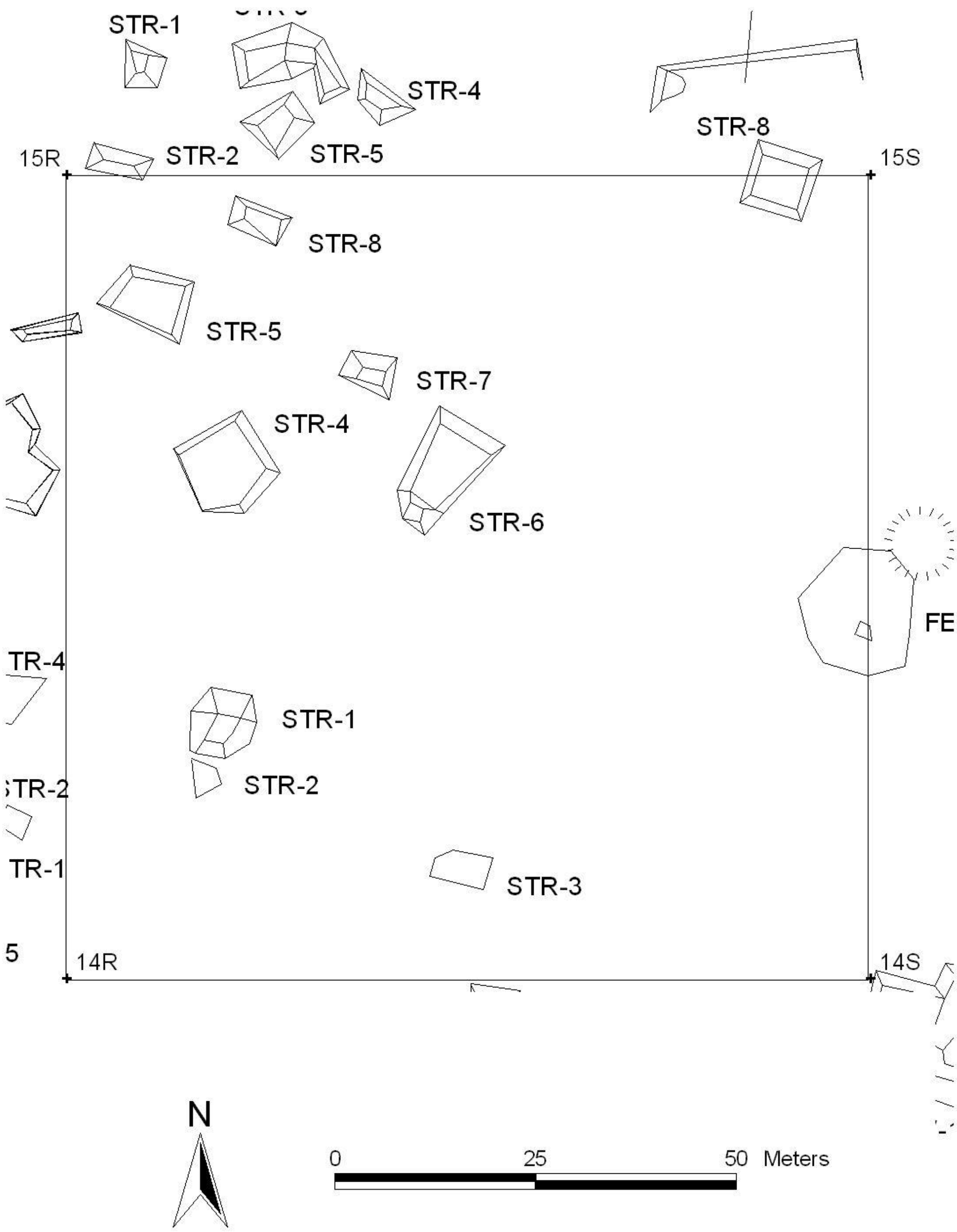


Figure B.104. Map of Section 14R.

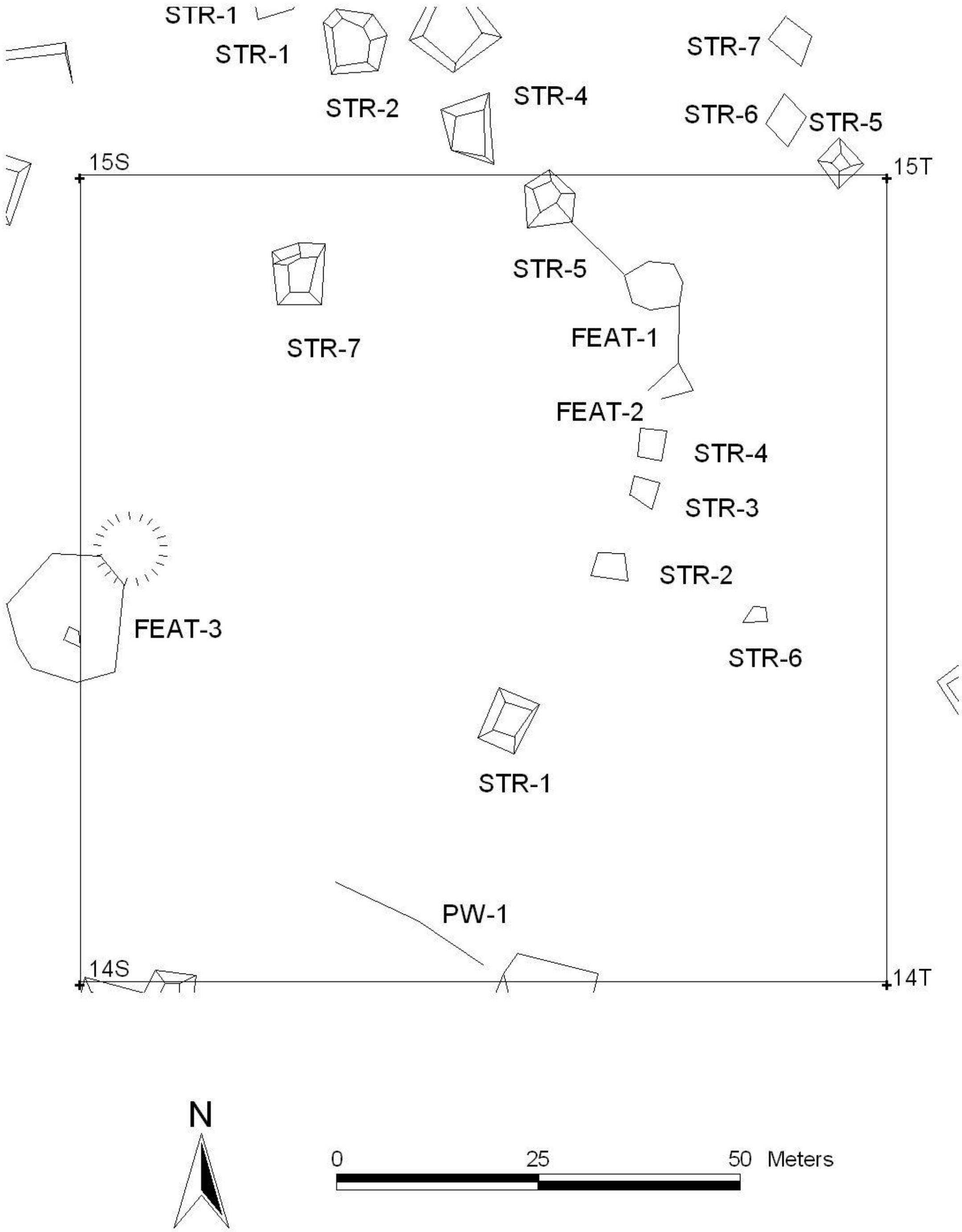


Figure B.105. Map of Section 14S.

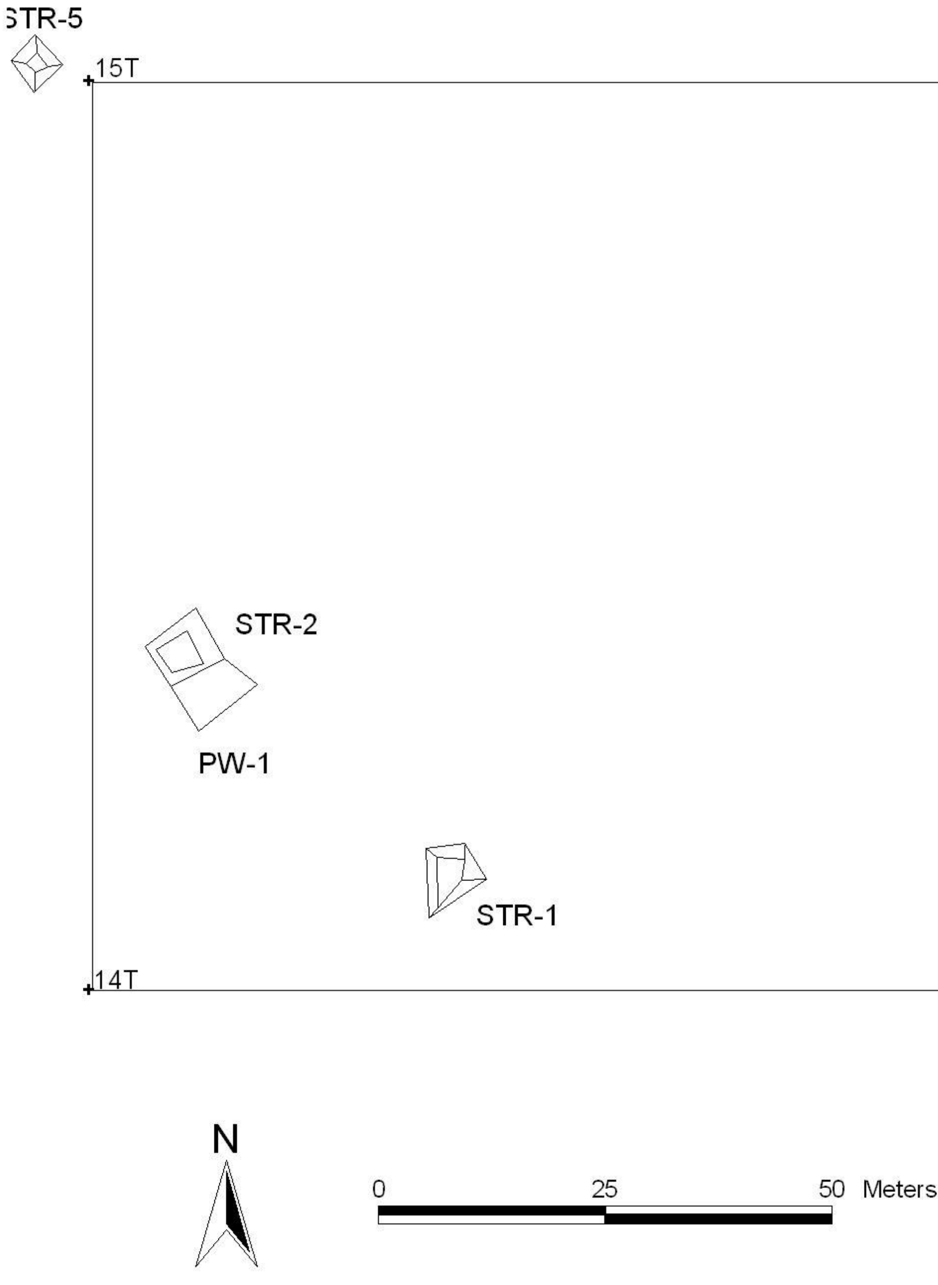


Figure B.106. Map of Section 14T.

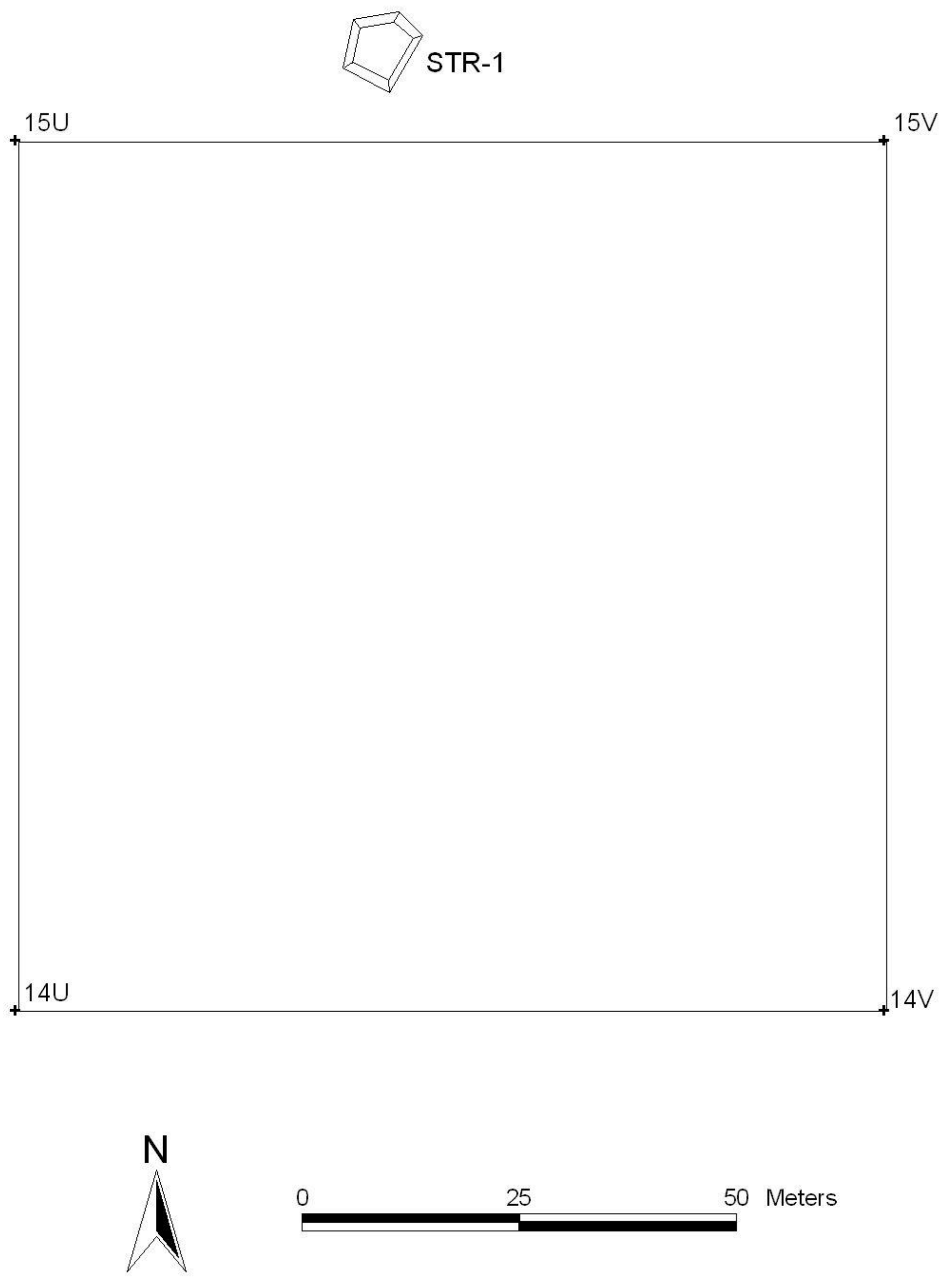


Figure B.107. Map of Section 14U.

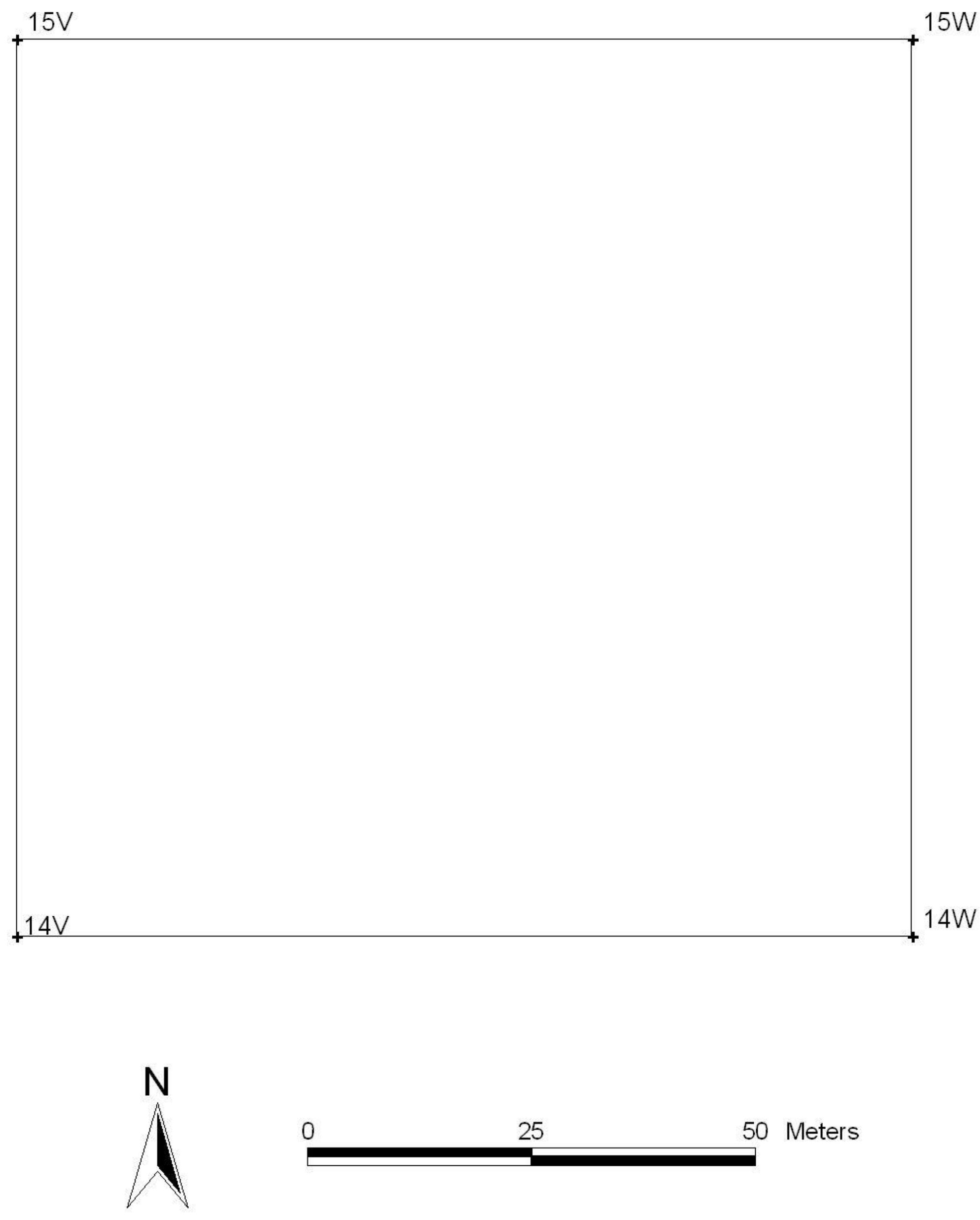


Figure B.108. Map of Section 14V.

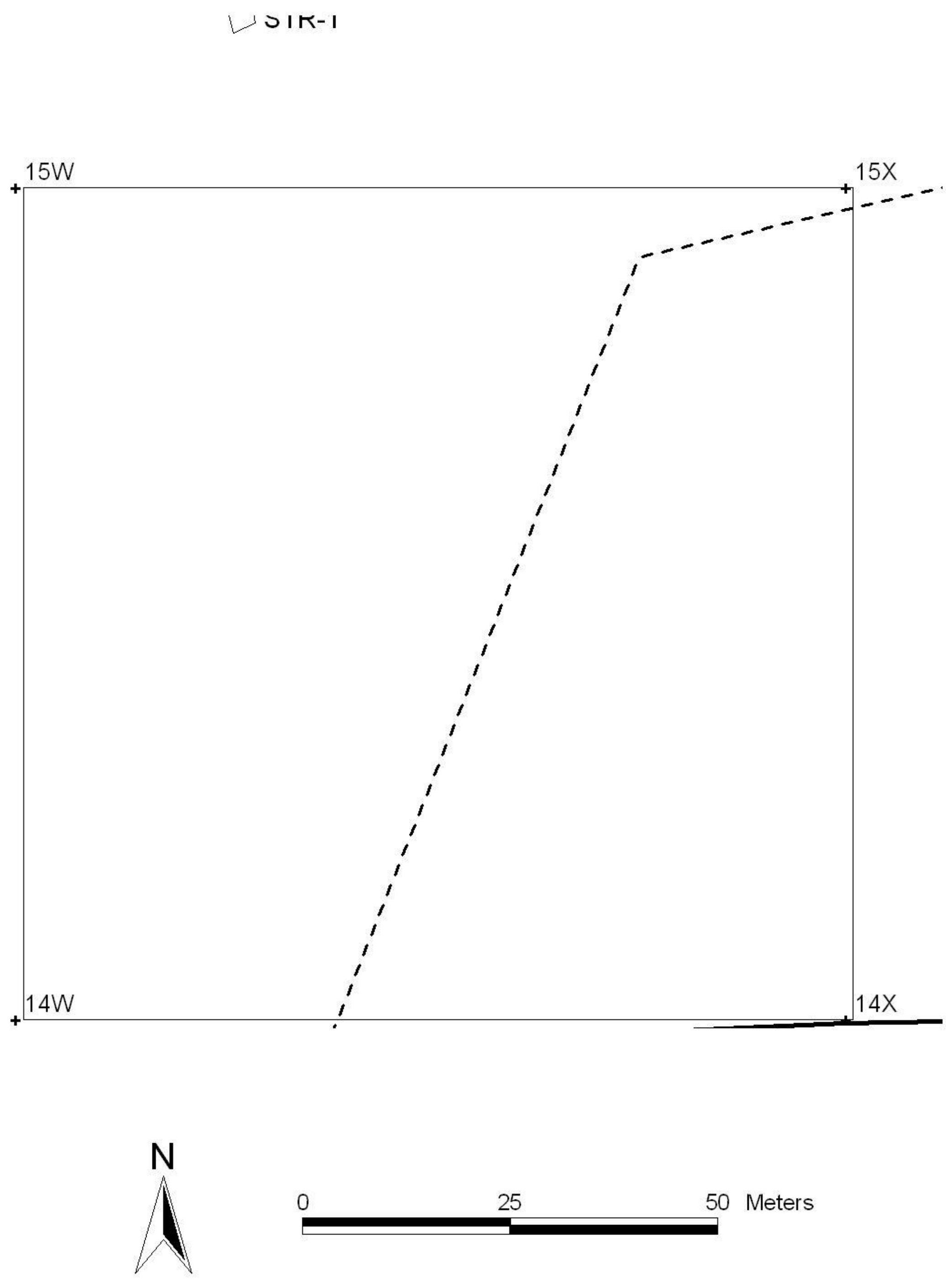


Figure B.109. Map of Section 14W.

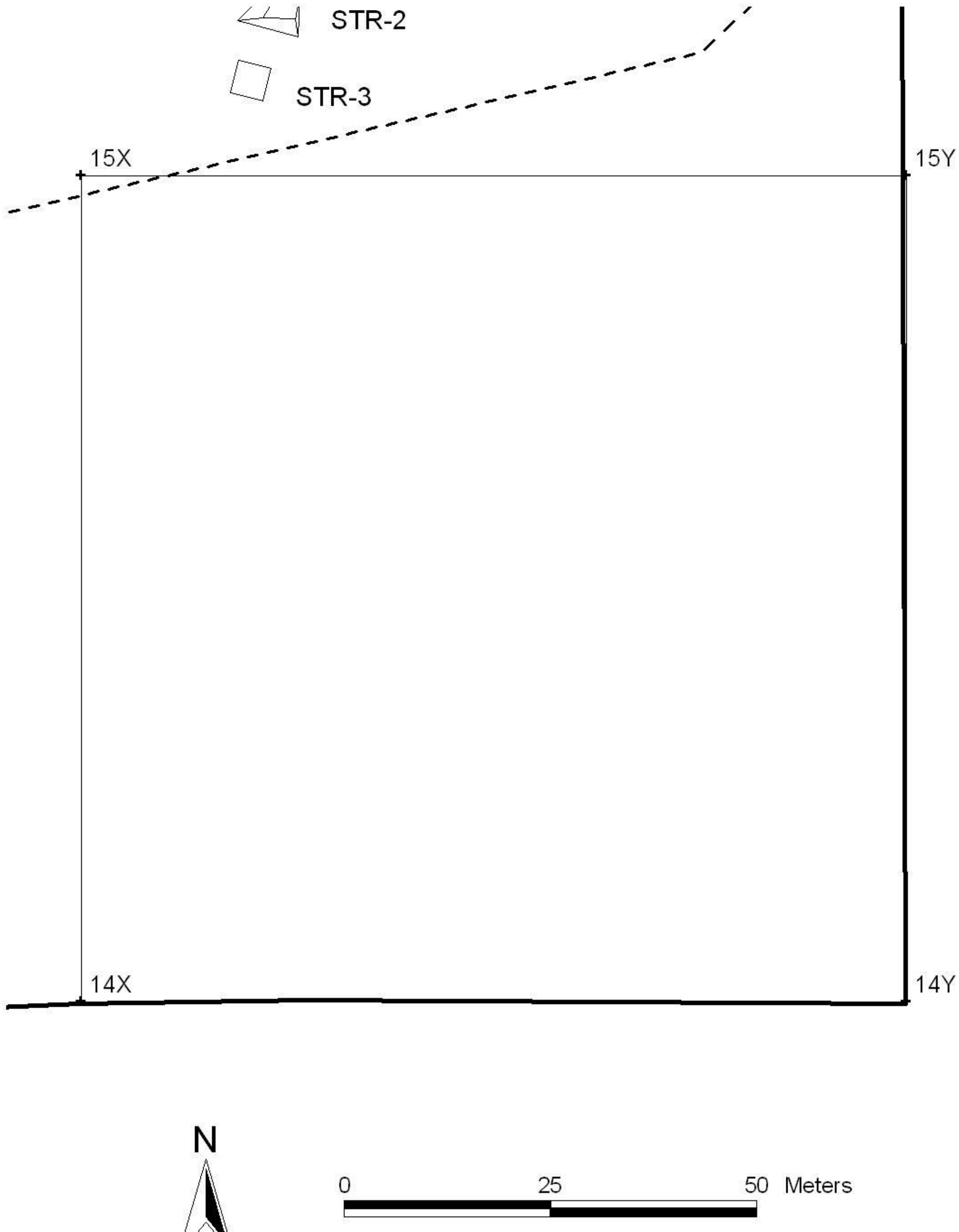


Figure B.110. Map of Section 14X.

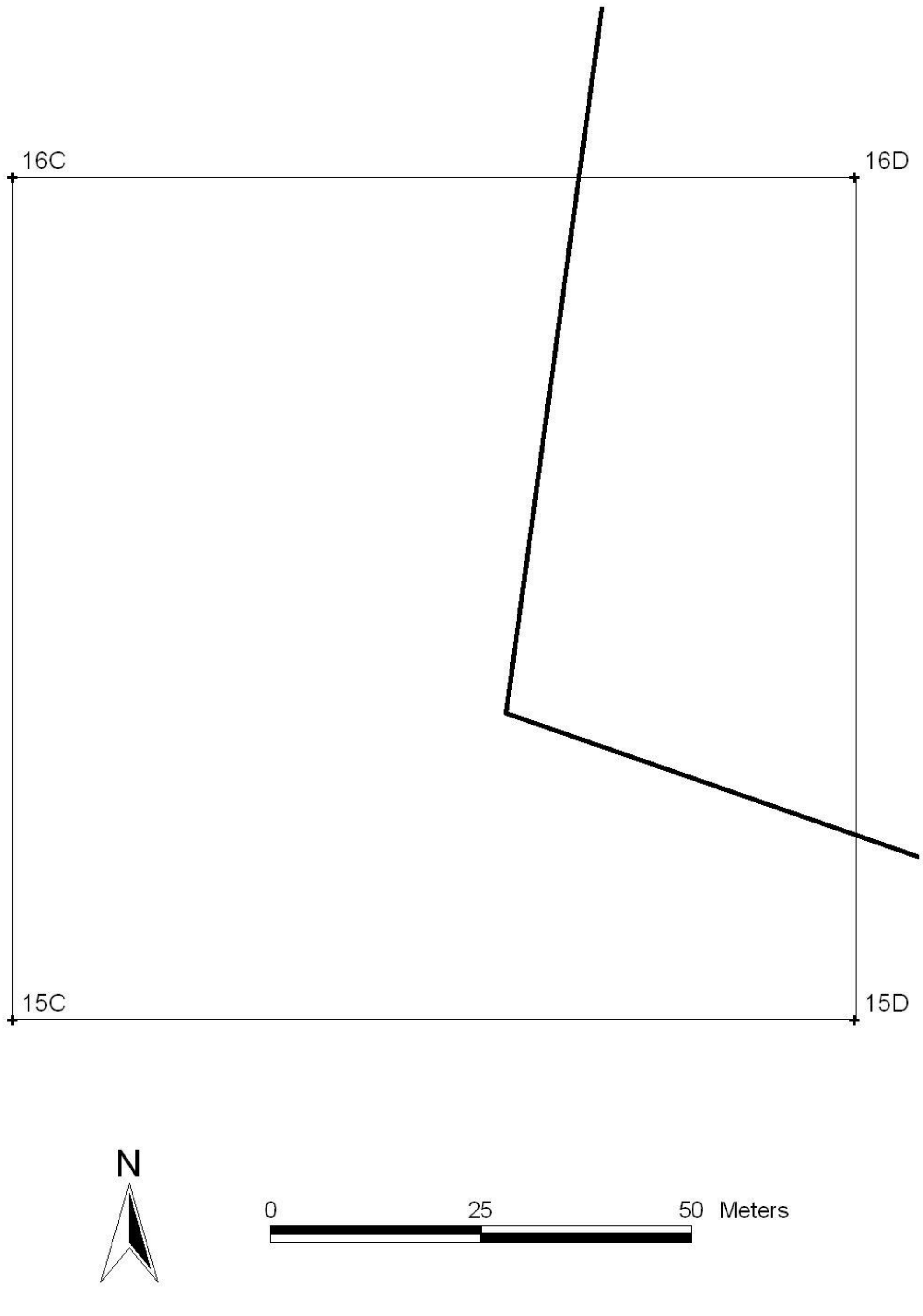


Figure B.111. Map of Section 15C.

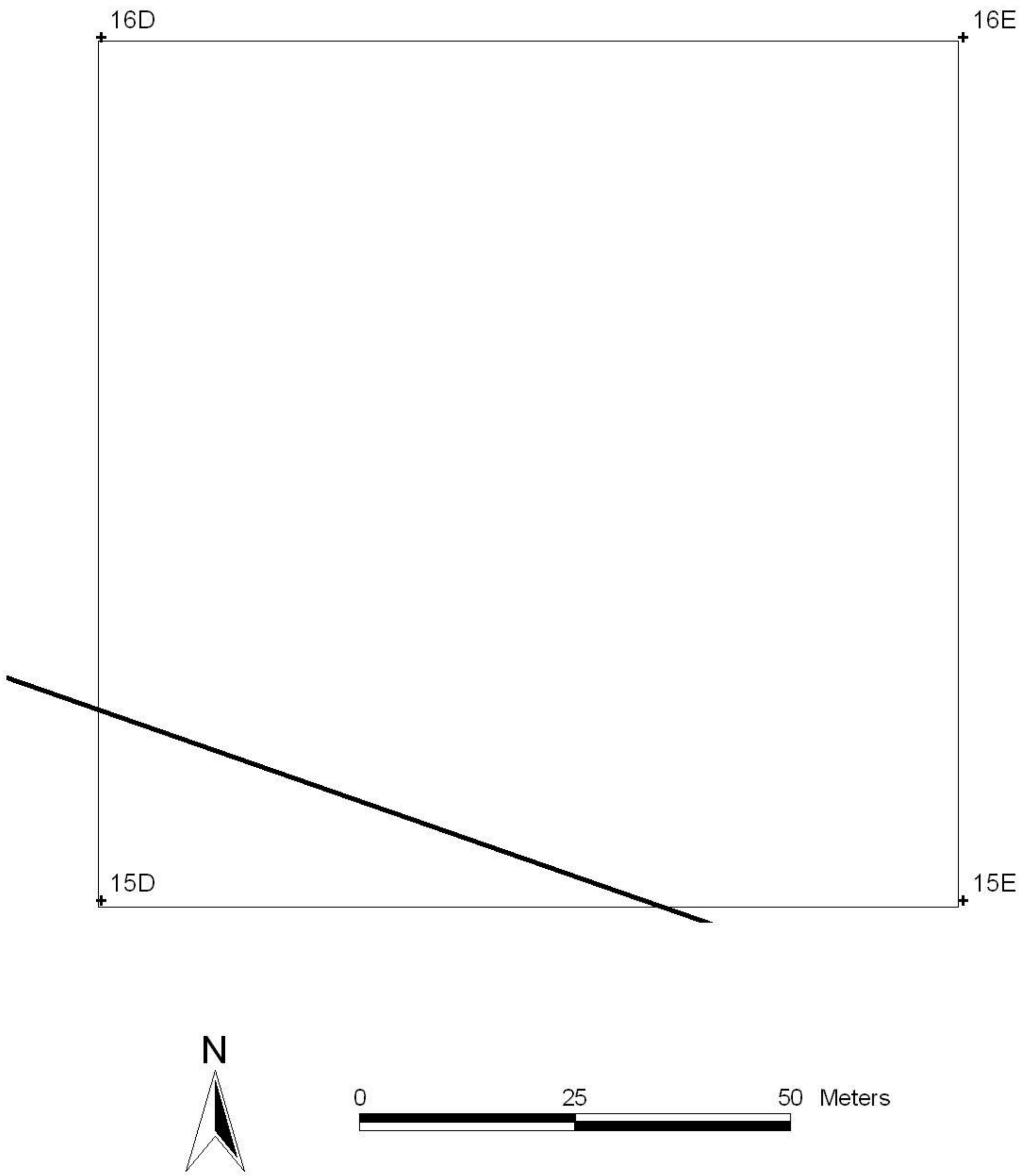


Figure B.112. Map of Section 15D.

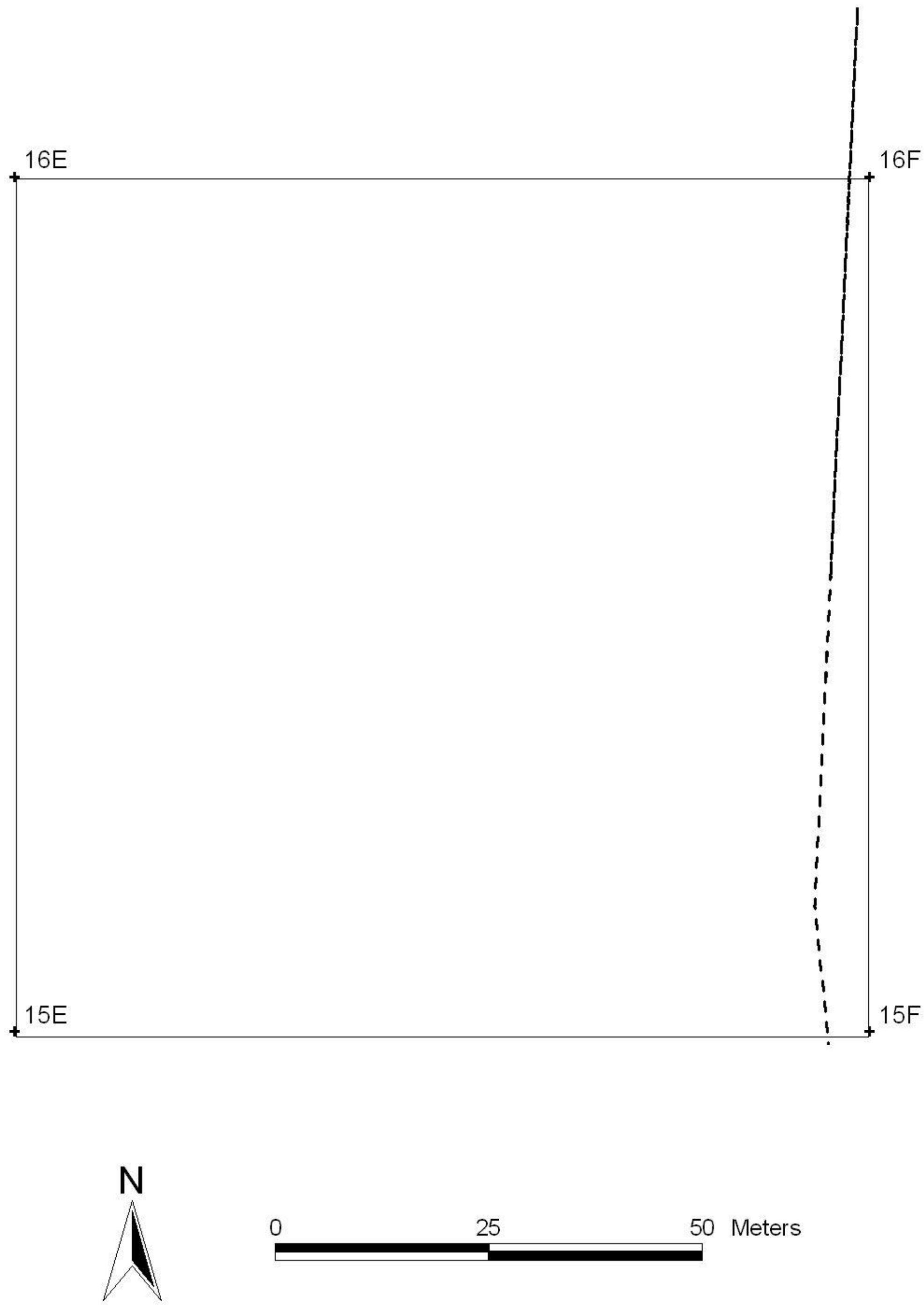


Figure B.113. Map of Section 15E.

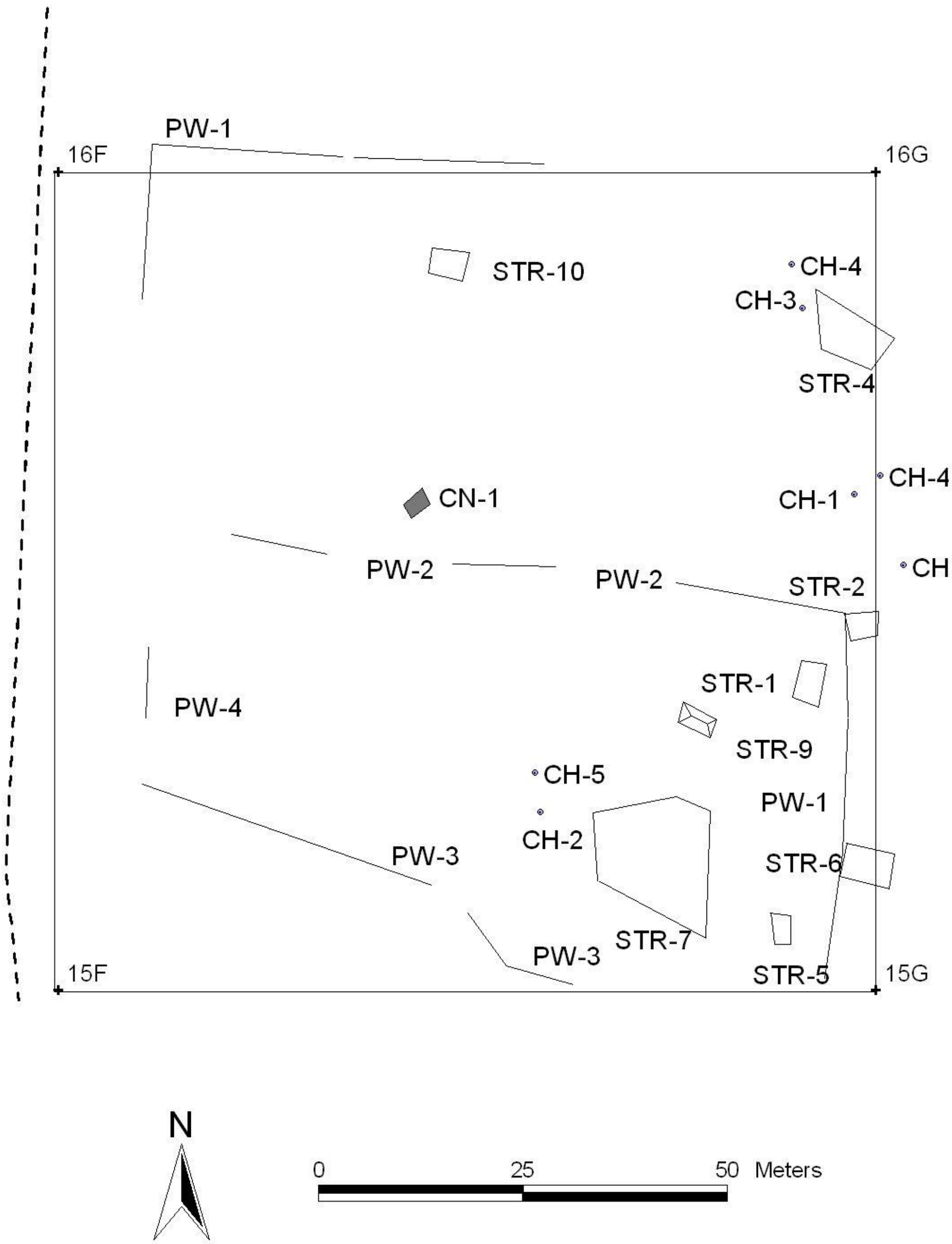


Figure B.114. Map of Section 15F.

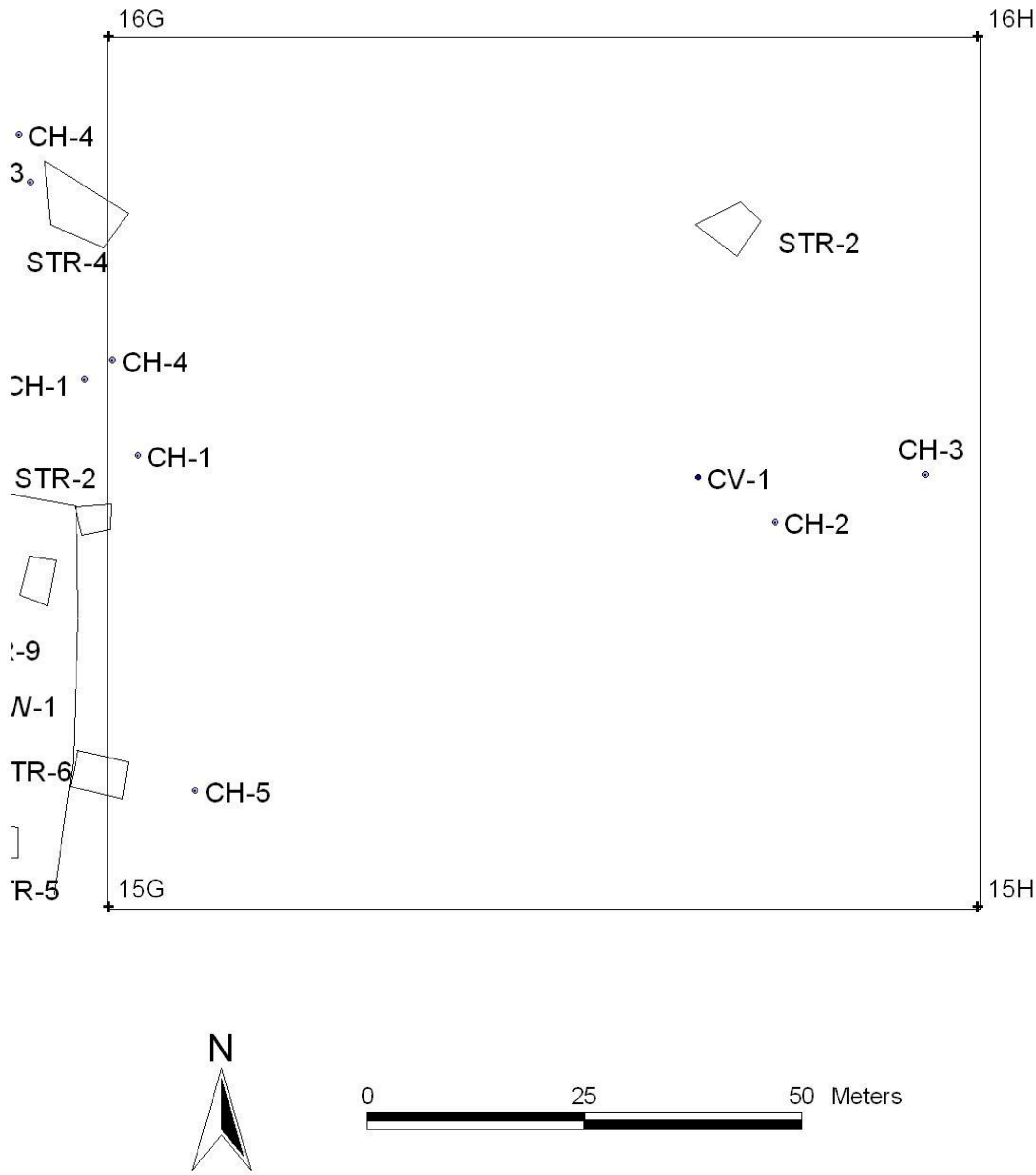


Figure B.115. Map of Section 15G.

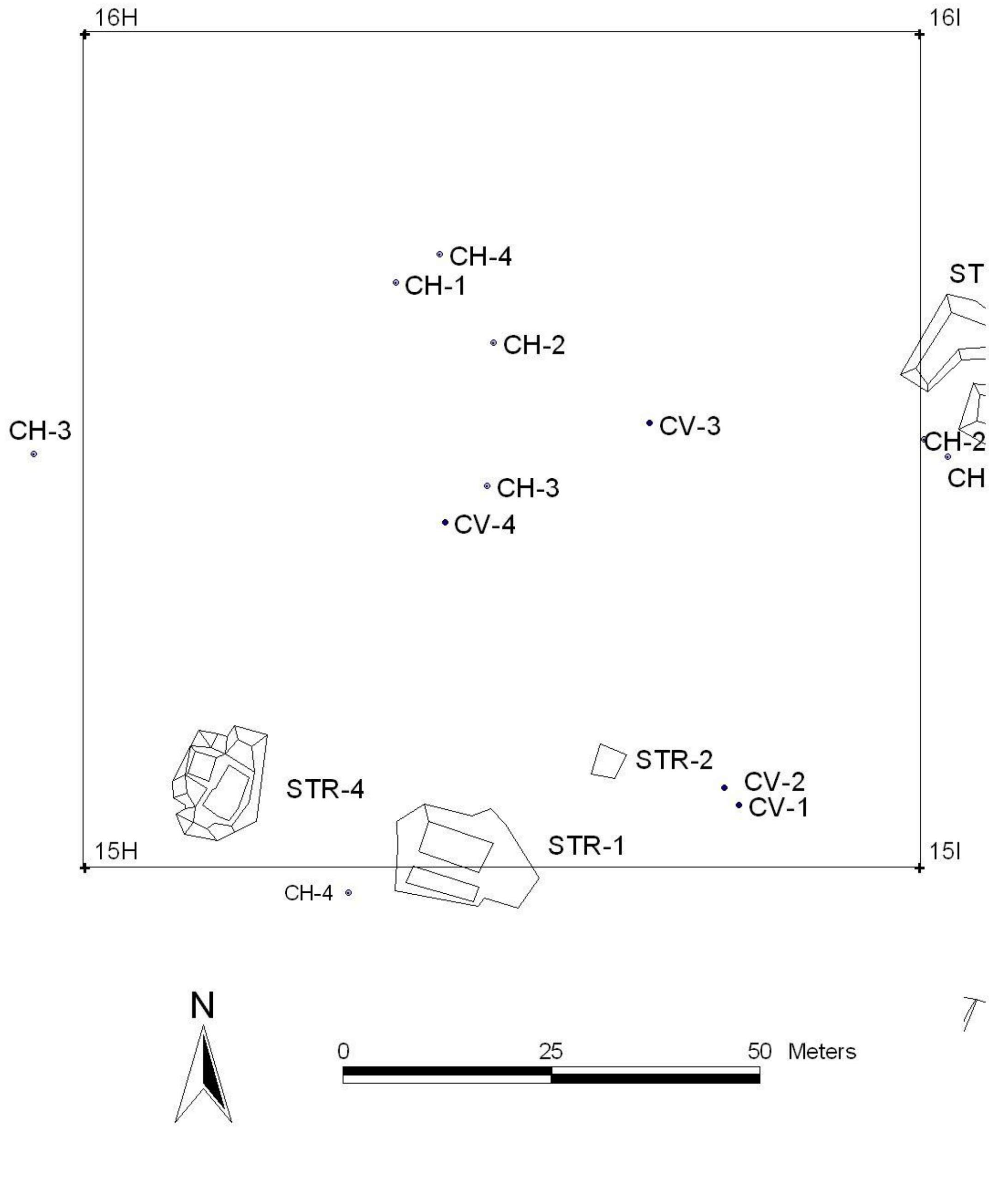


Figure B.116. Map of Section 15H.

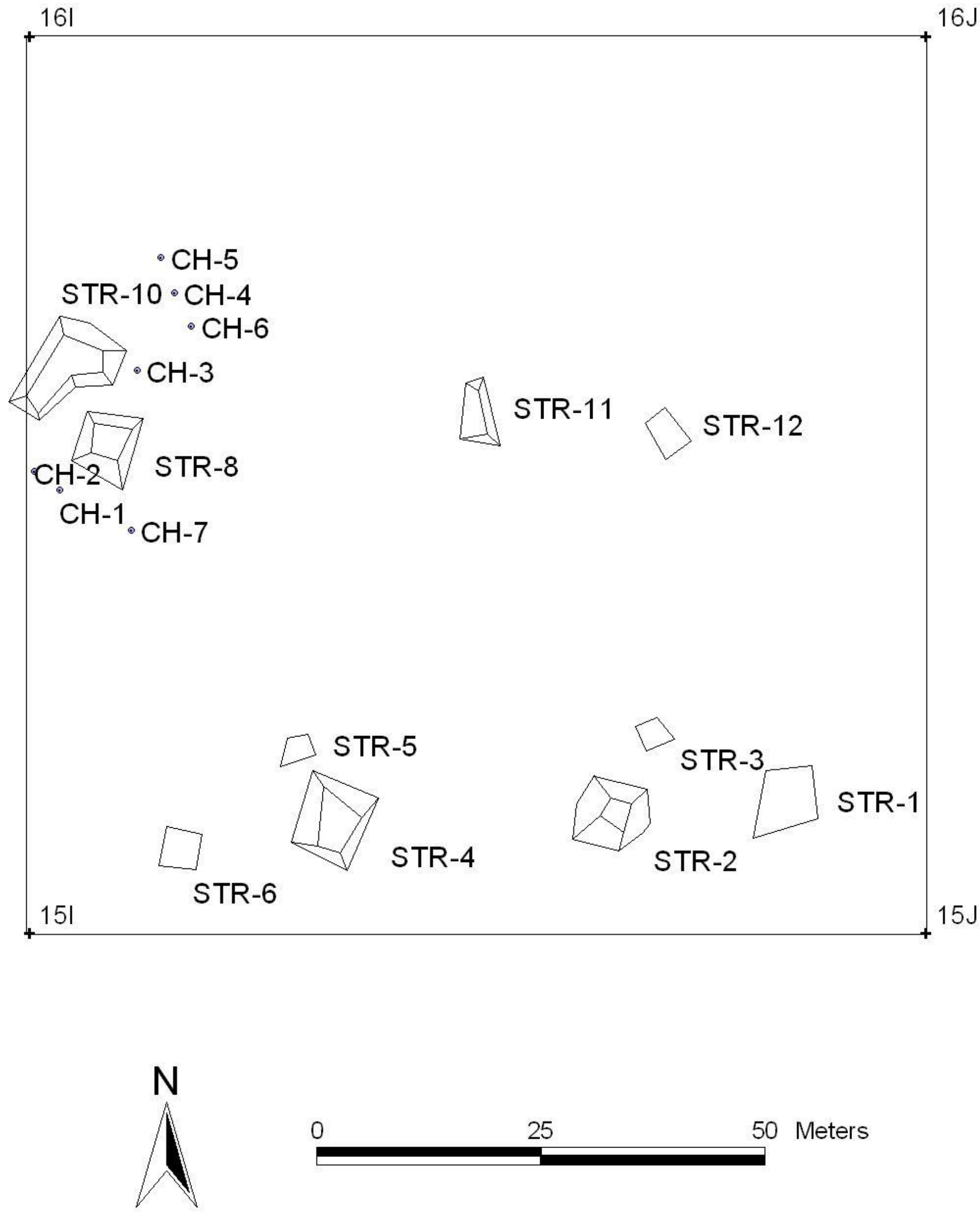


Figure B.117. Map of Section 15I.

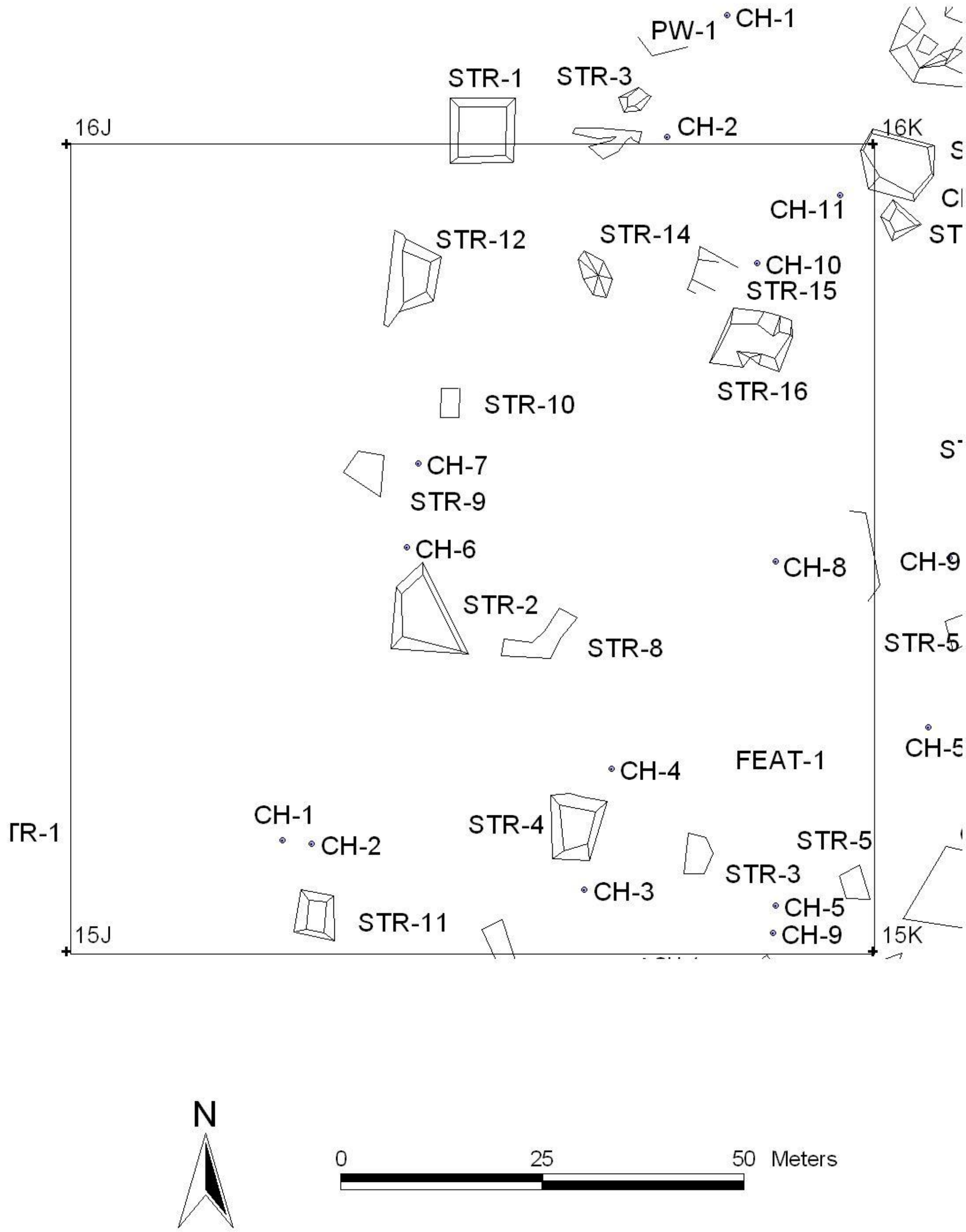


Figure B.118. Map of Section 15J.

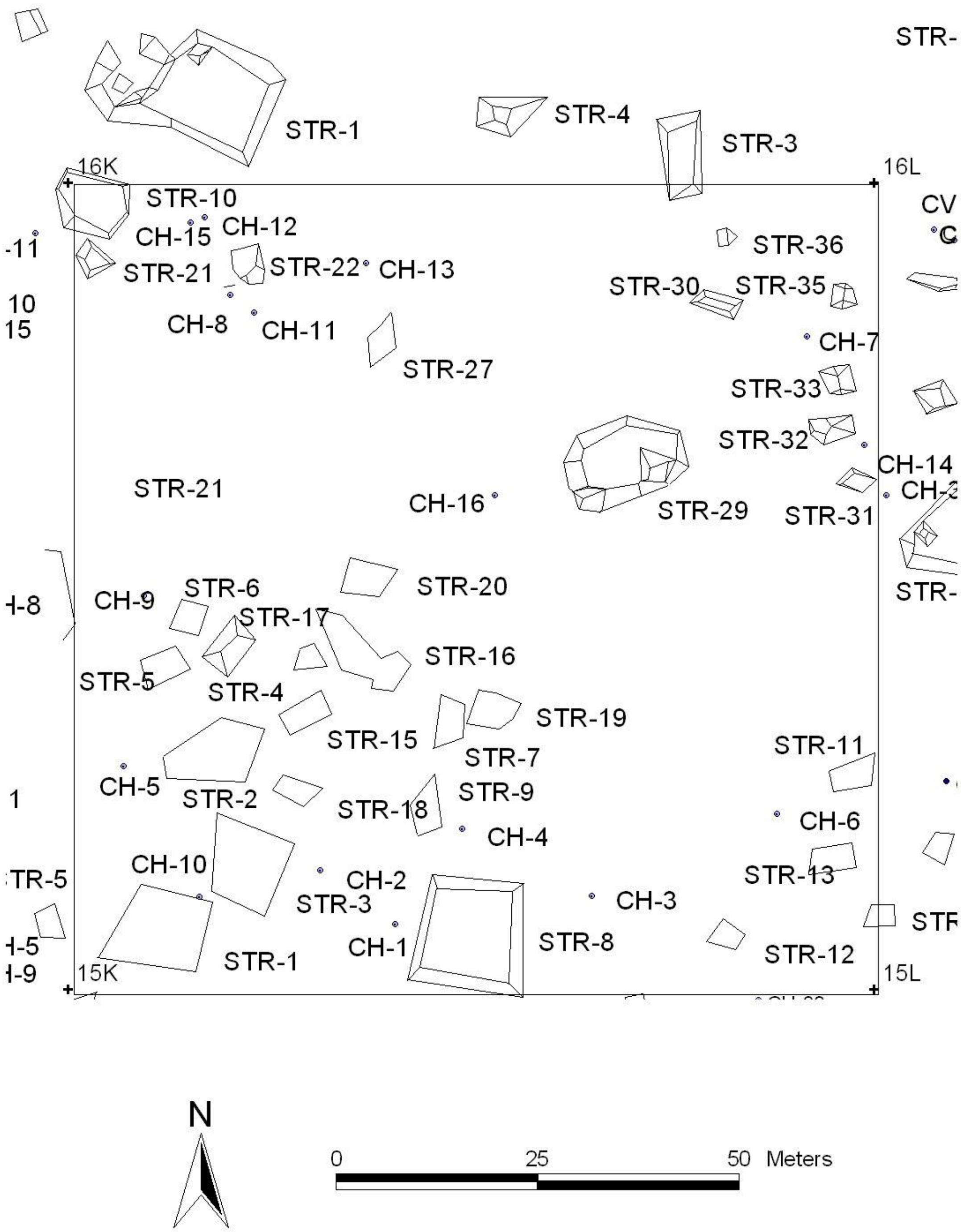


Figure B.119. Map of Section 15K.

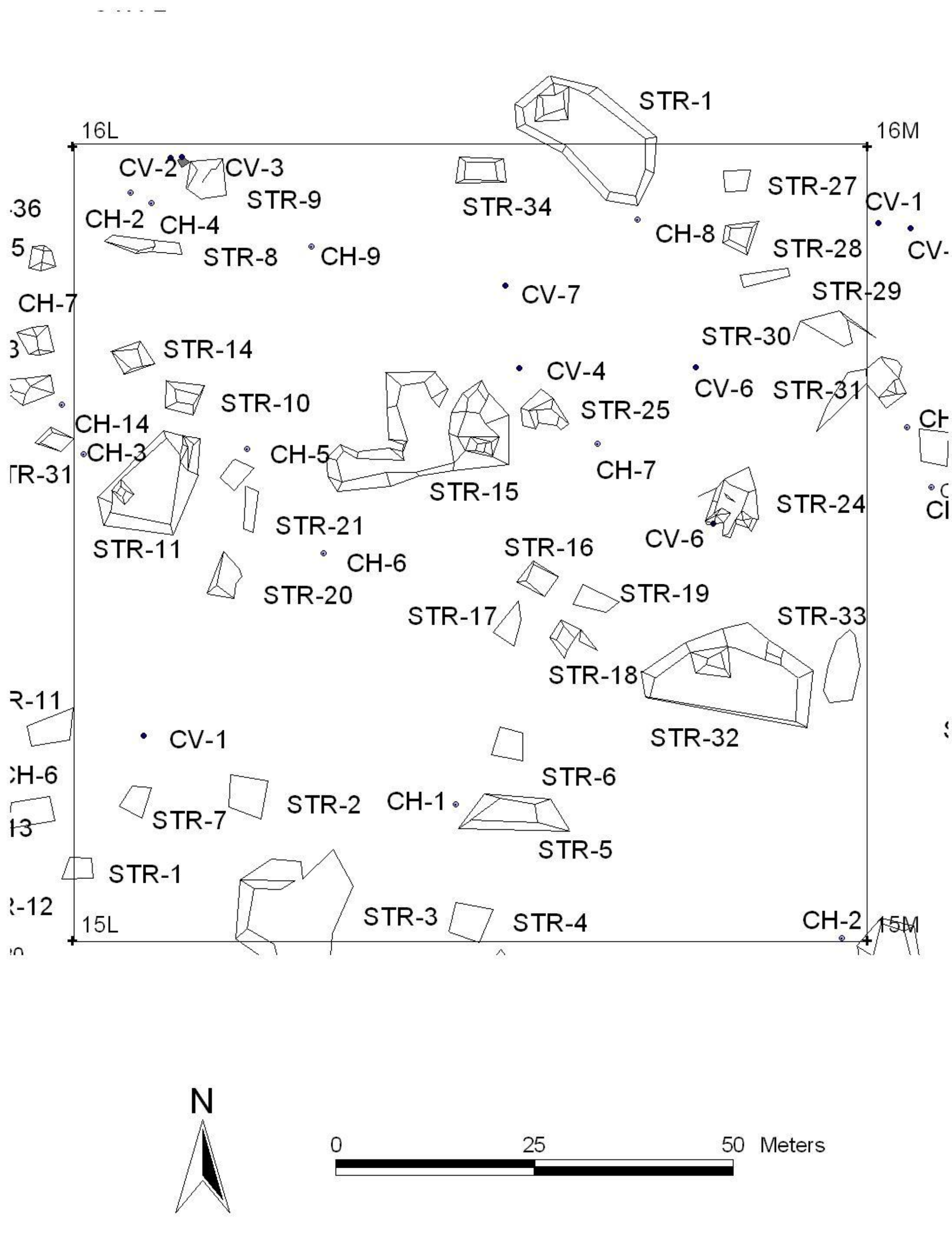
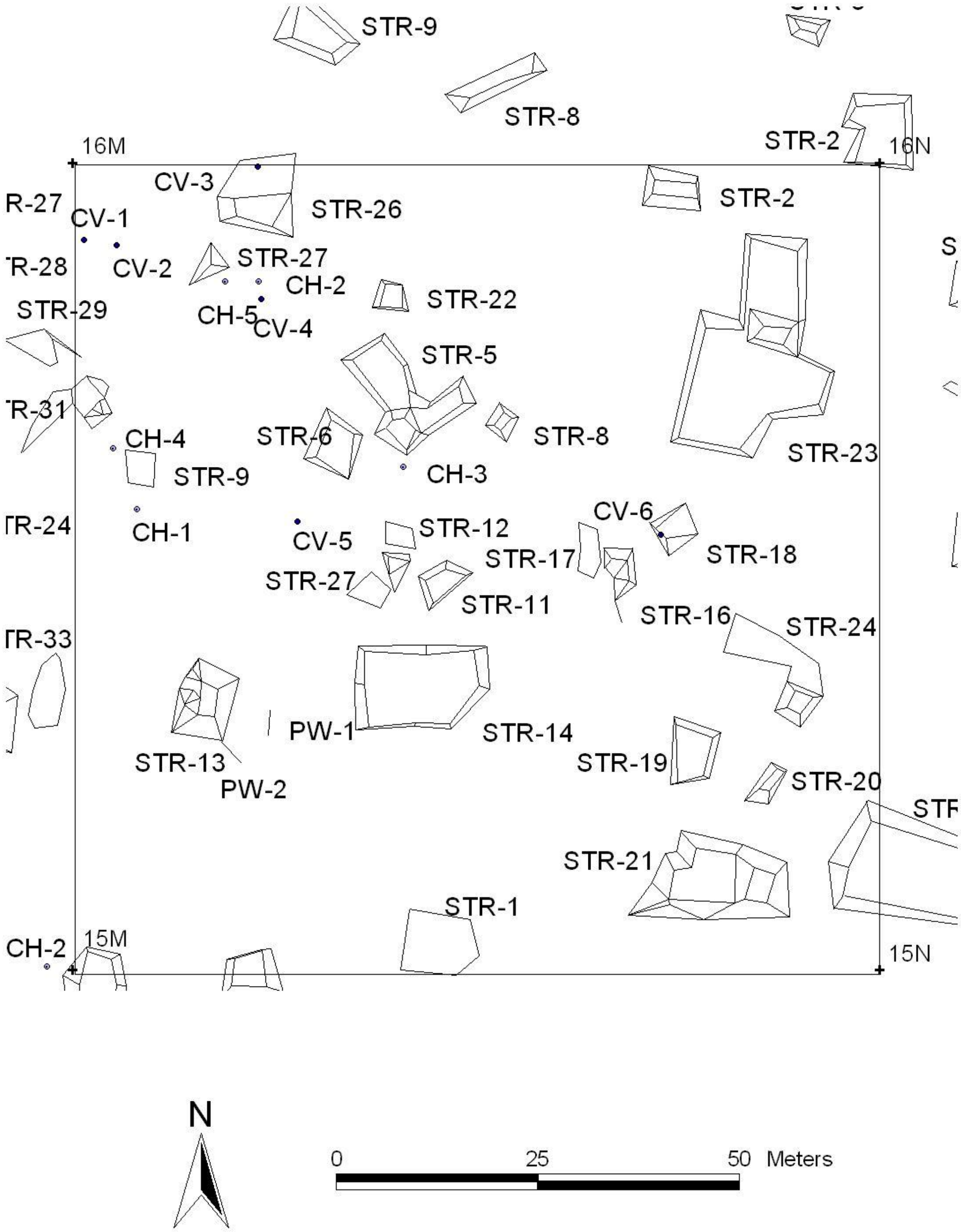


Figure B.120. Map of Section 15L.



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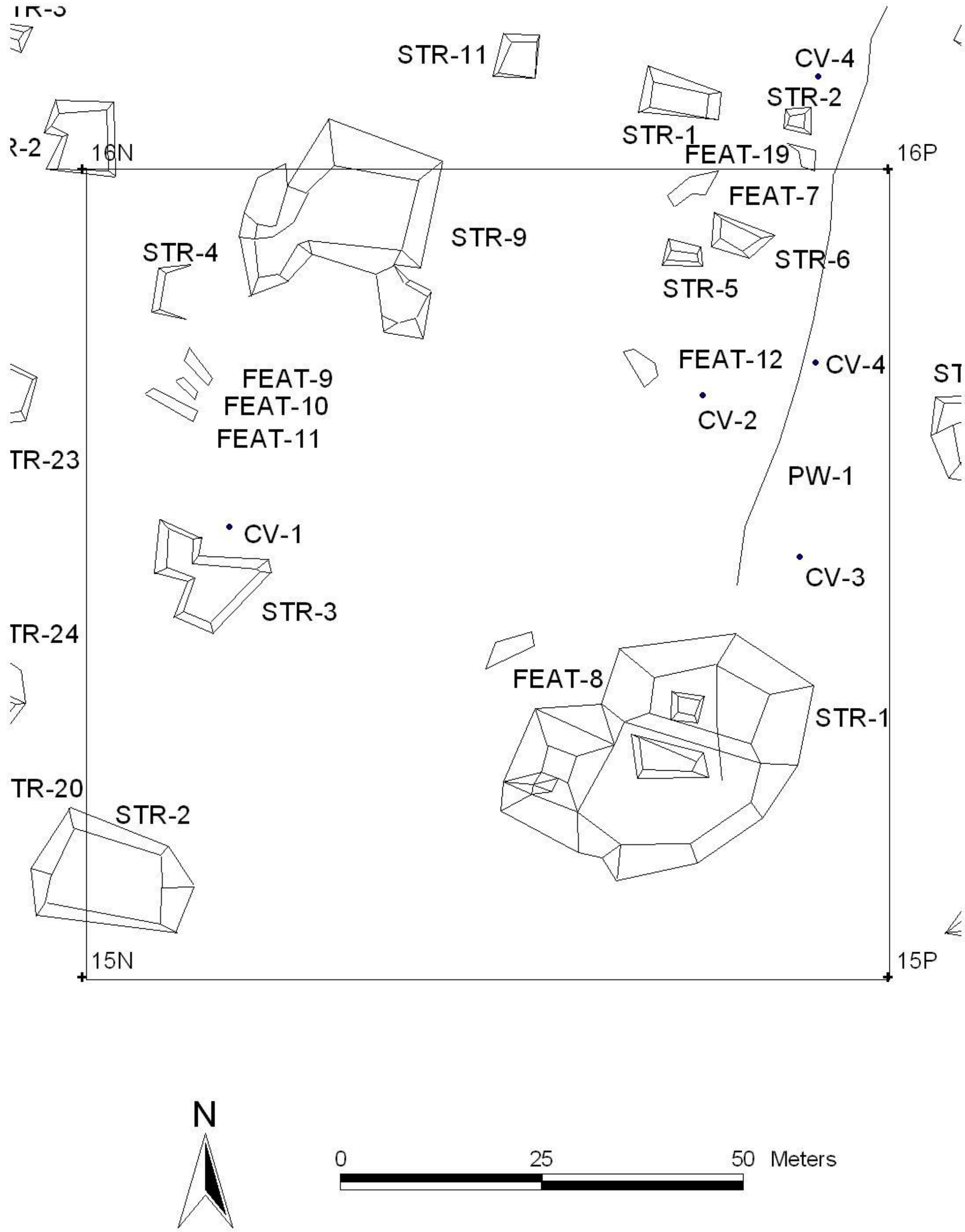
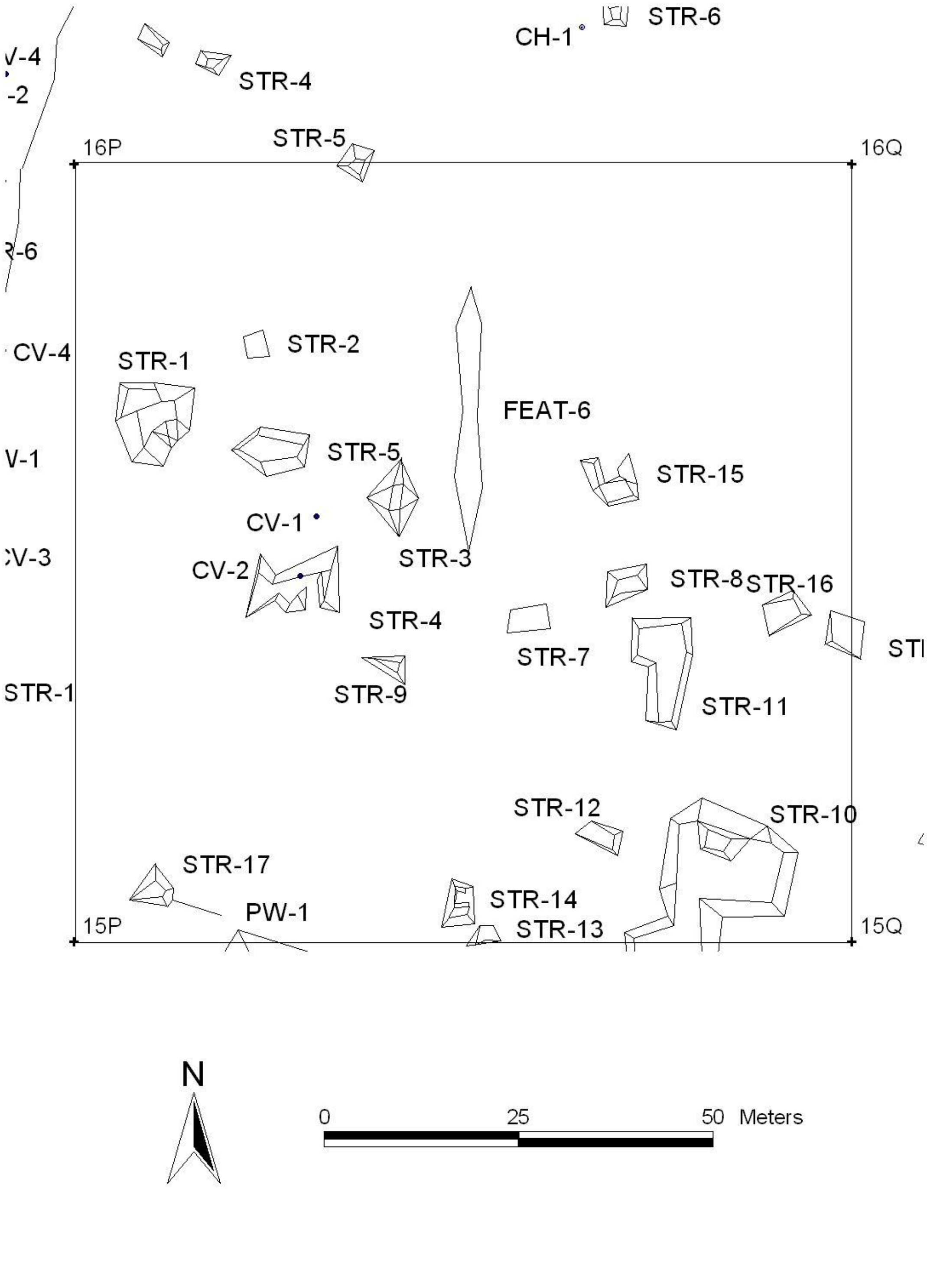


Figure B.122. Map of Section 15N.



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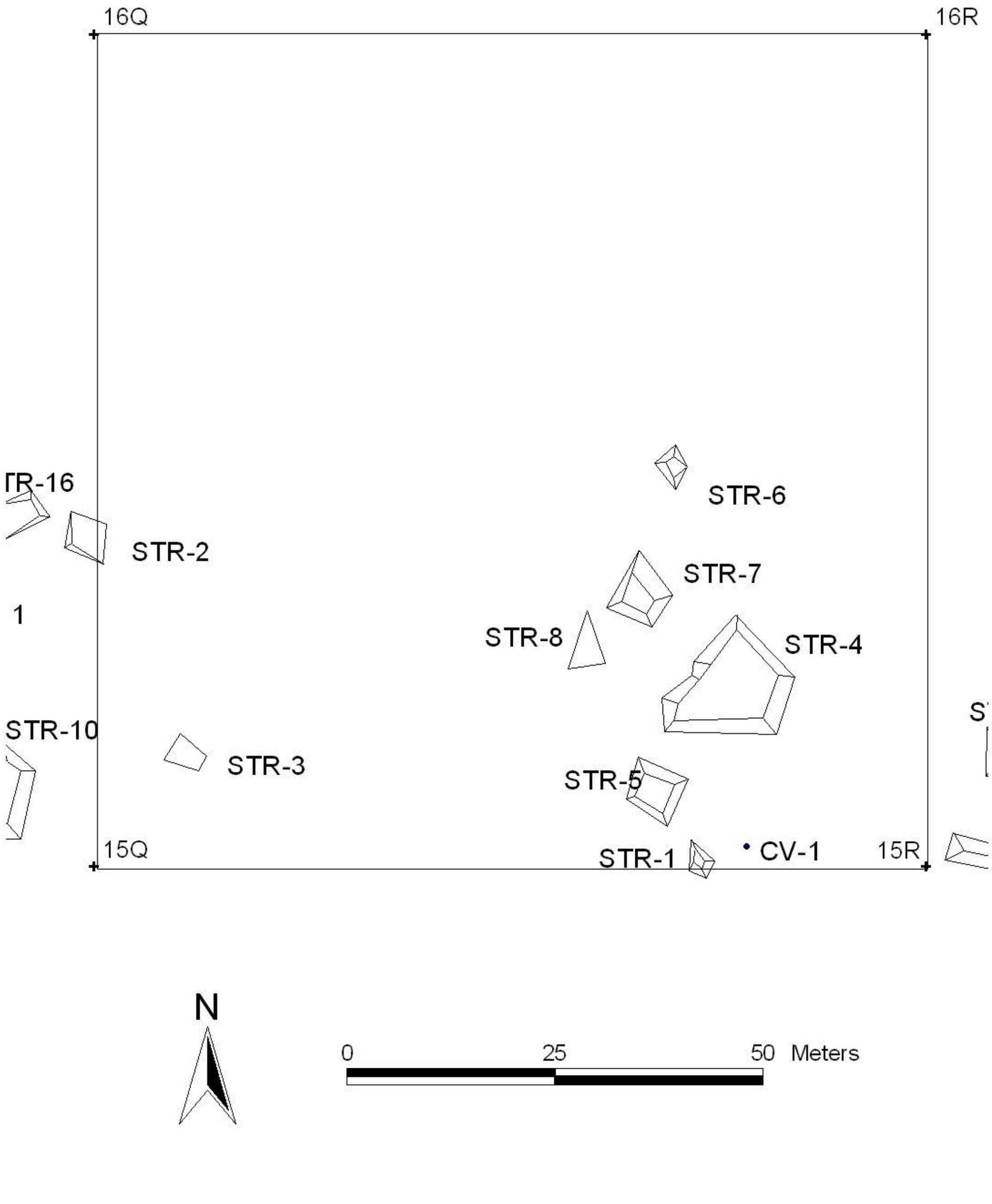


Figure B.124. Map of Section 15Q.

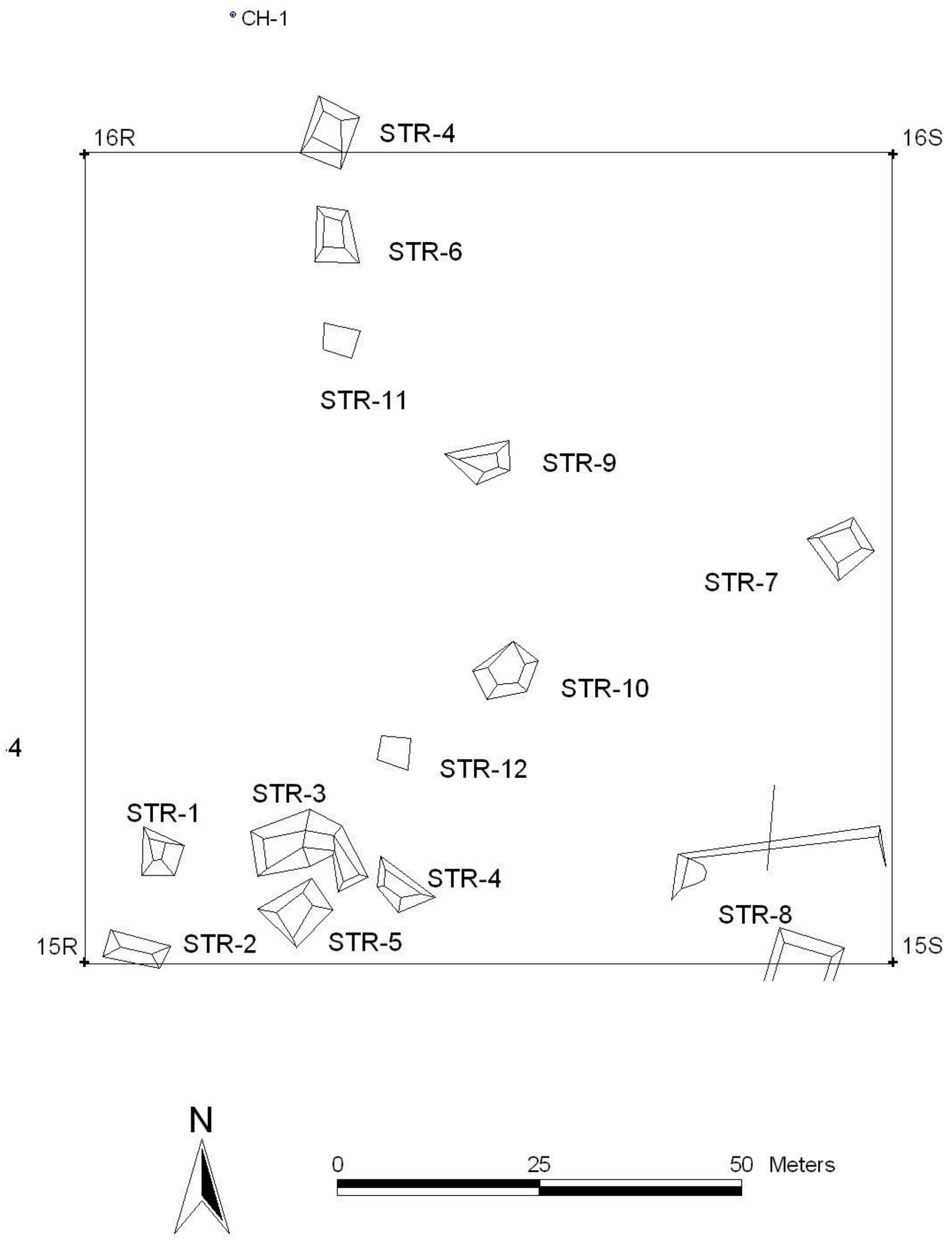


Figure B.125. Map of Section 15R.

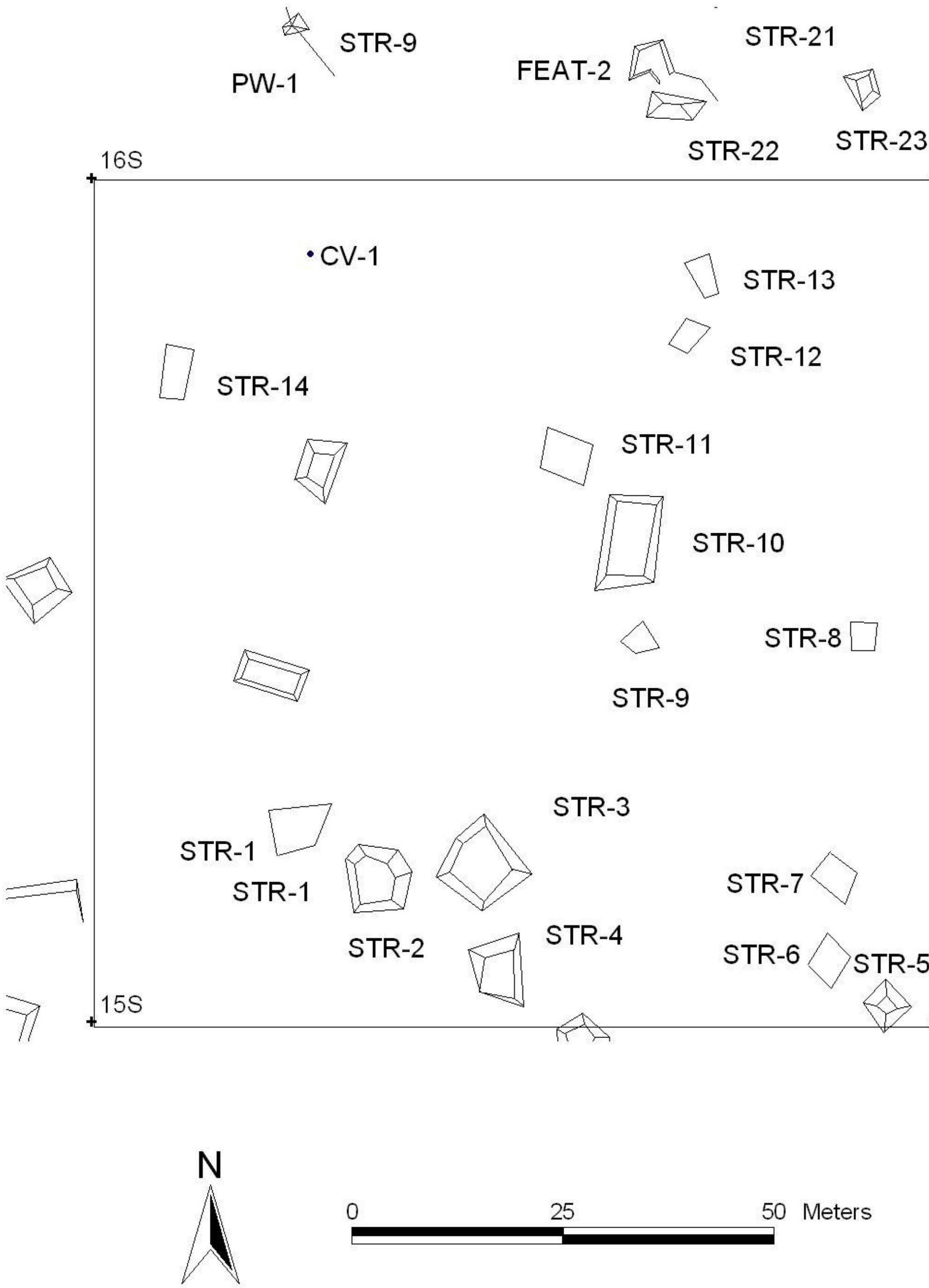


Figure B.126. Map of Section 15S.

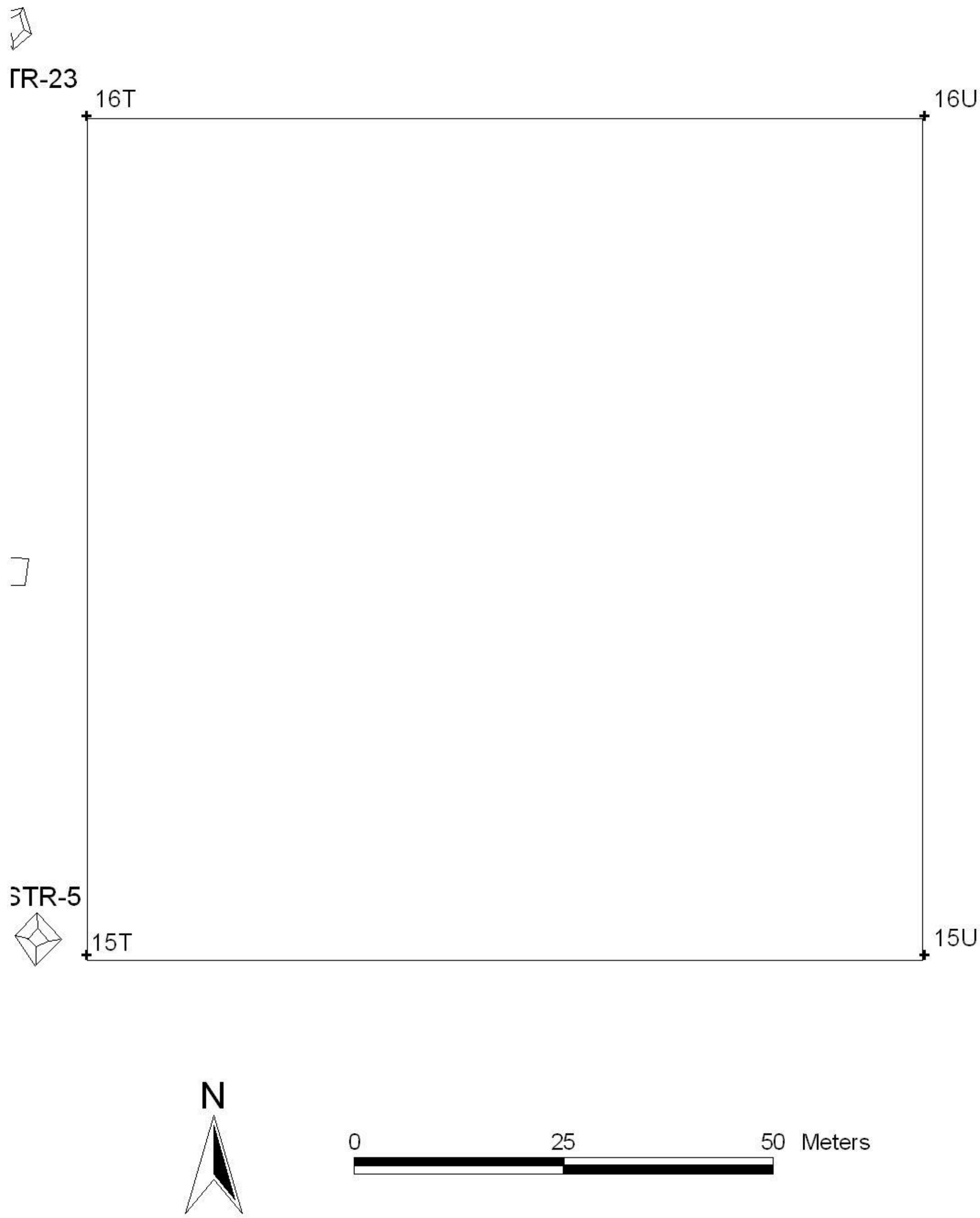


Figure B.127. Map of Section 15T.

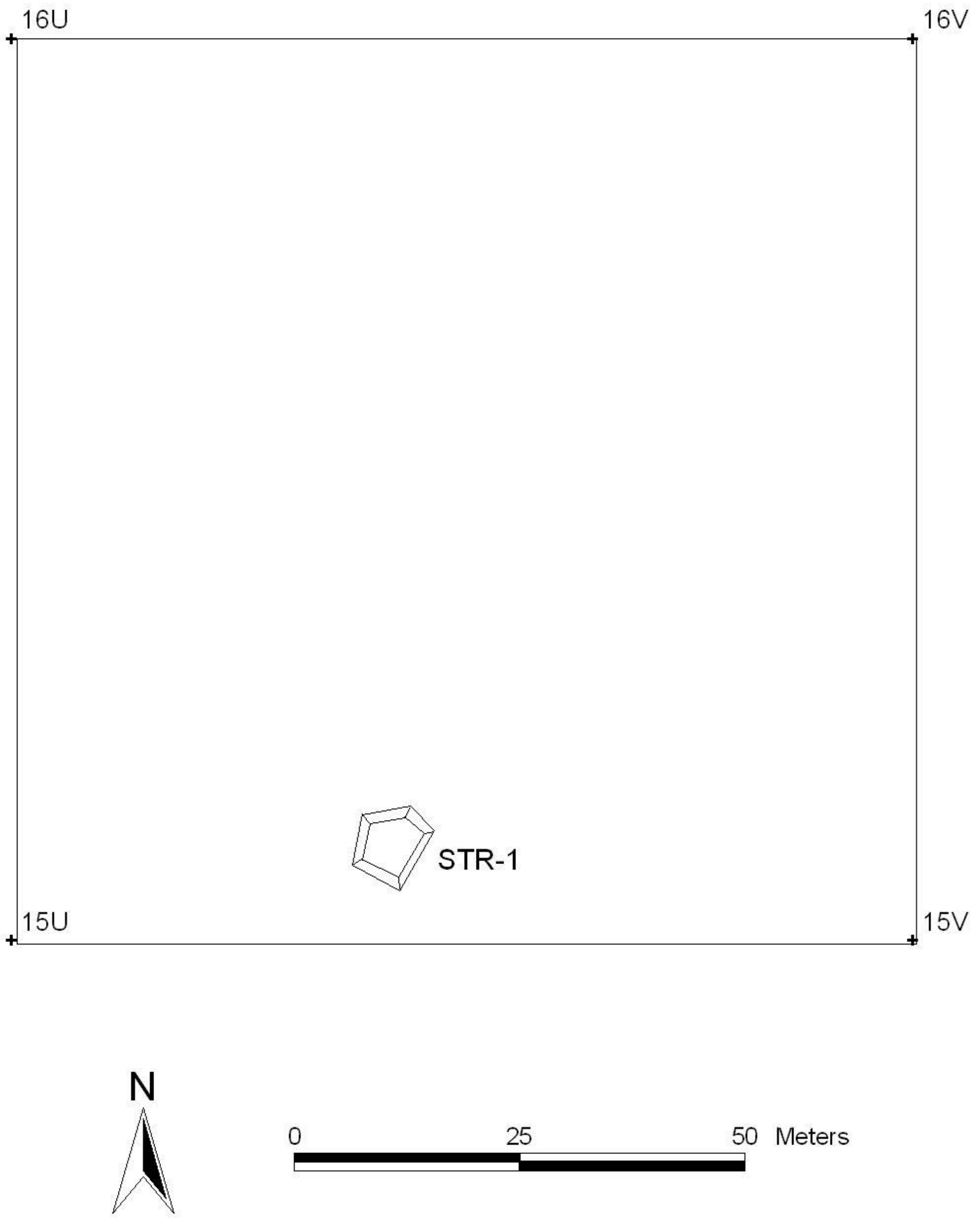


Figure B.128. Map of Section 15U.

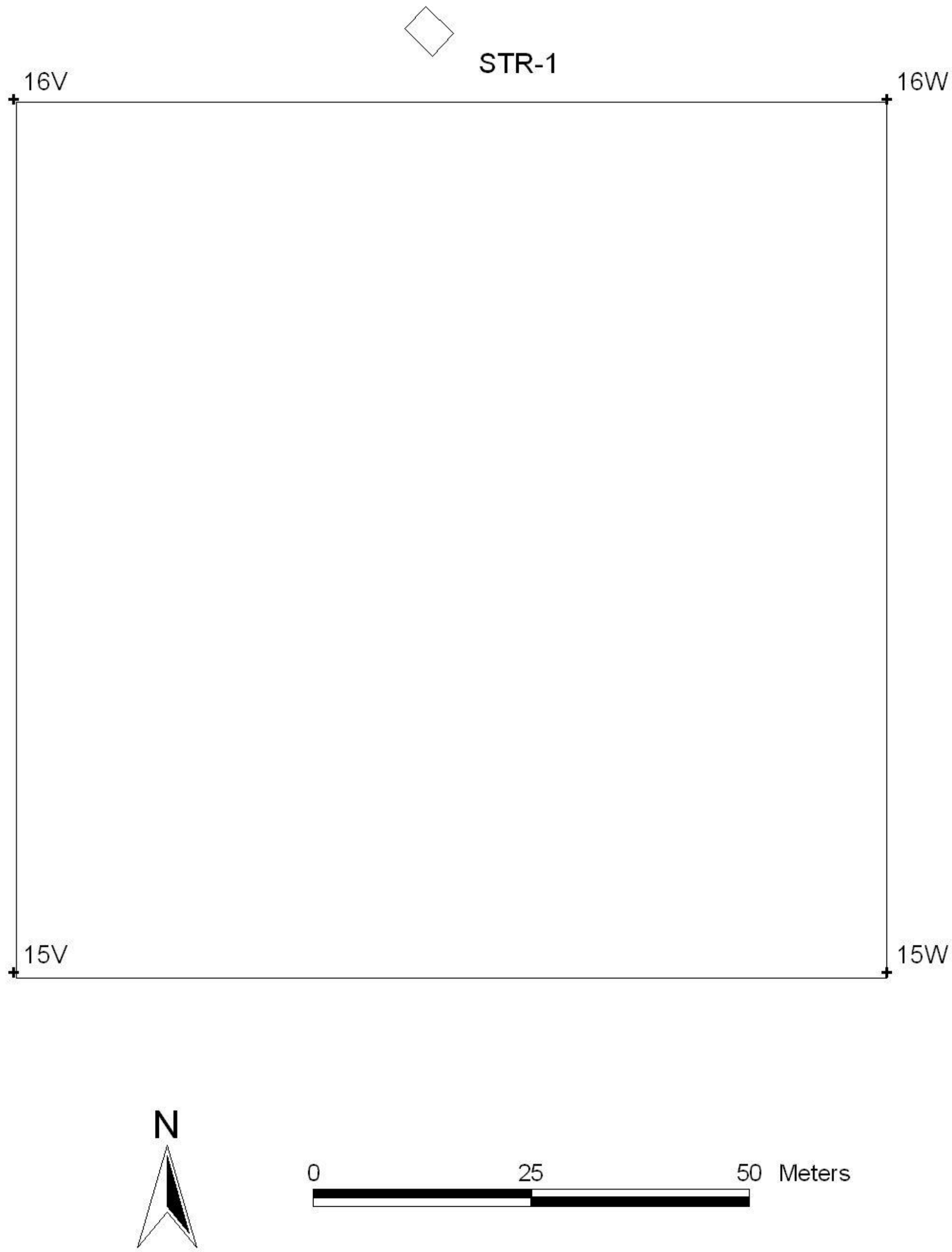


Figure B.129. Map of Section 15V.

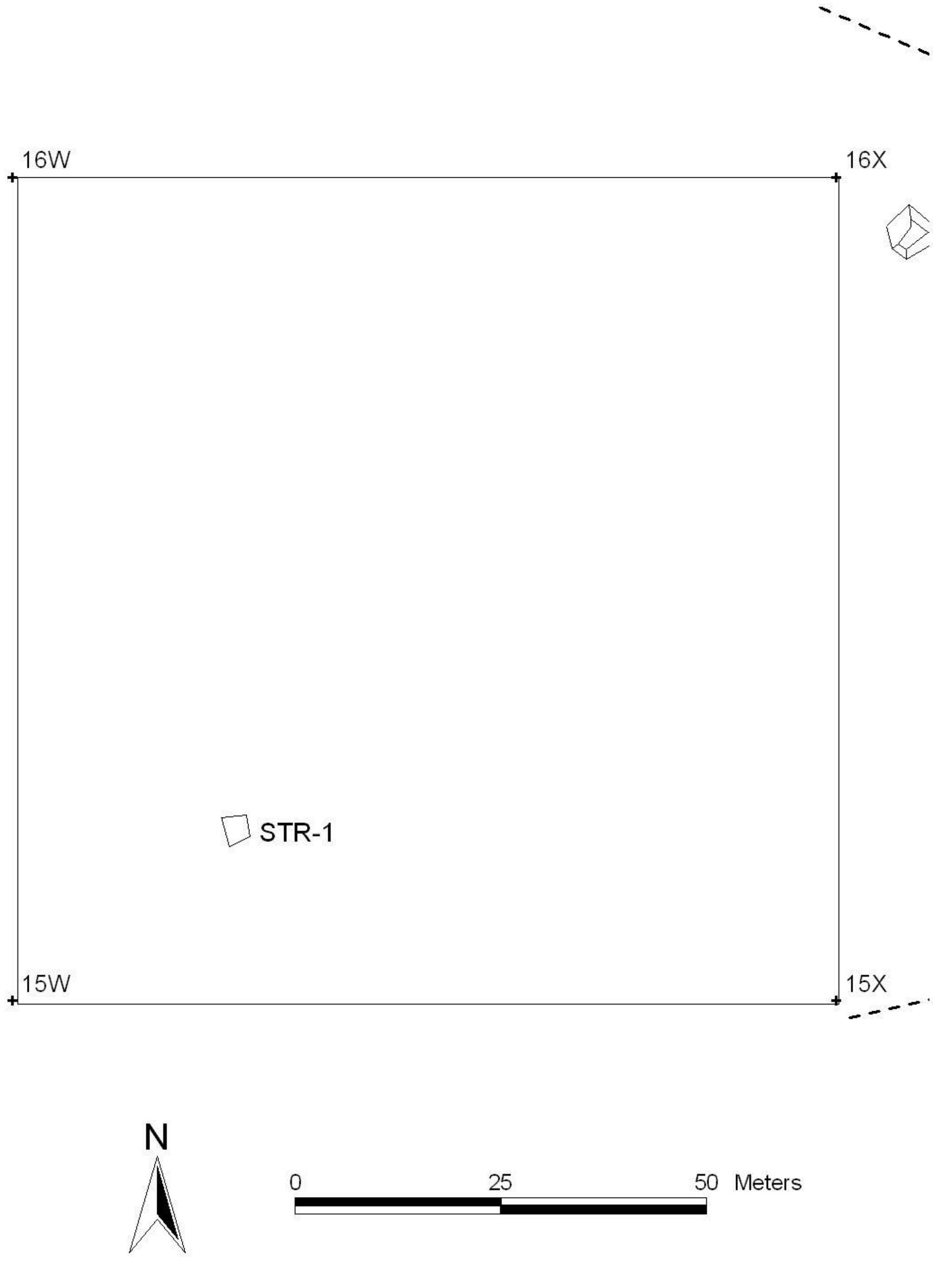


Figure B.130. Map of Section 15W.

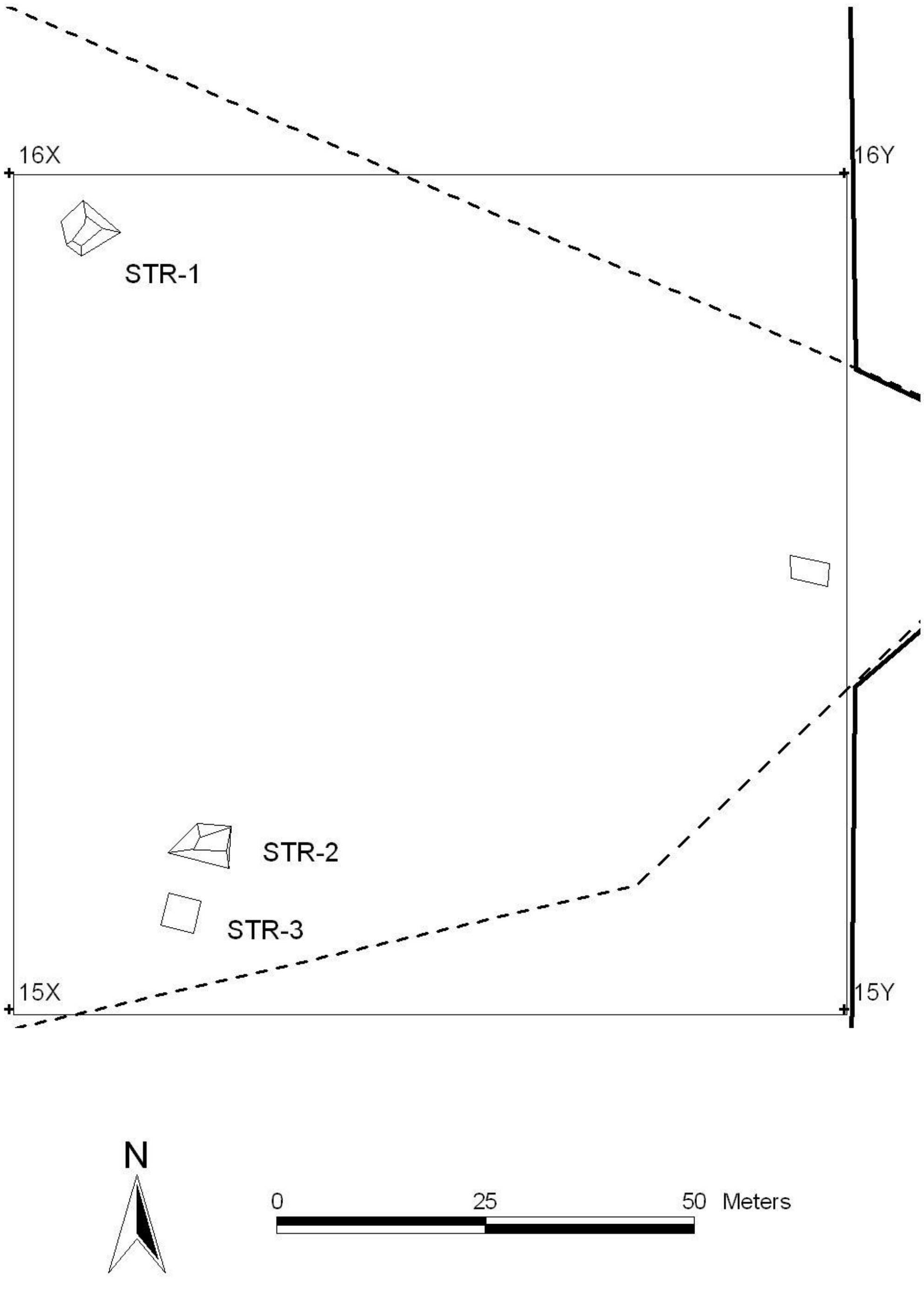


Figure B.131. Map of Section 15X.

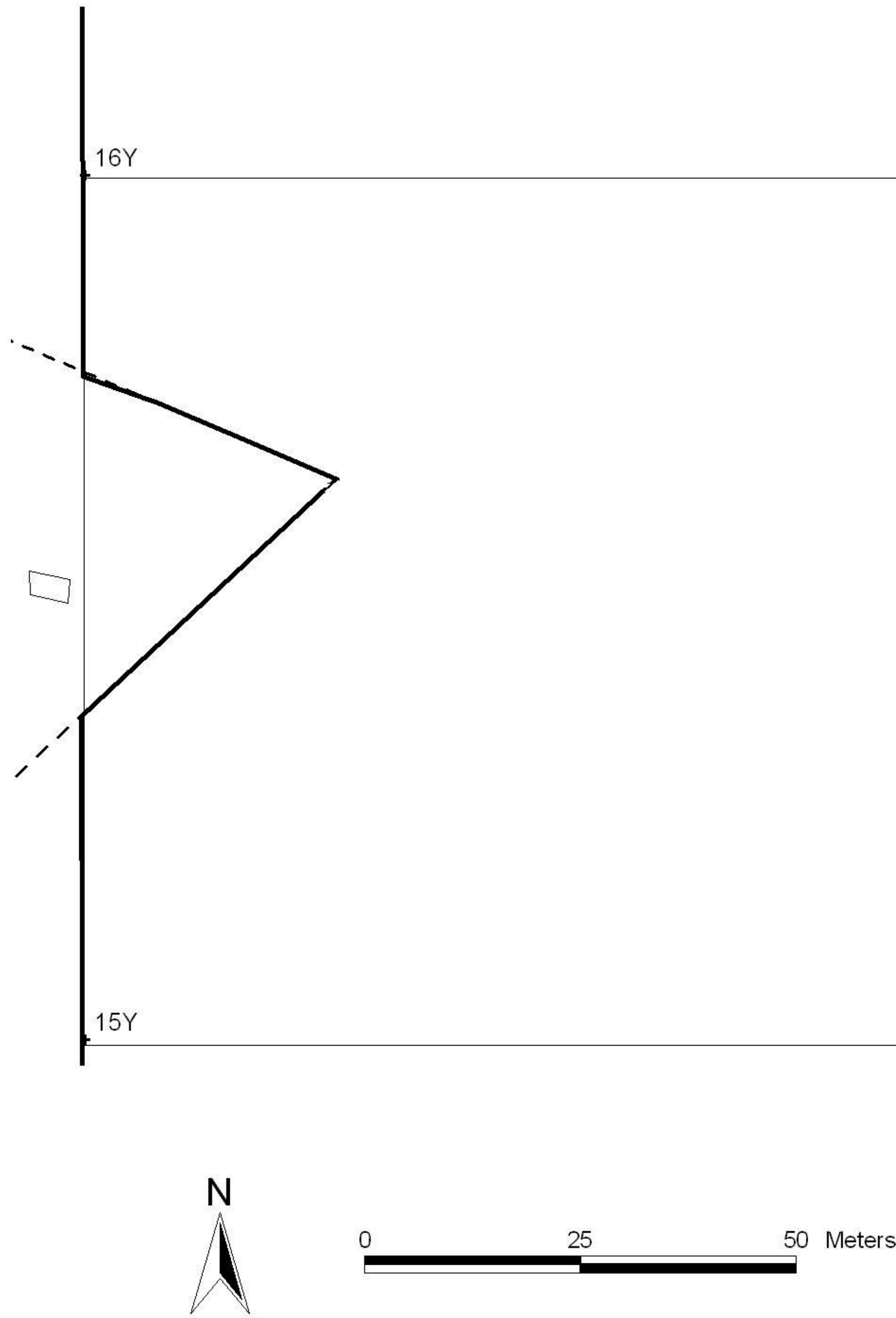


Figure B.132. Map of Section 15Y.

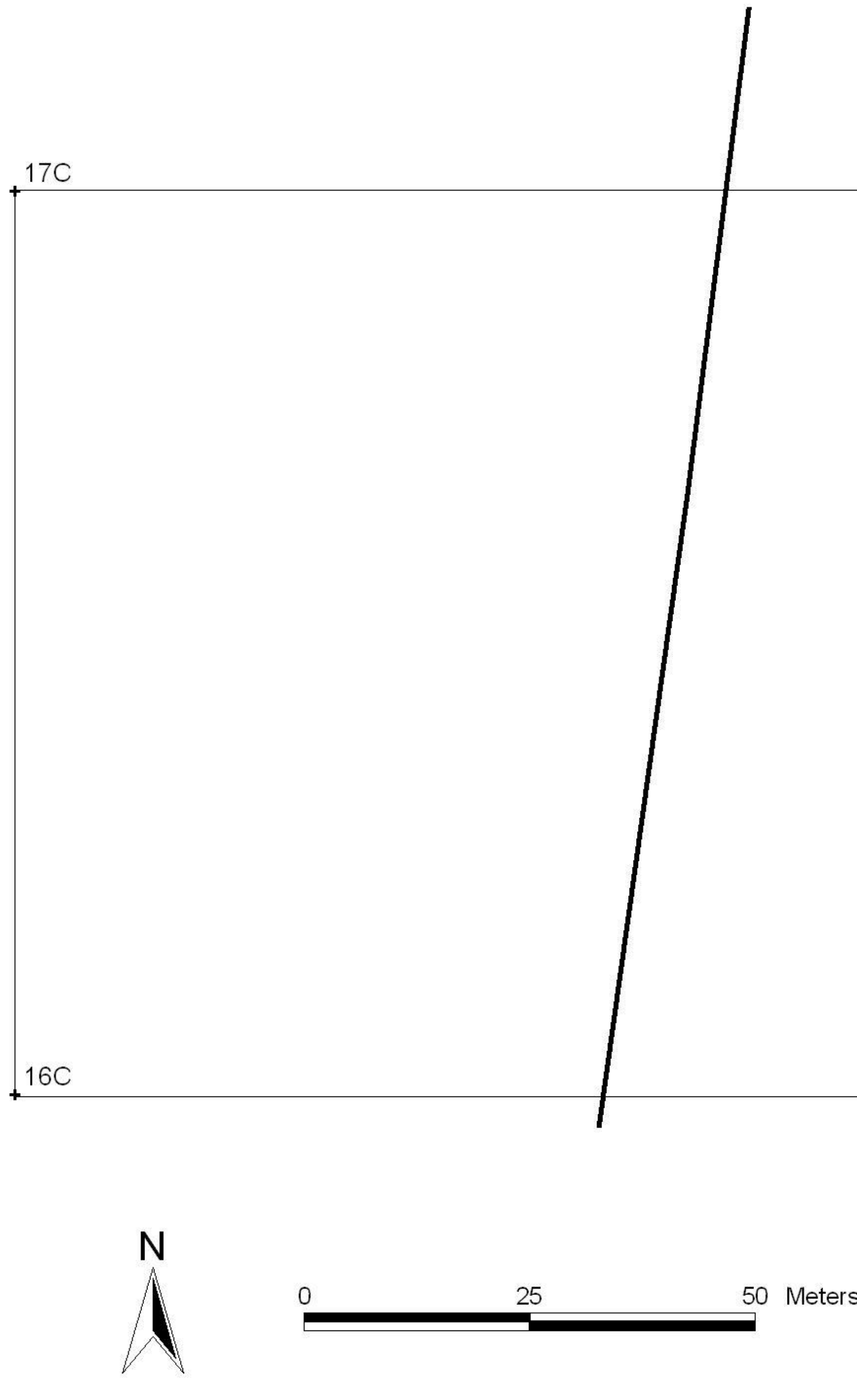


Figure B.133. Map of Section 16C.

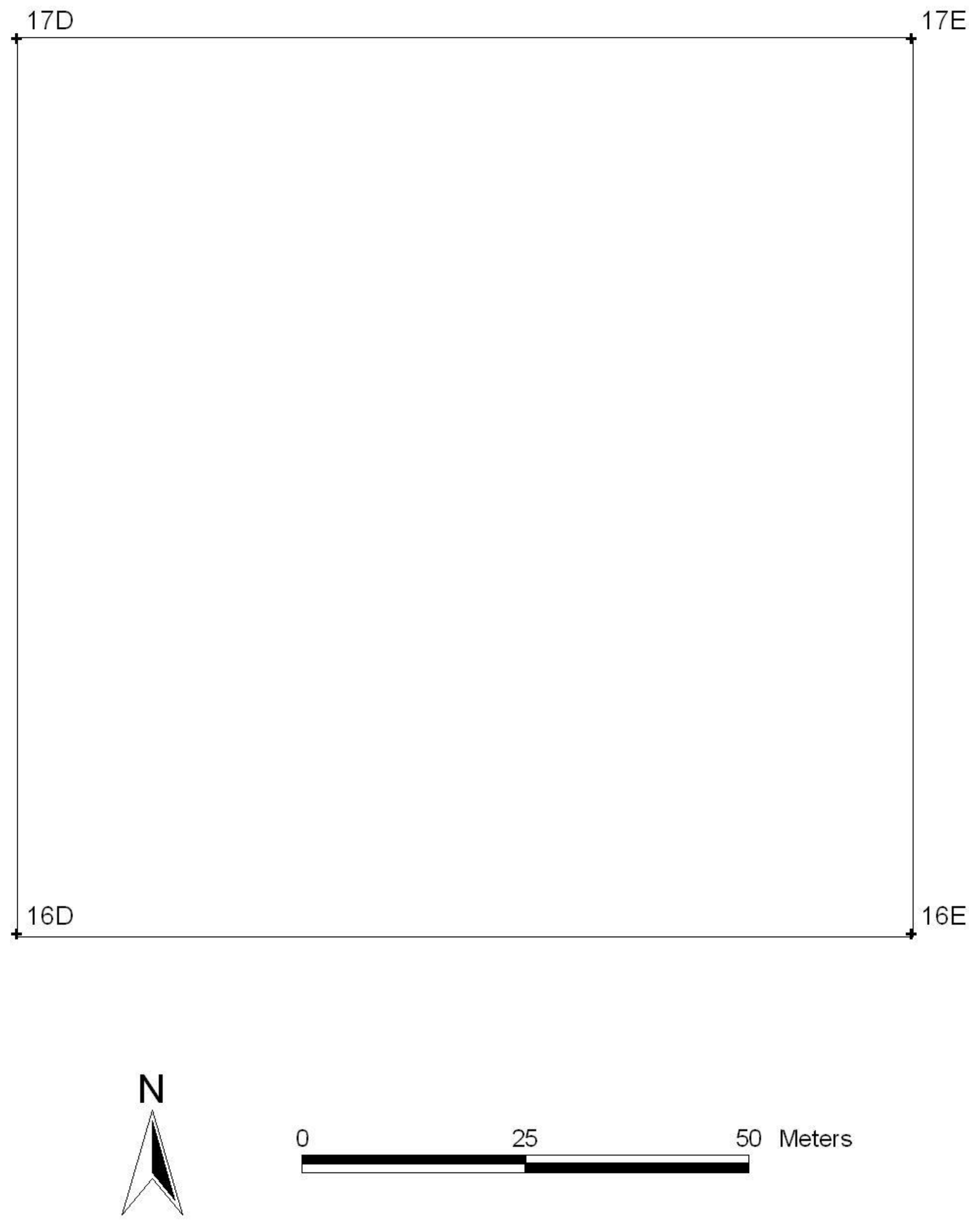


Figure B.134. Map of Section 16D.

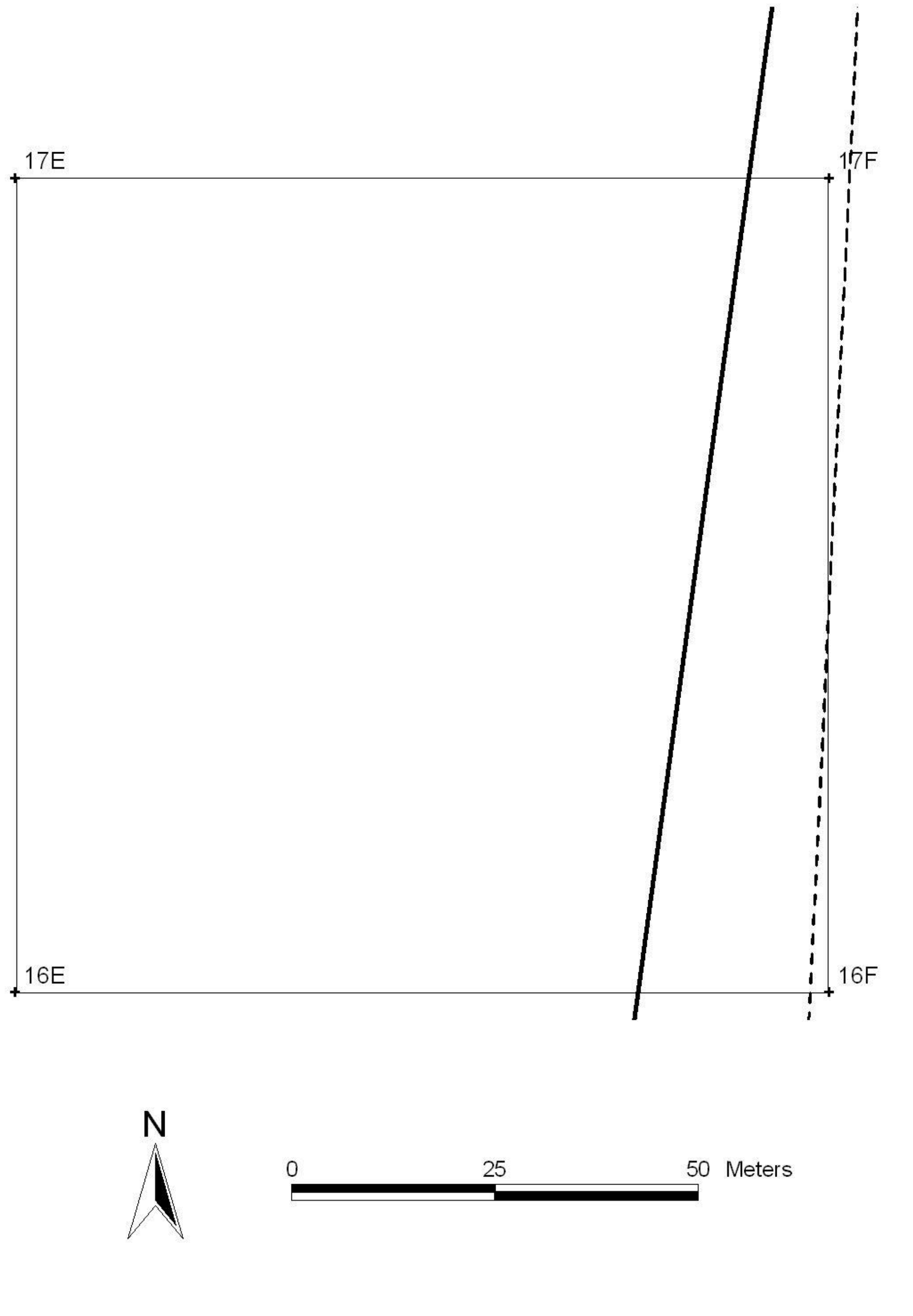


Figure B.135. Map of Section 16E.

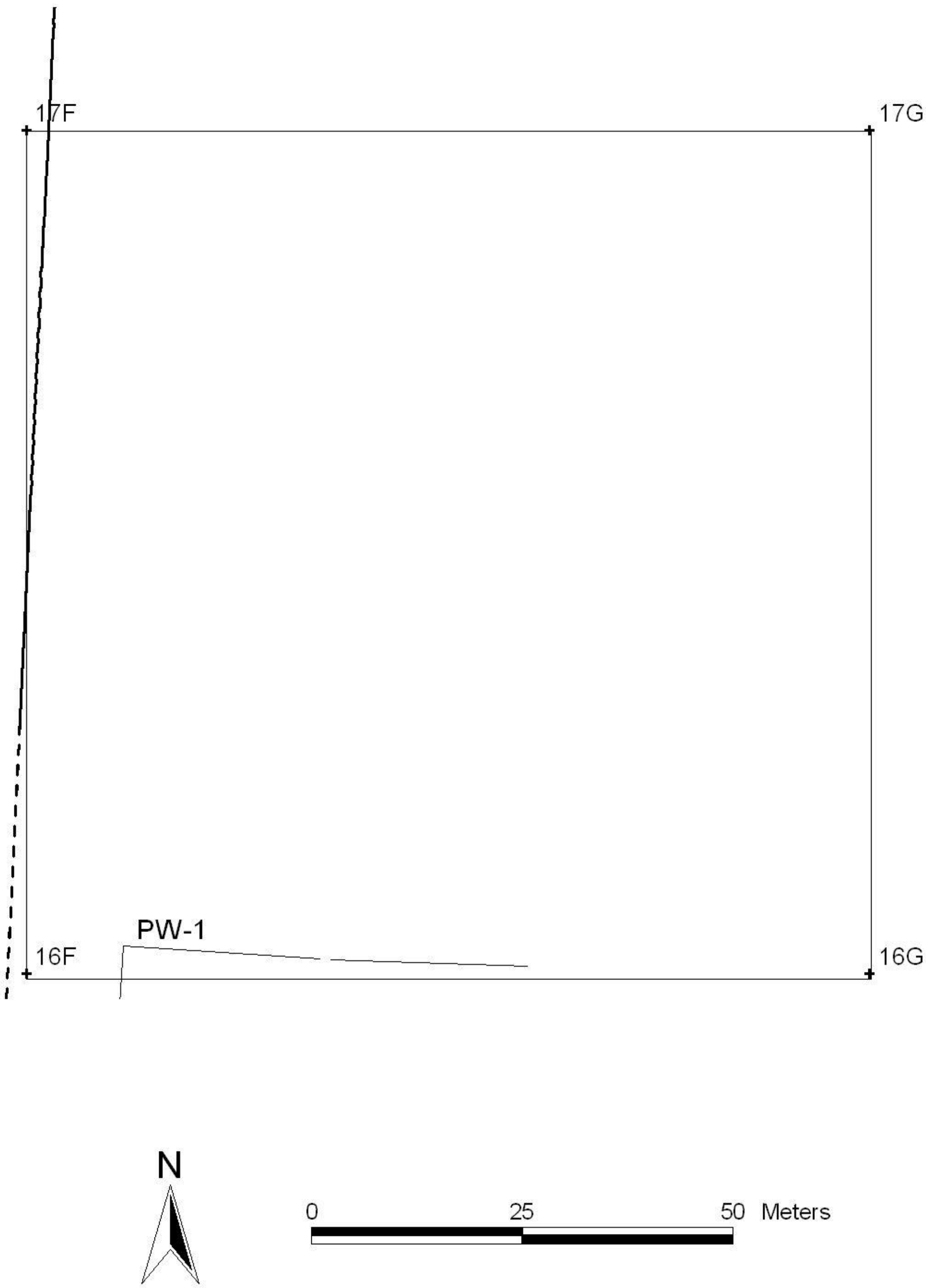


Figure B.136. Map of Section 16F.

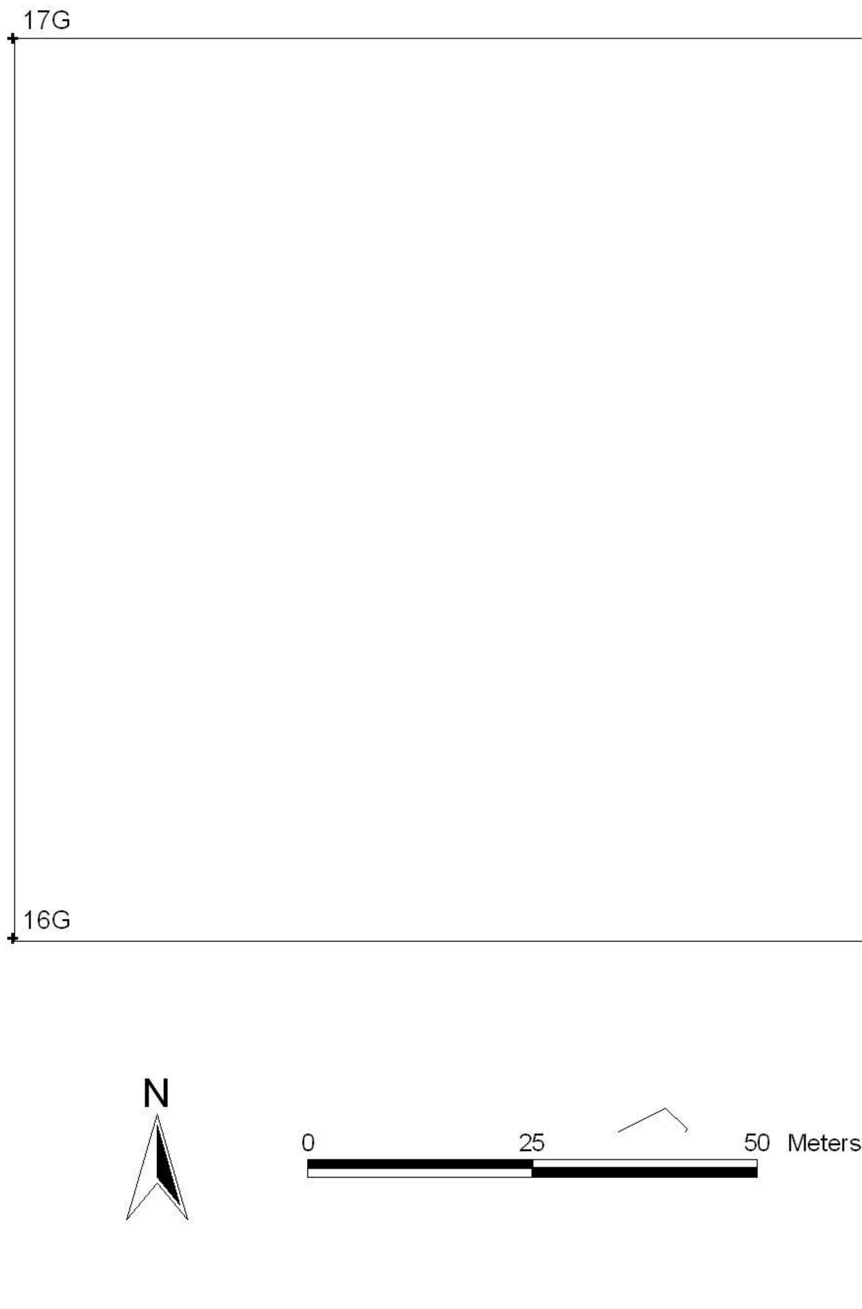


Figure B.137. Map of Section 16G.

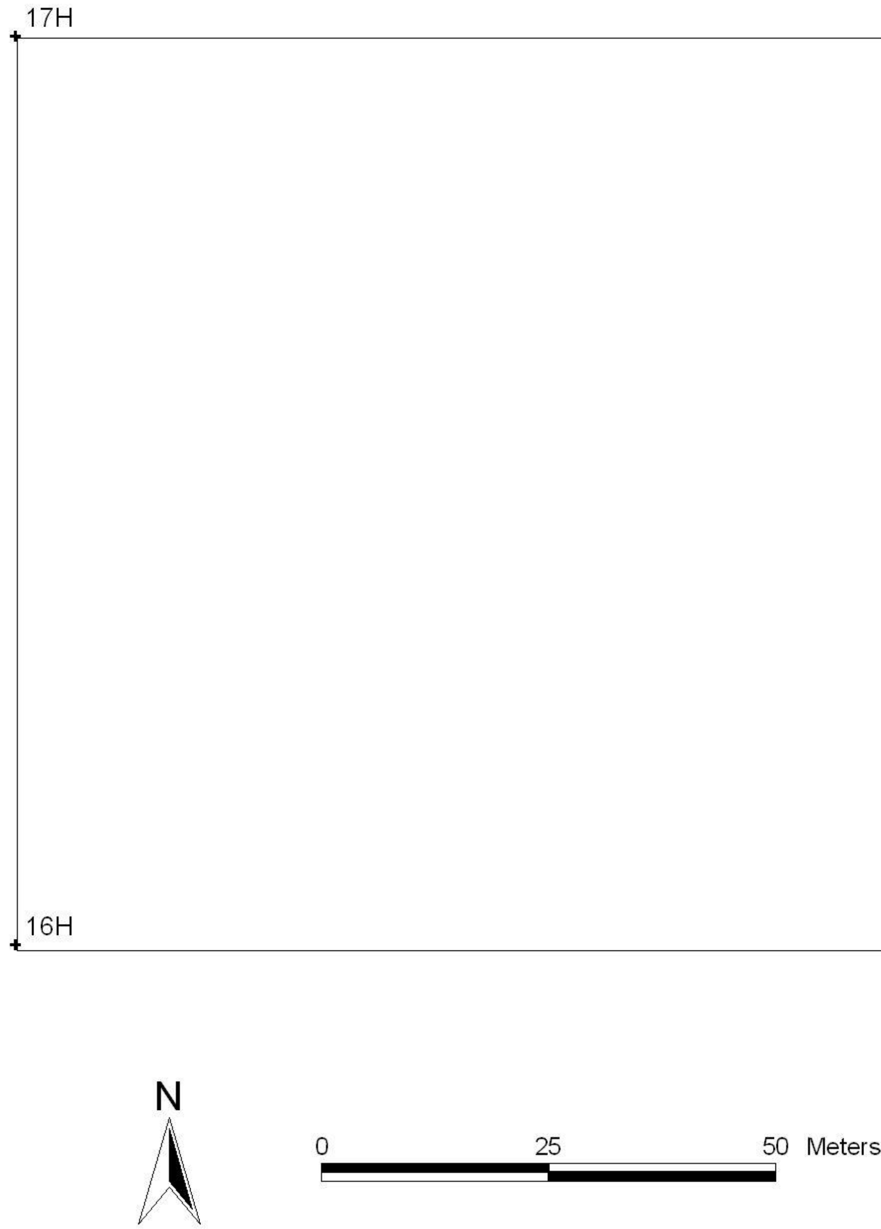


Figure B.138. Map of Section 16H.

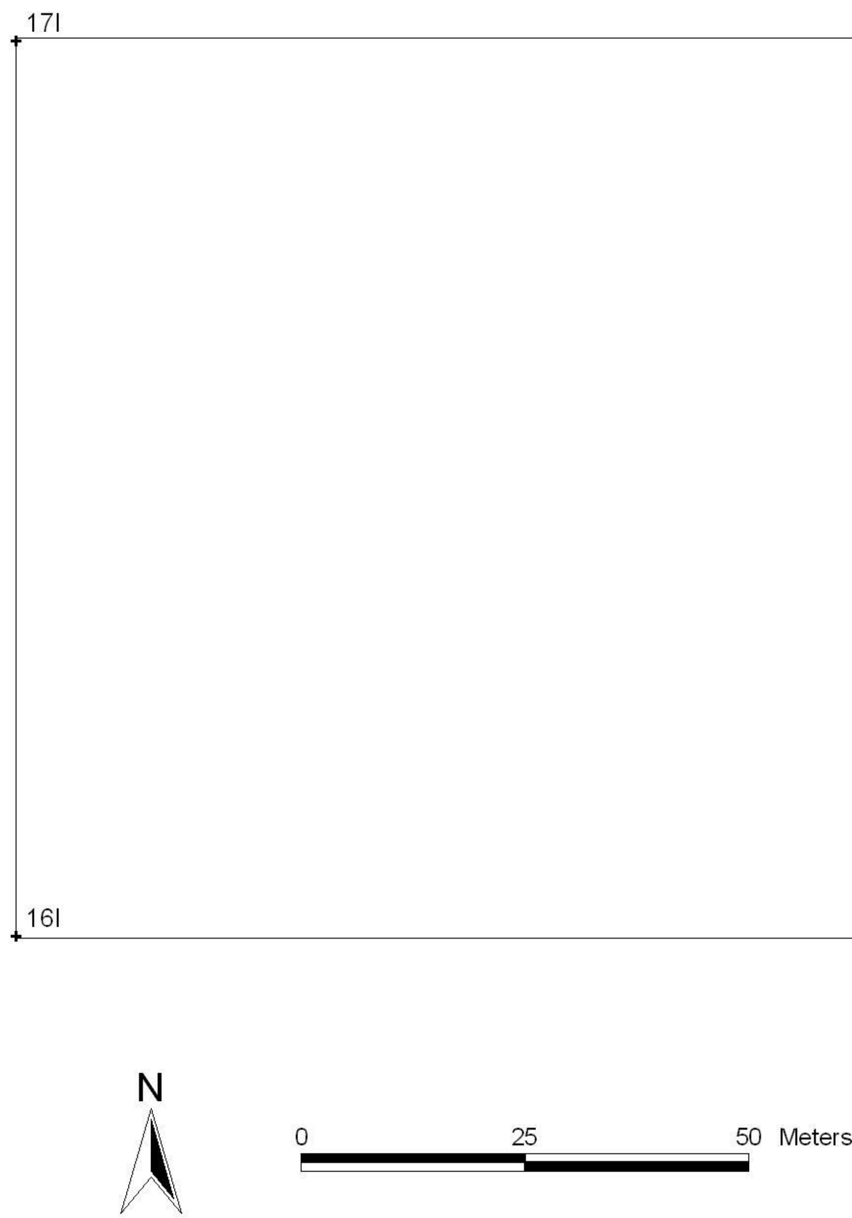


Figure B.139. Map of Section 16I.

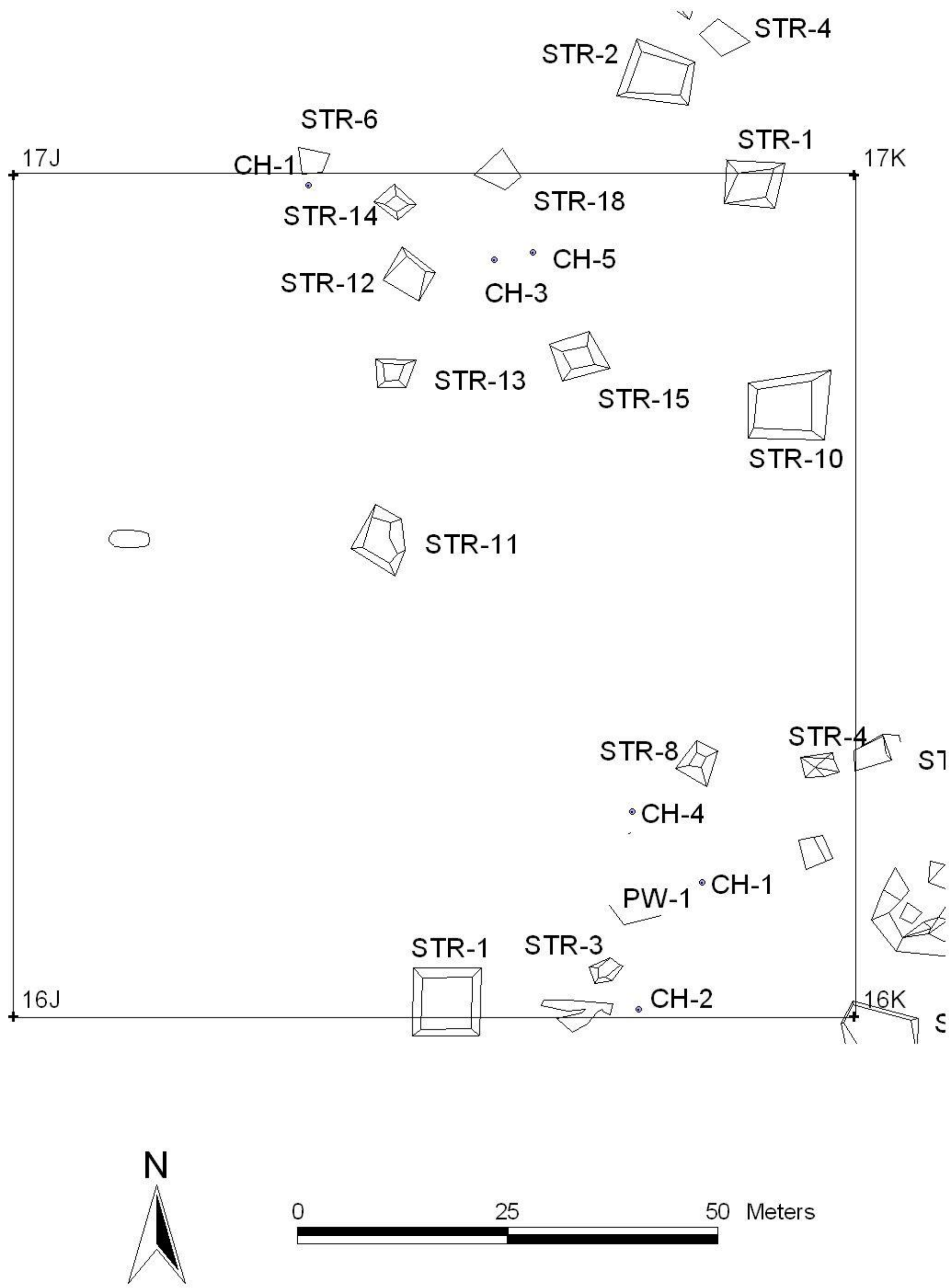


Figure B.140. Map of Section 16J.

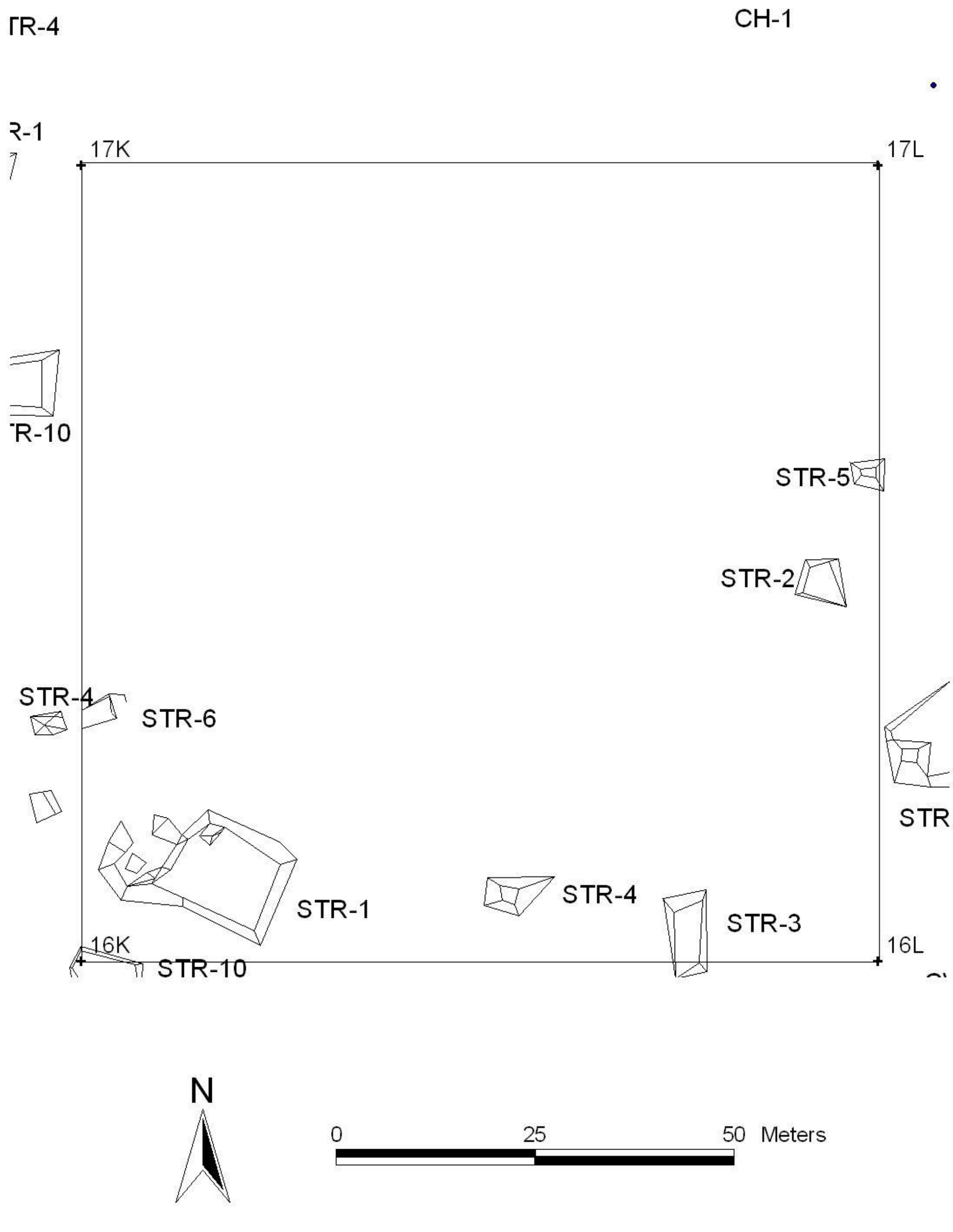


Figure B.141. Map of Section 16K.

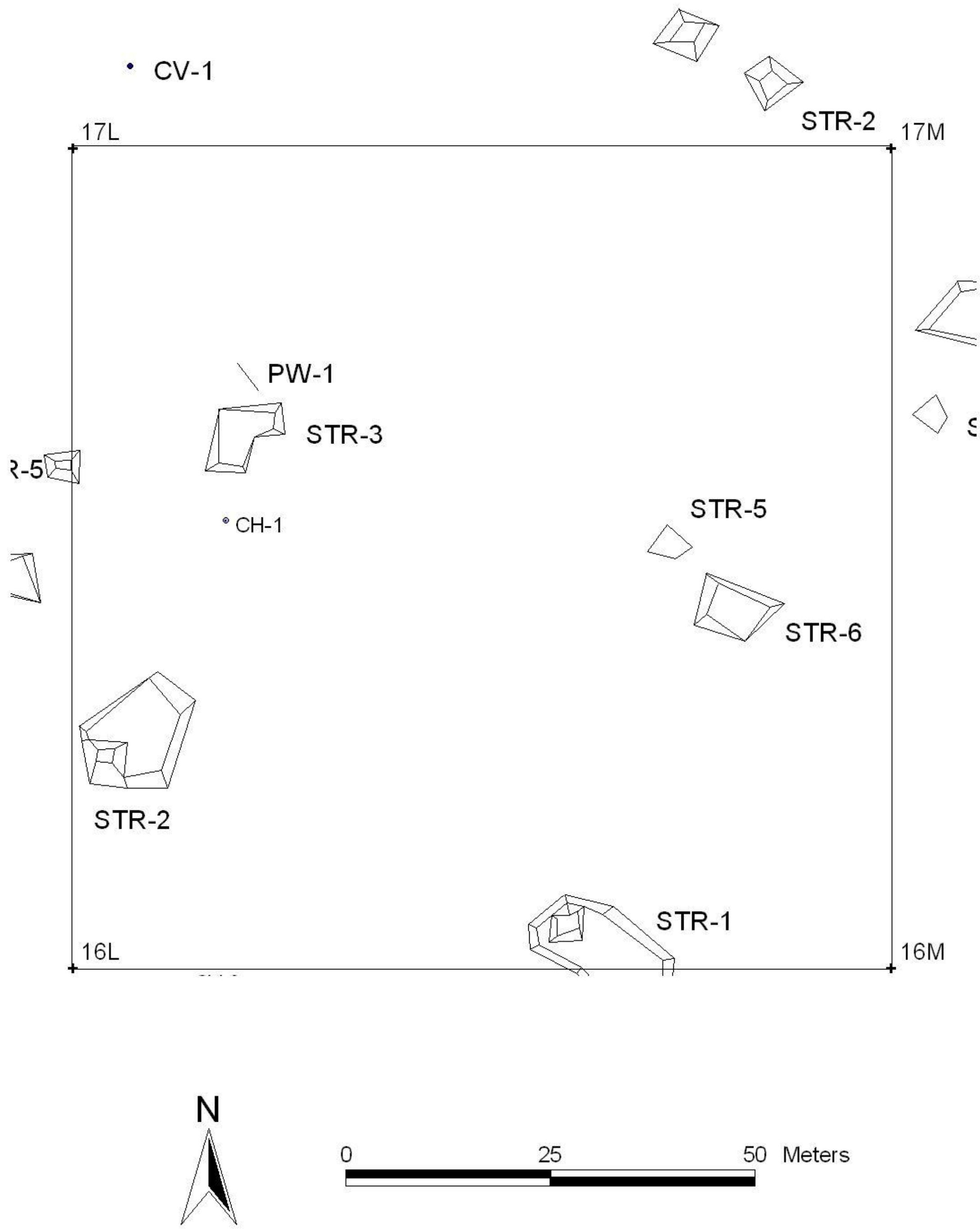


Figure B.142. Map of Section 16L.

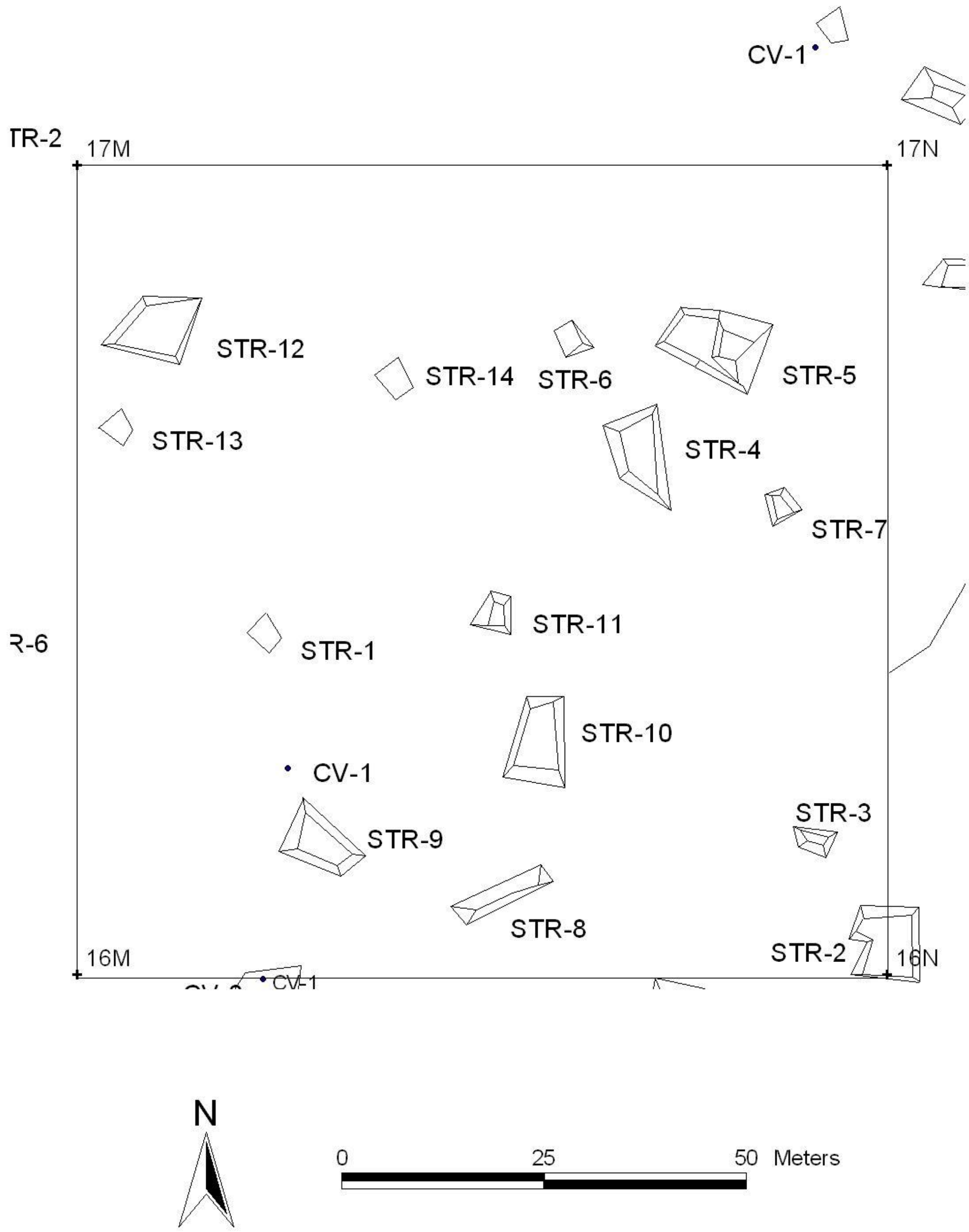


Figure B.143. Map of Section 16M.

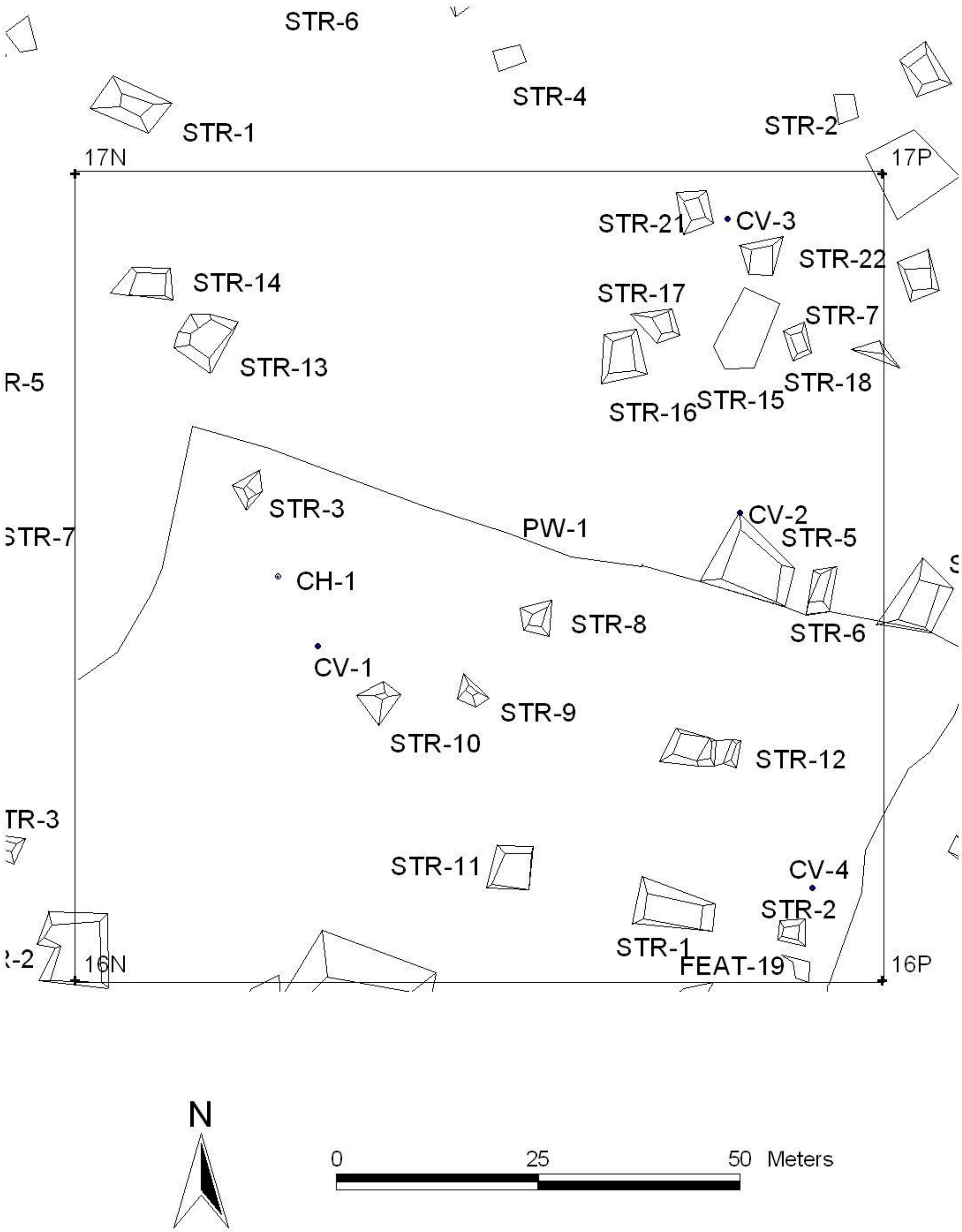


Figure B.144. Map of Section 16N.

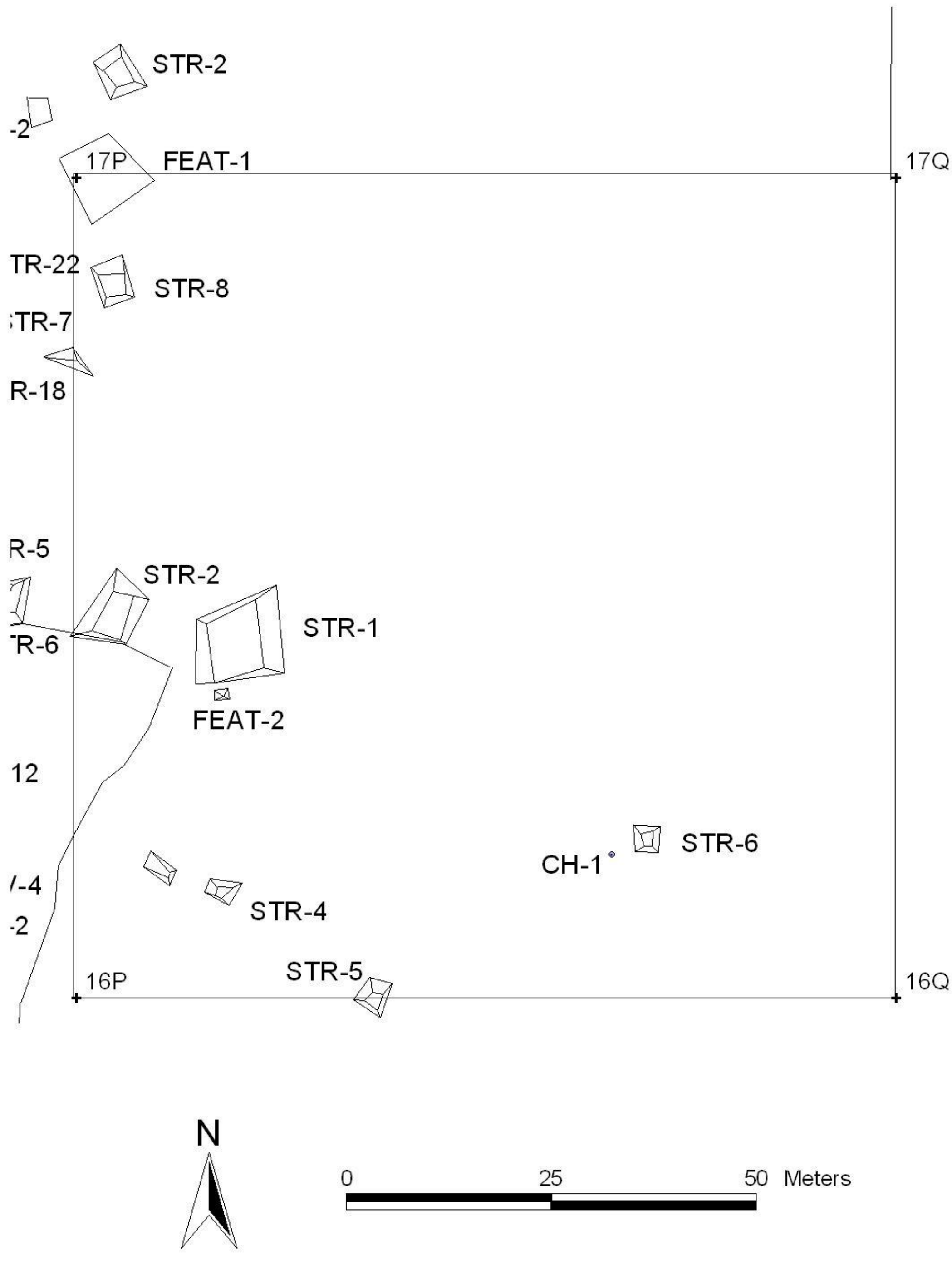


Figure B.145. Map of Section 16P.

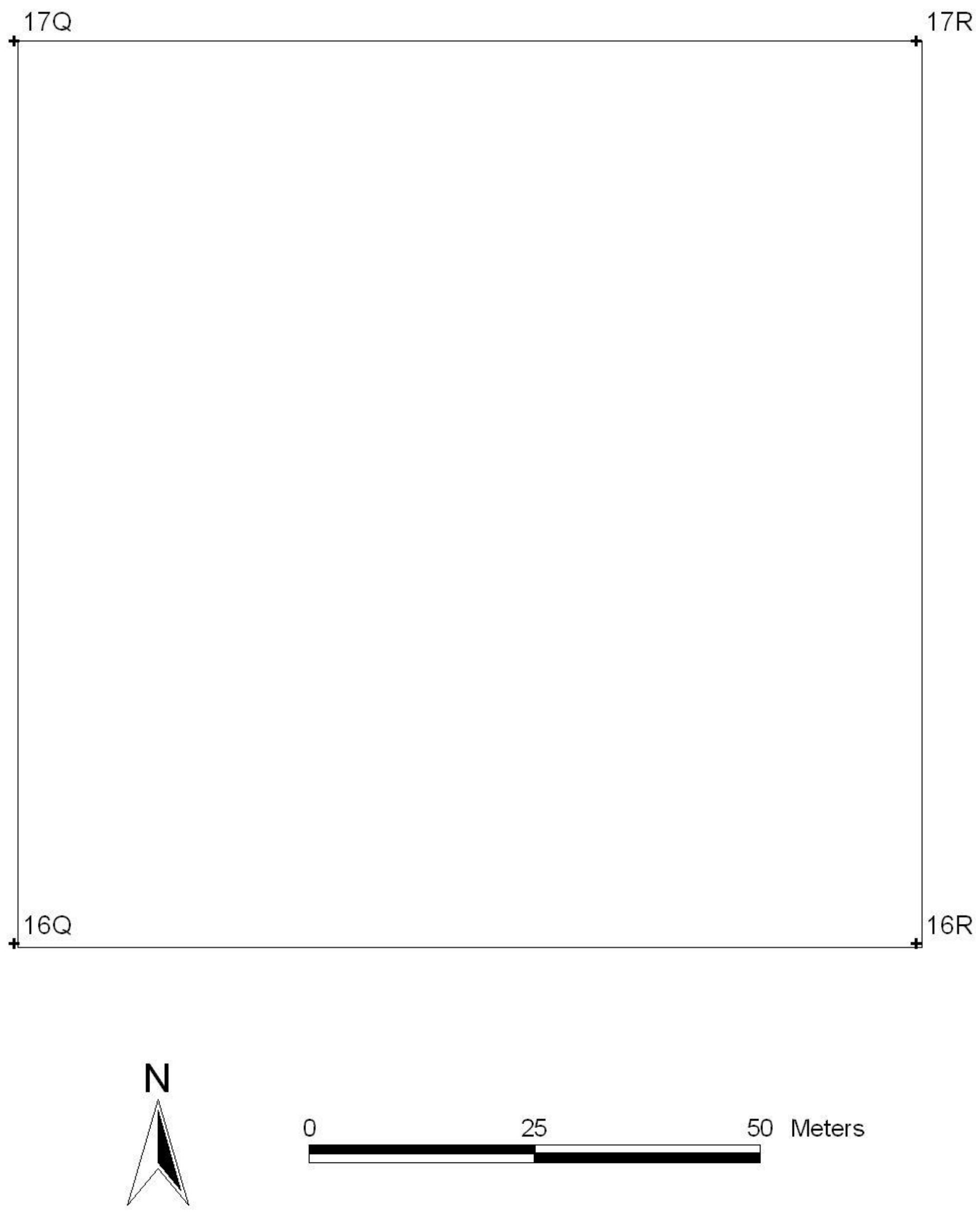


Figure B.146. Map of Section 16Q.

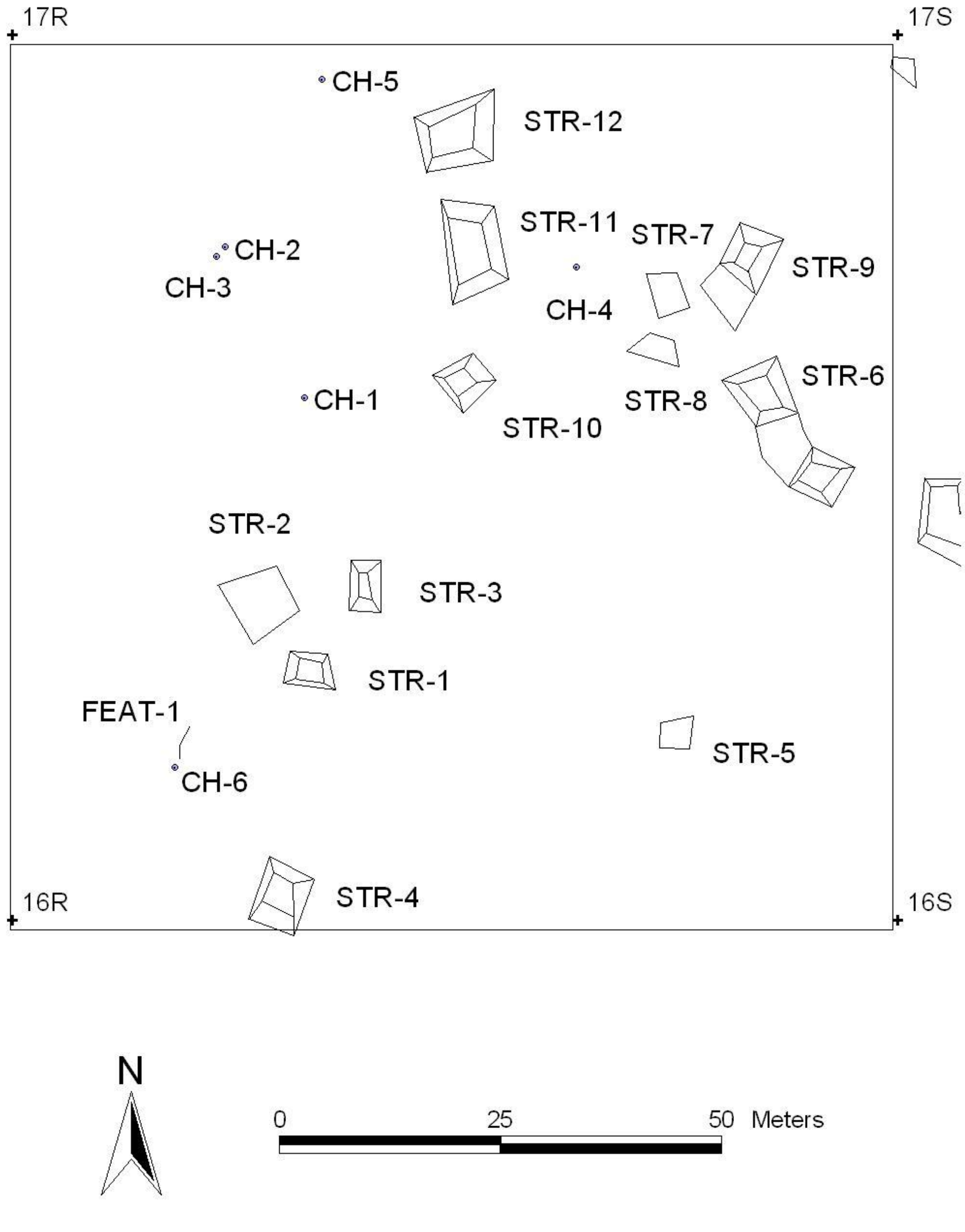


Figure B.147. Map of Section 16R.

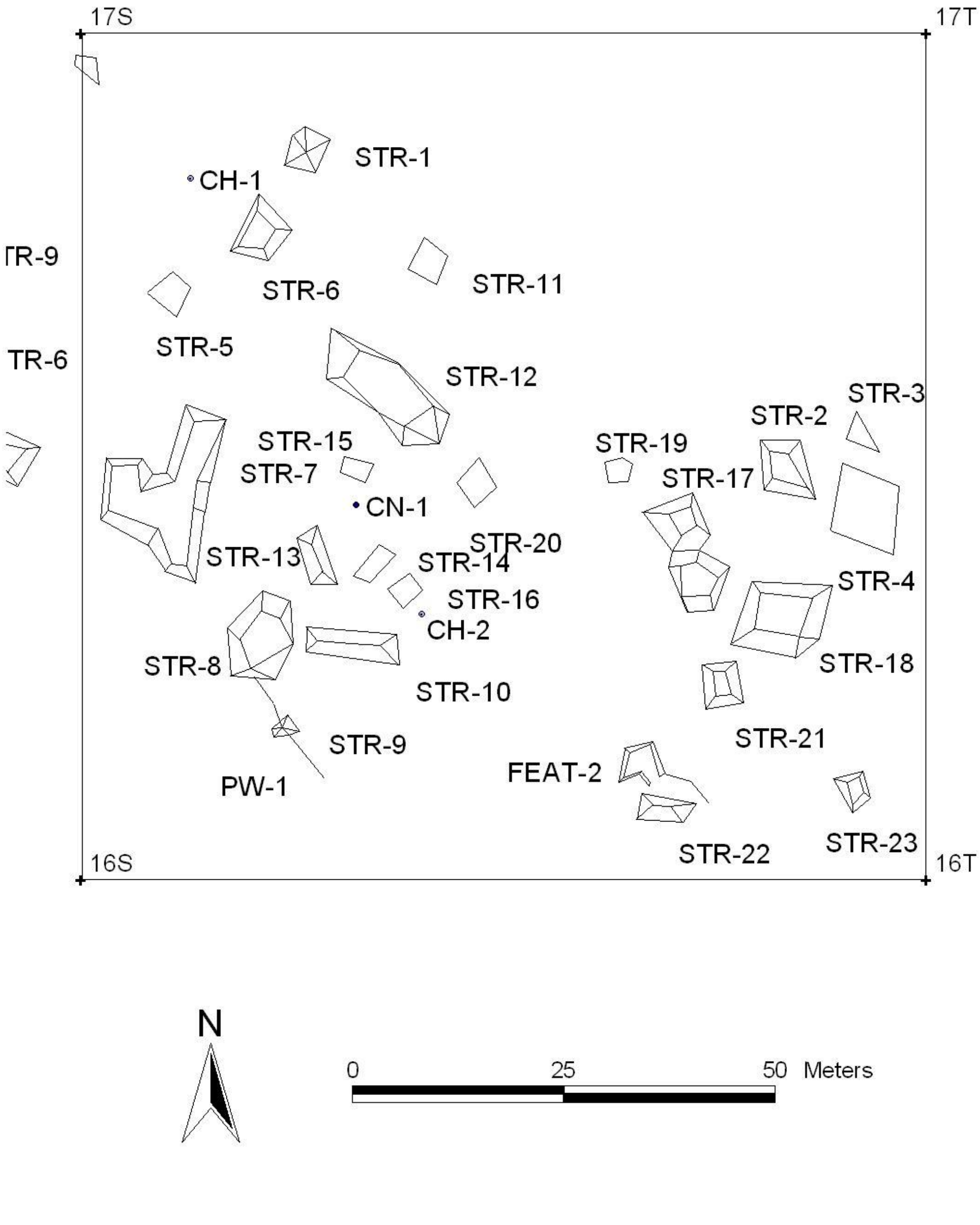


Figure B.148. Map of Section 16S.

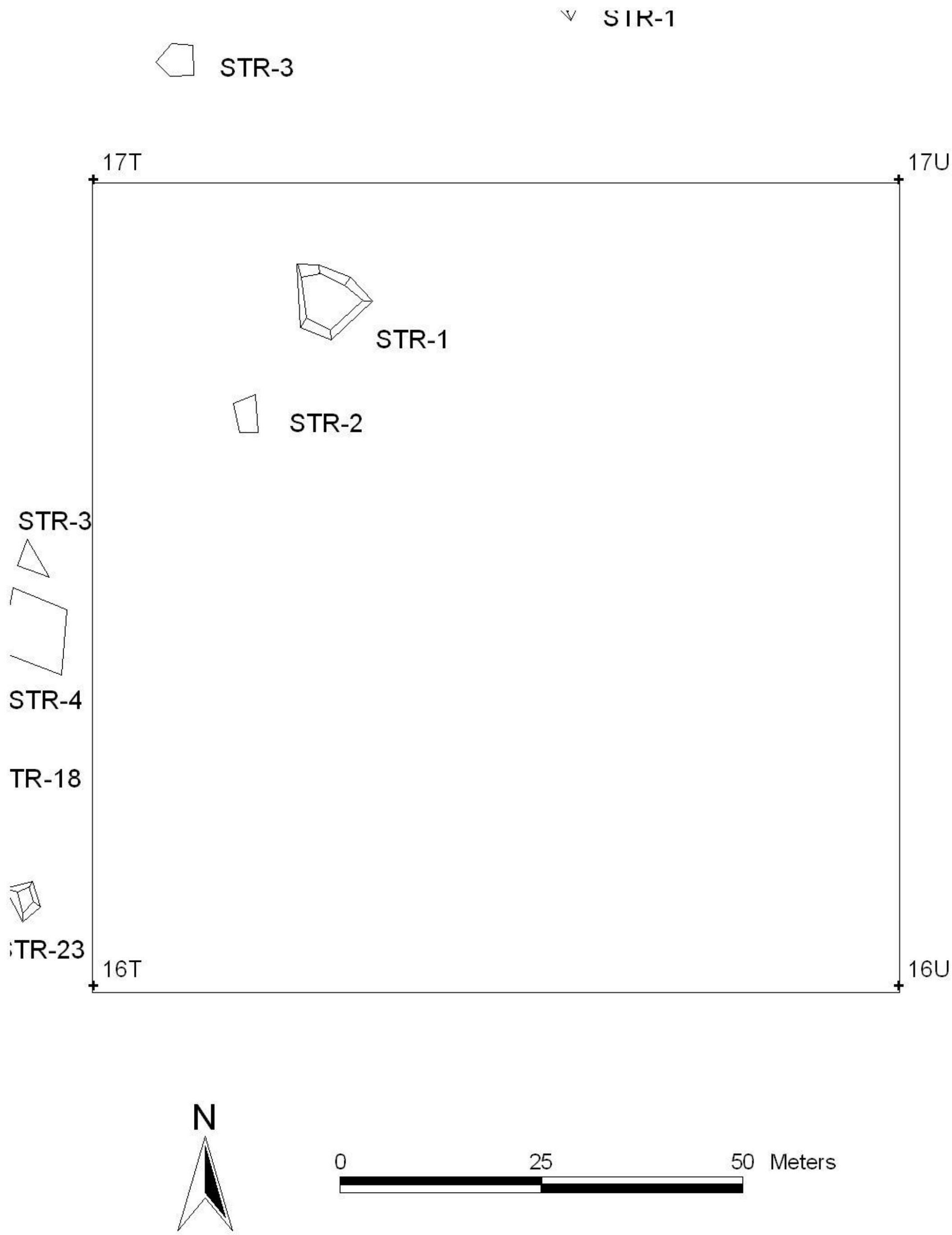


Figure B.149. Map of Section 16T.

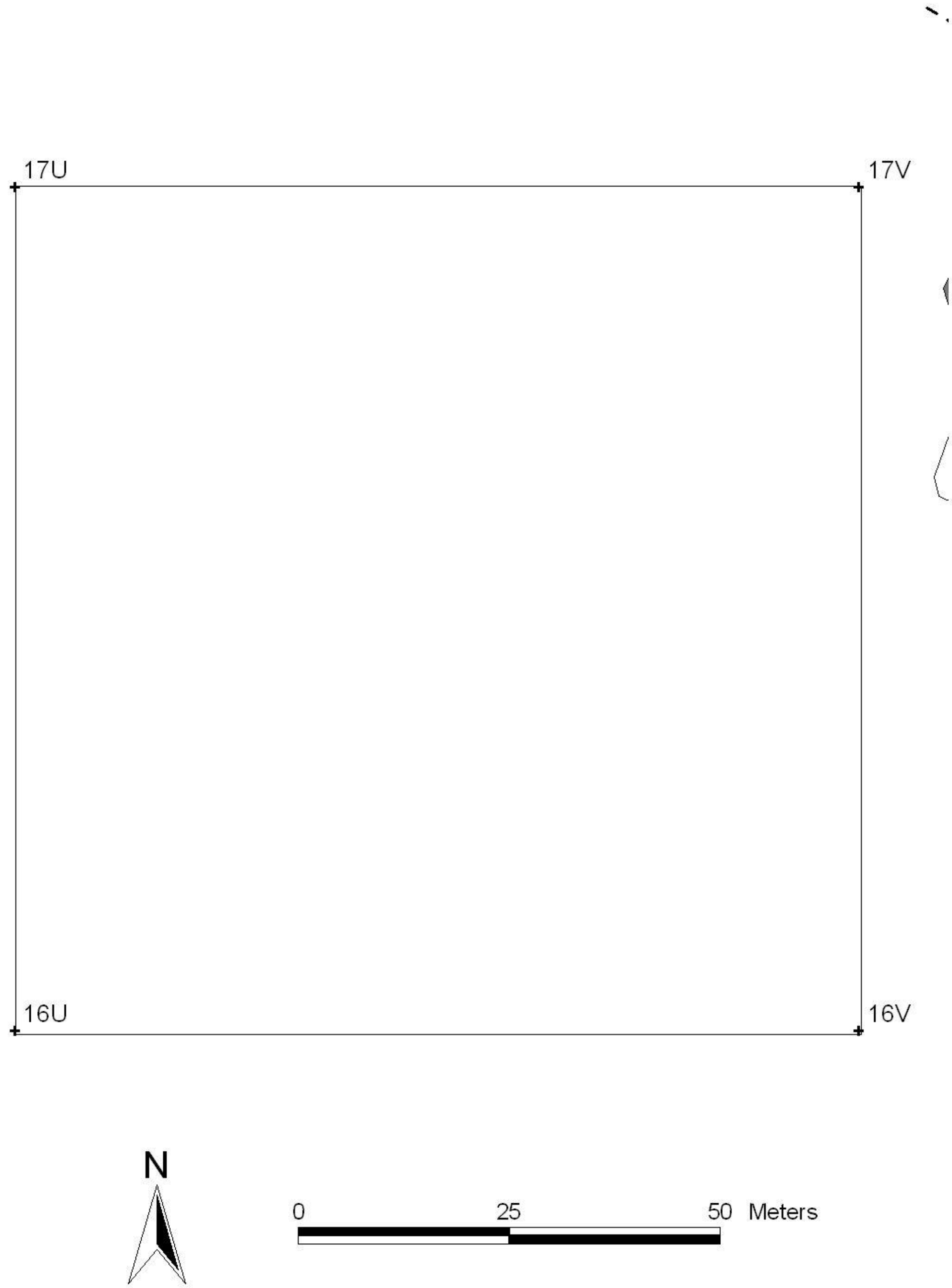


Figure B.150. Map of Section 16U.

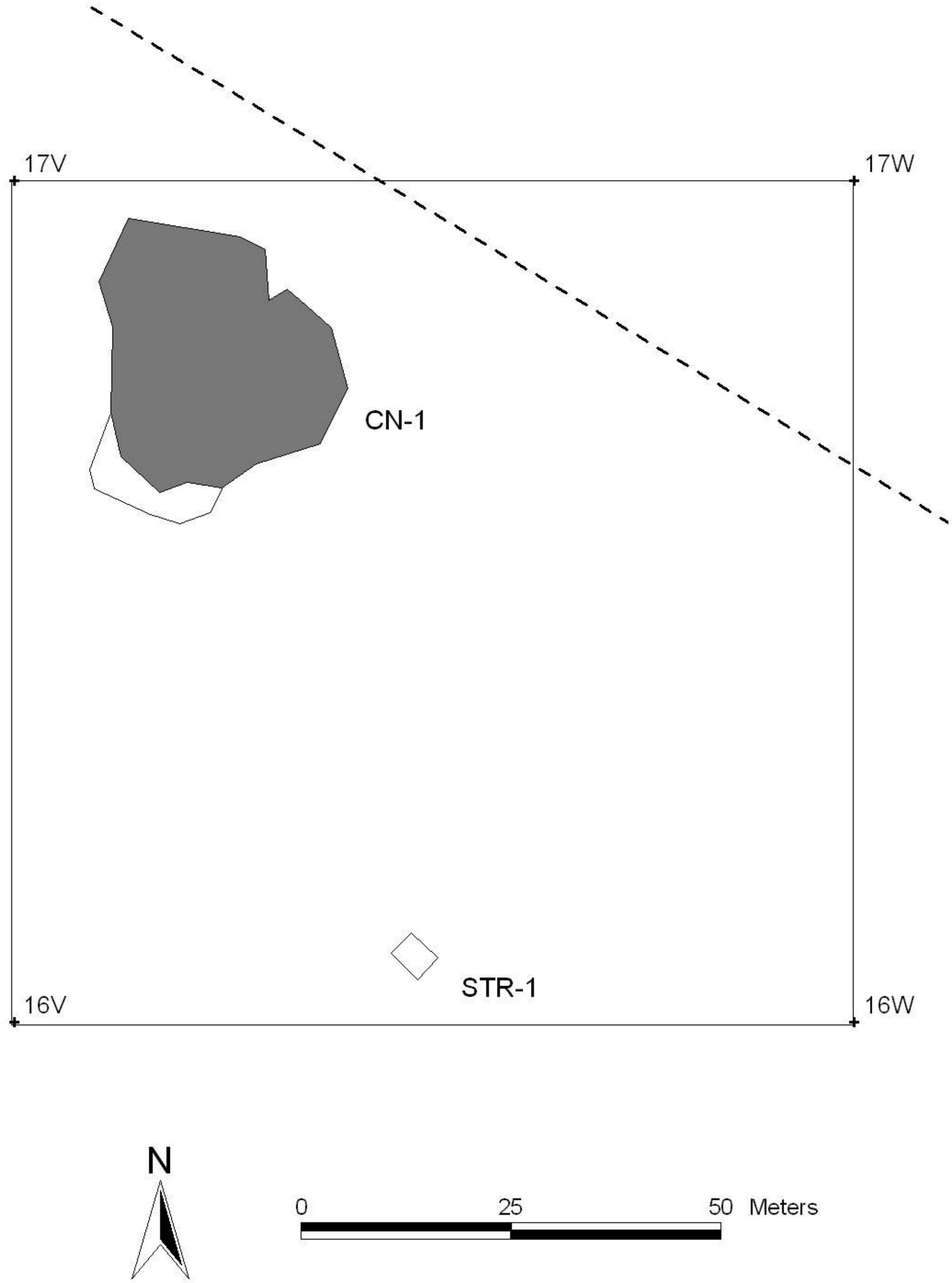


Figure B.151. Map of Section 16V.

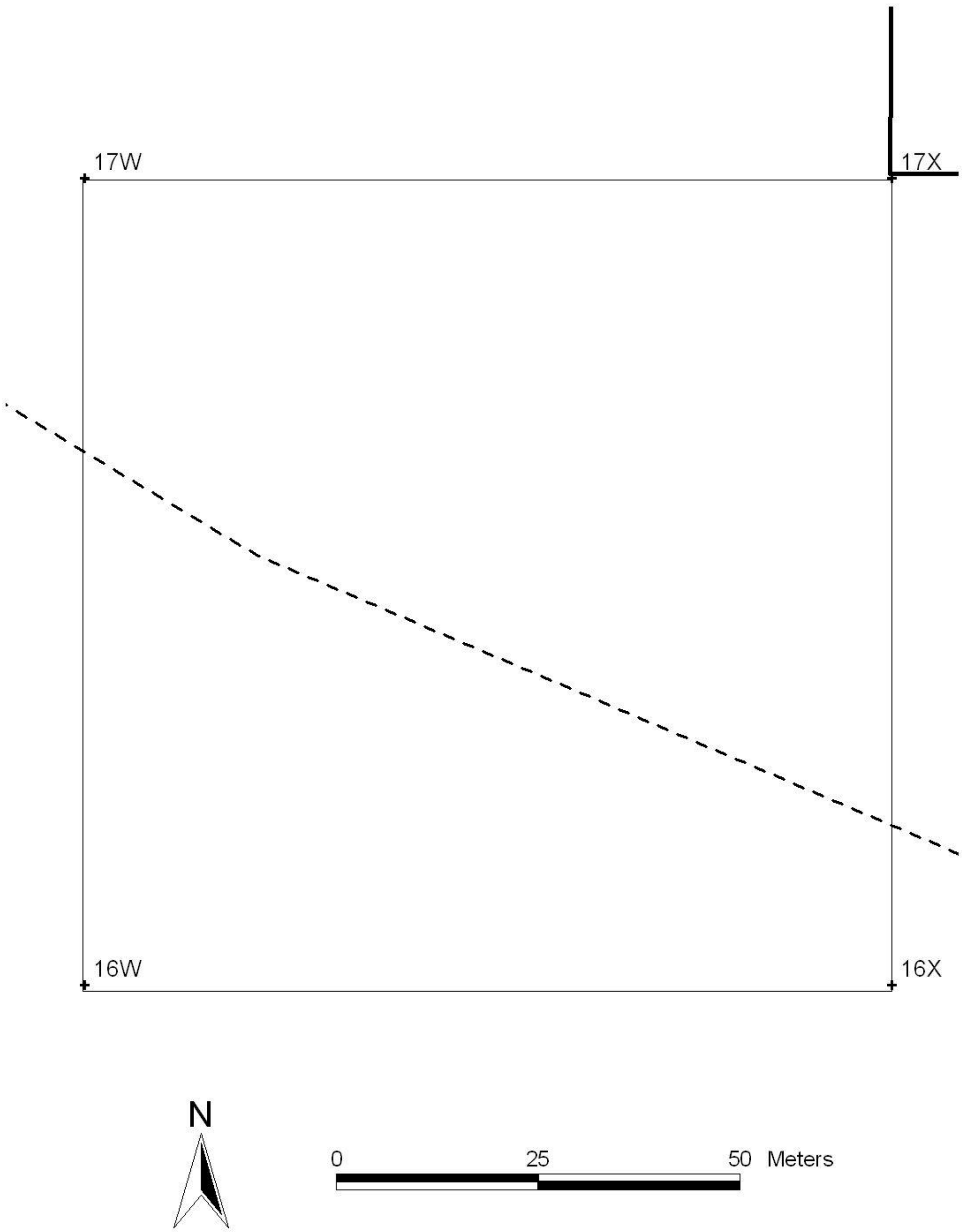


Figure B.152. Map of Section 16W.

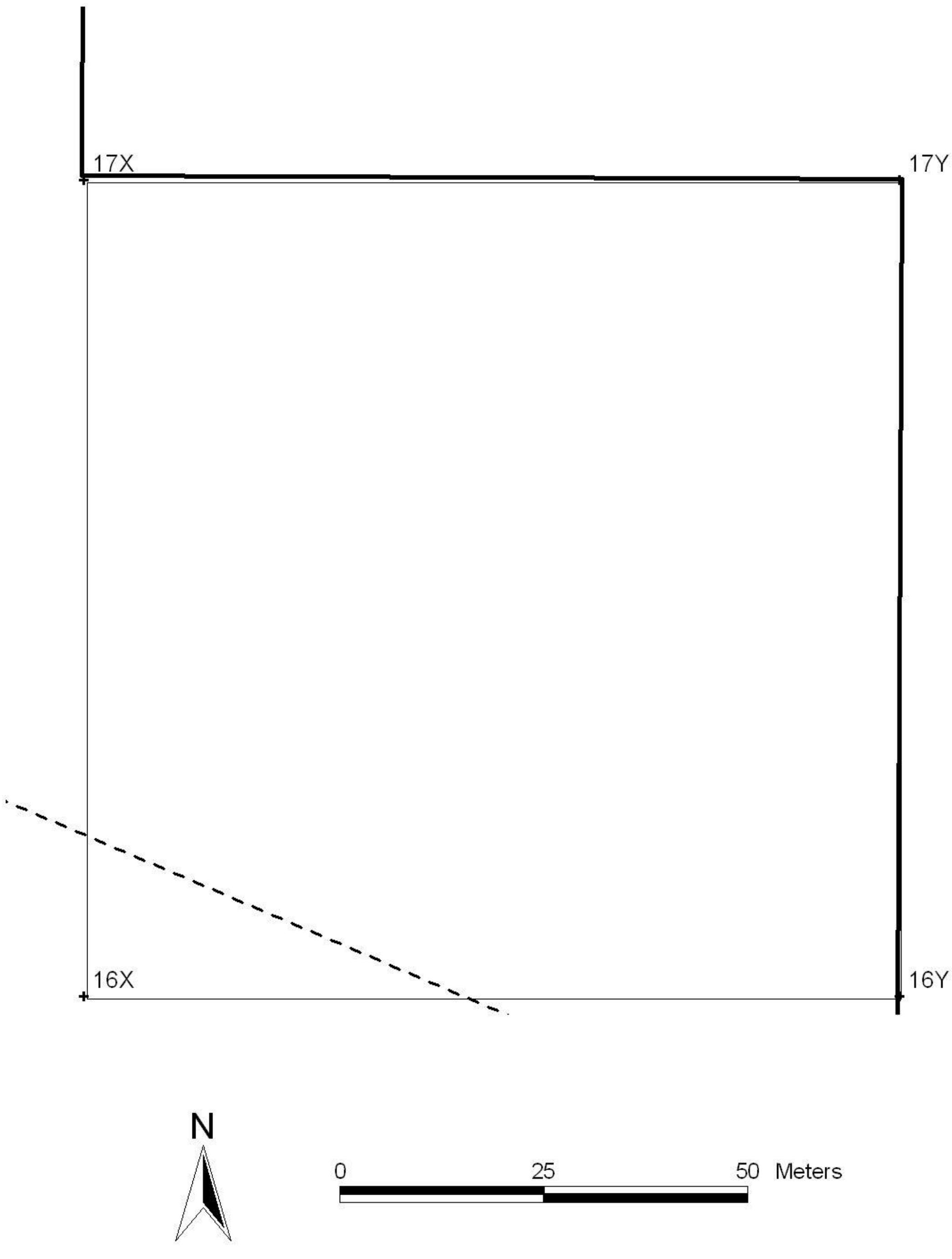


Figure B.153. Map of Section 16X.

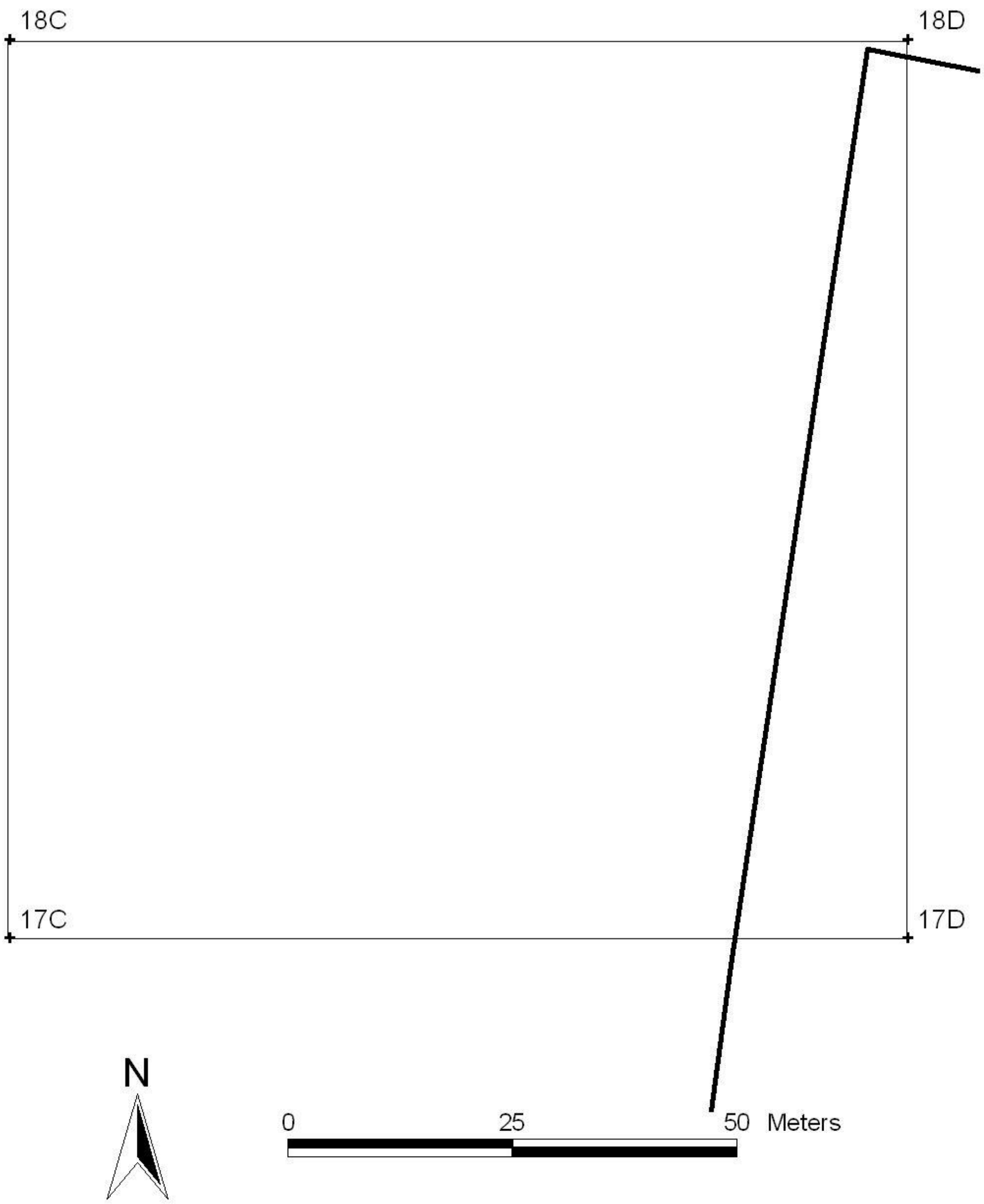


Figure B.154. Map of Section 17C.

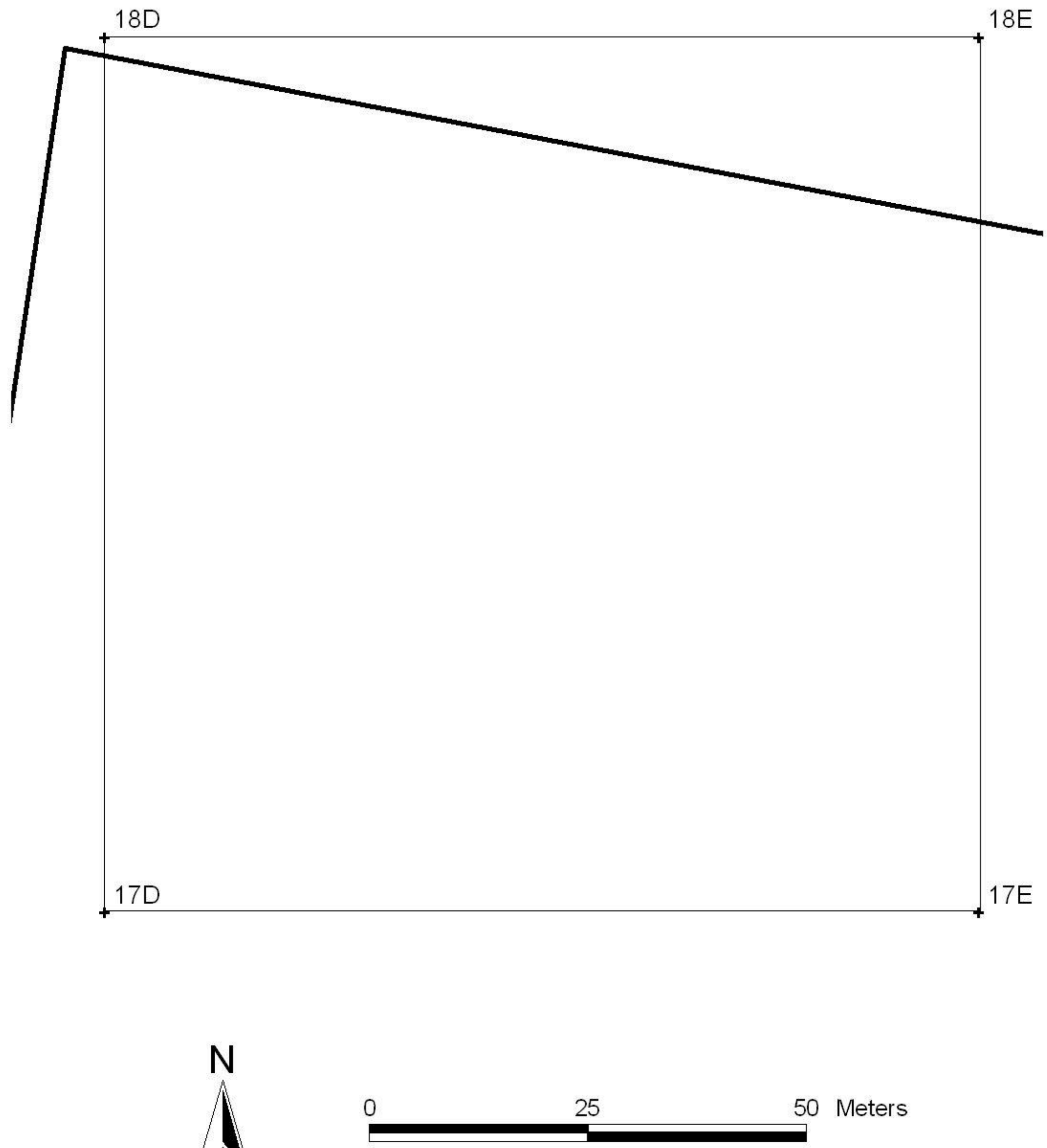


Figure B.155. Map of Section 17D.

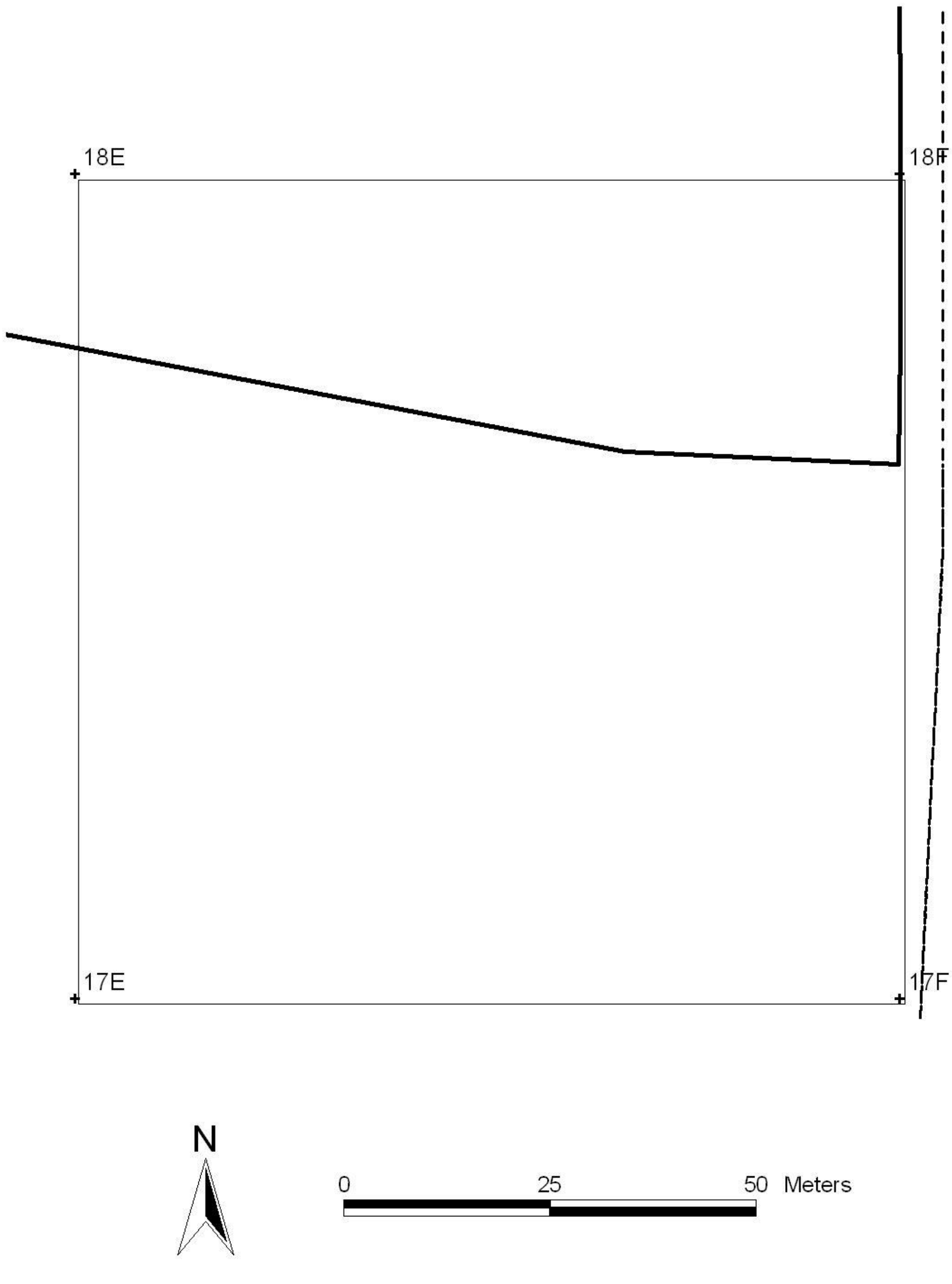


Figure B.156. Map of Section 17E.

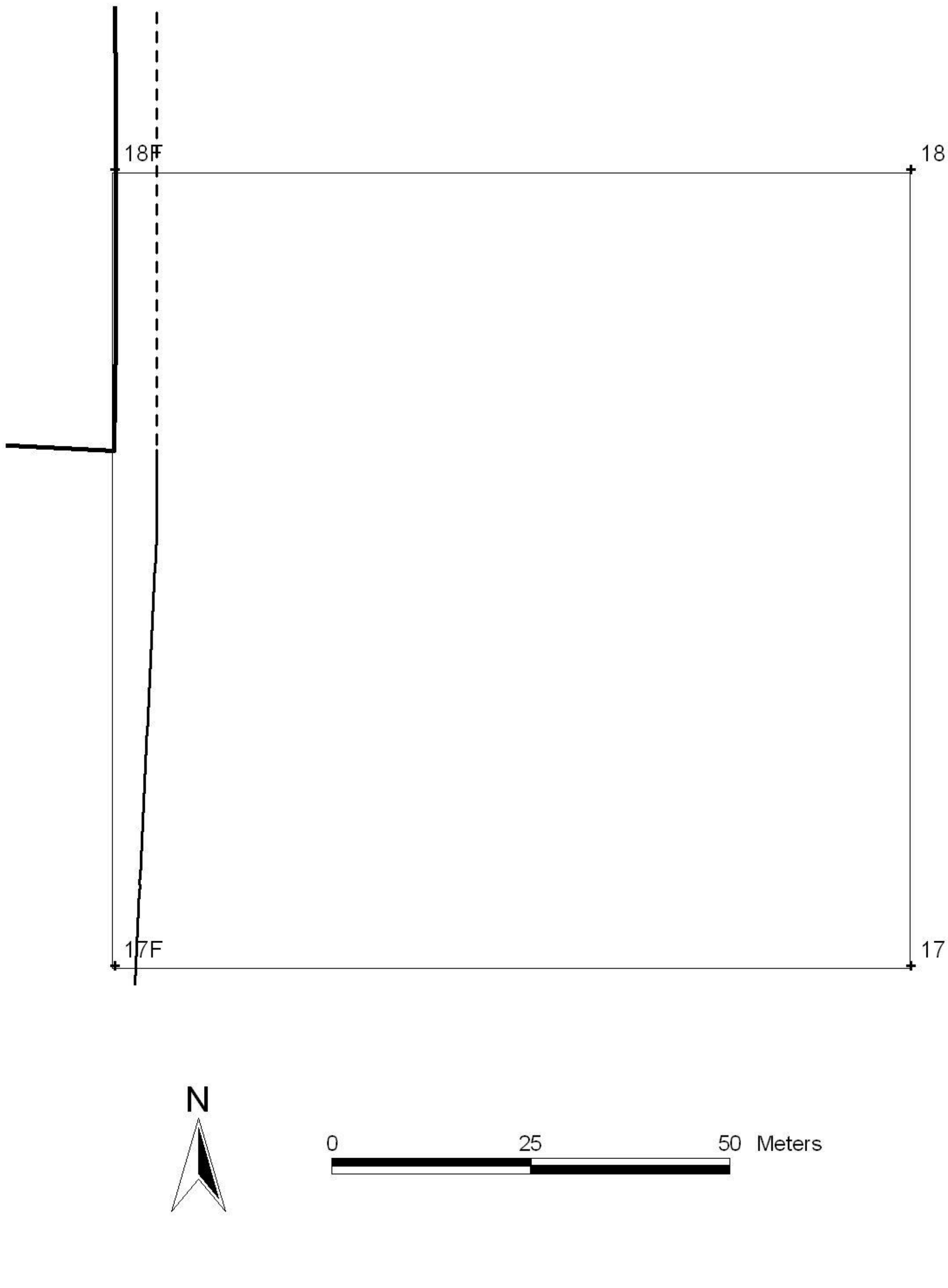


Figure B.157. Map of Section 17F.

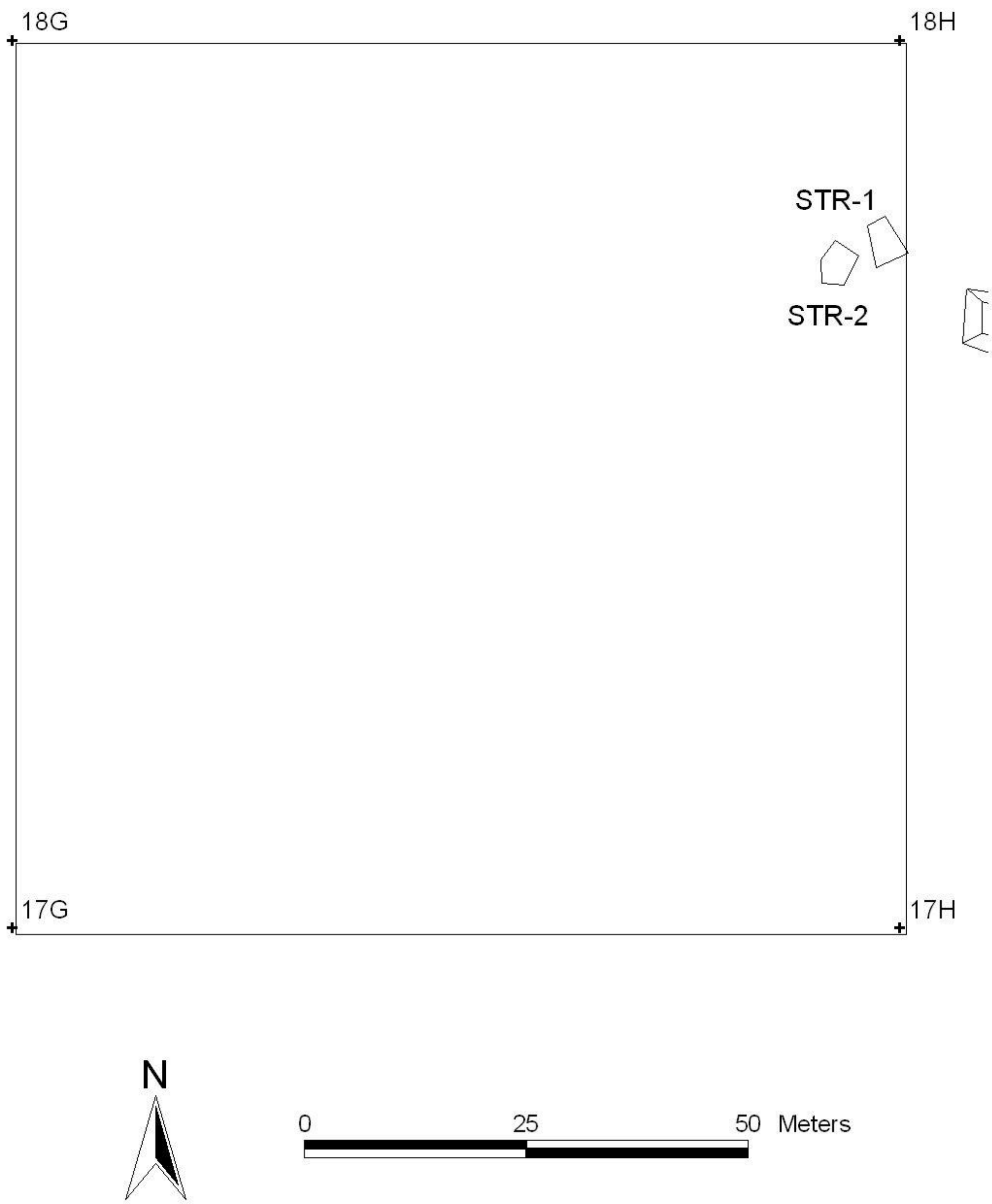


Figure B.158. Map of Section 17G.

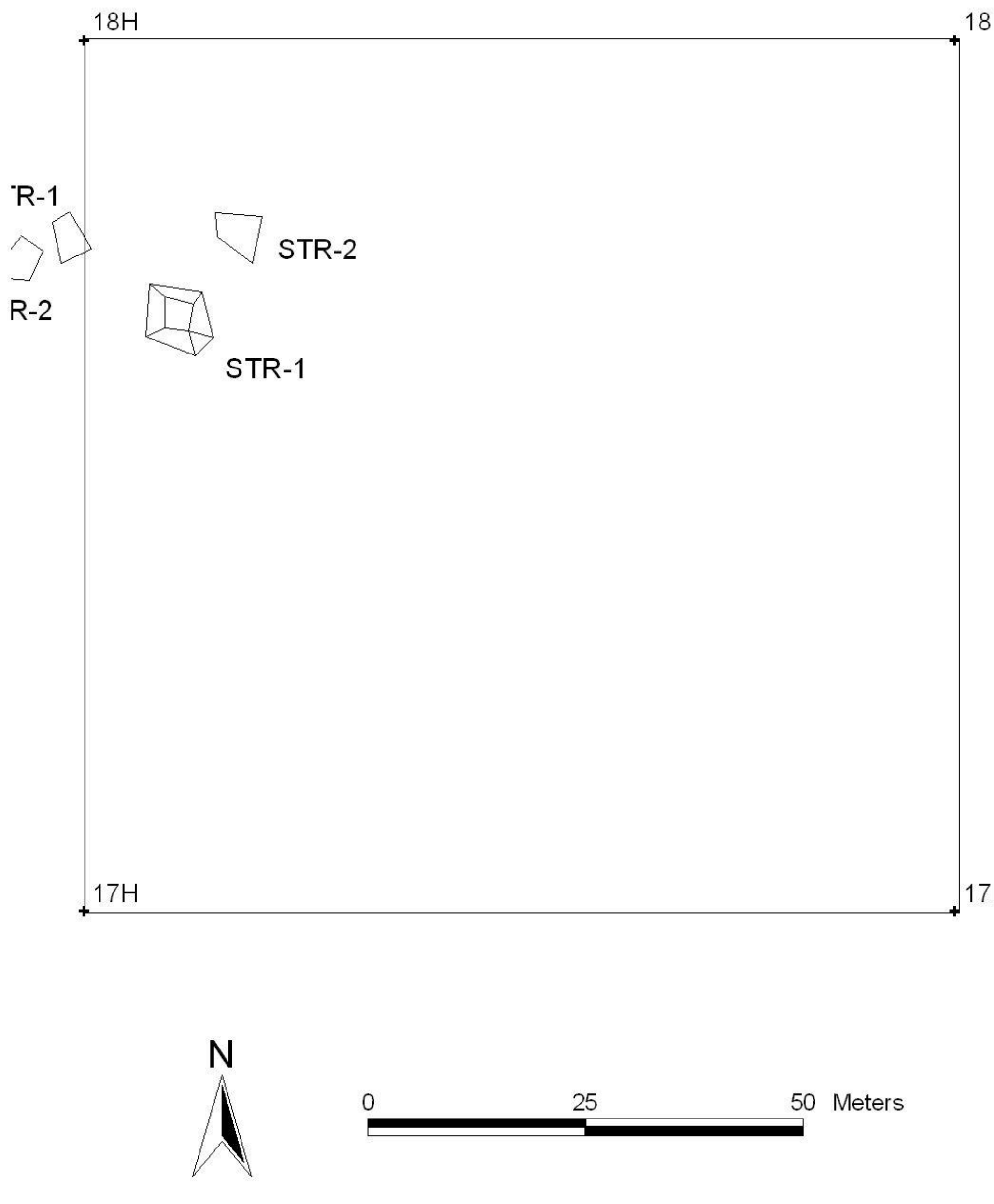


Figure B.159. Map of Section 17H.

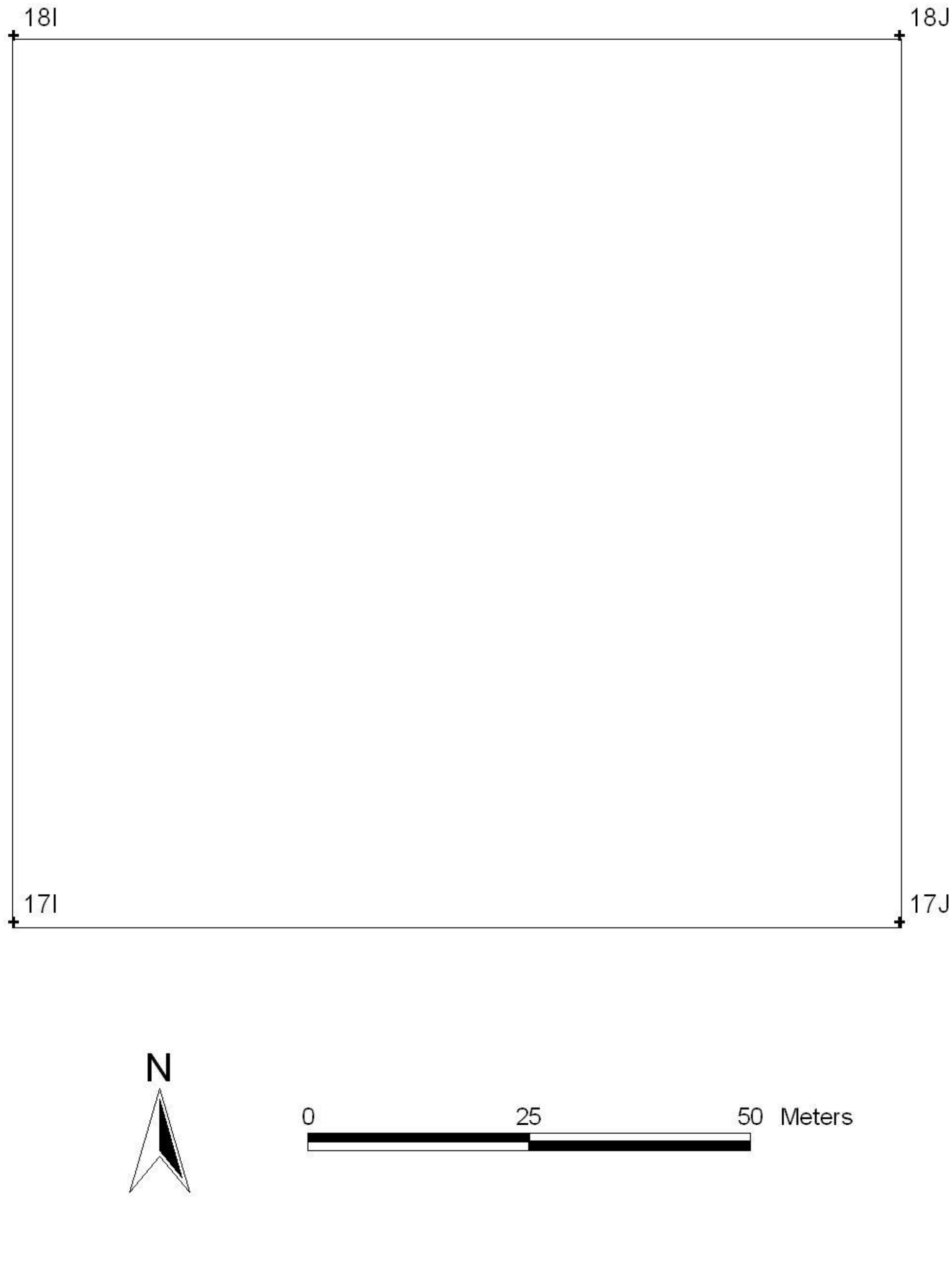


Figure B.160. Map of Section 17I.

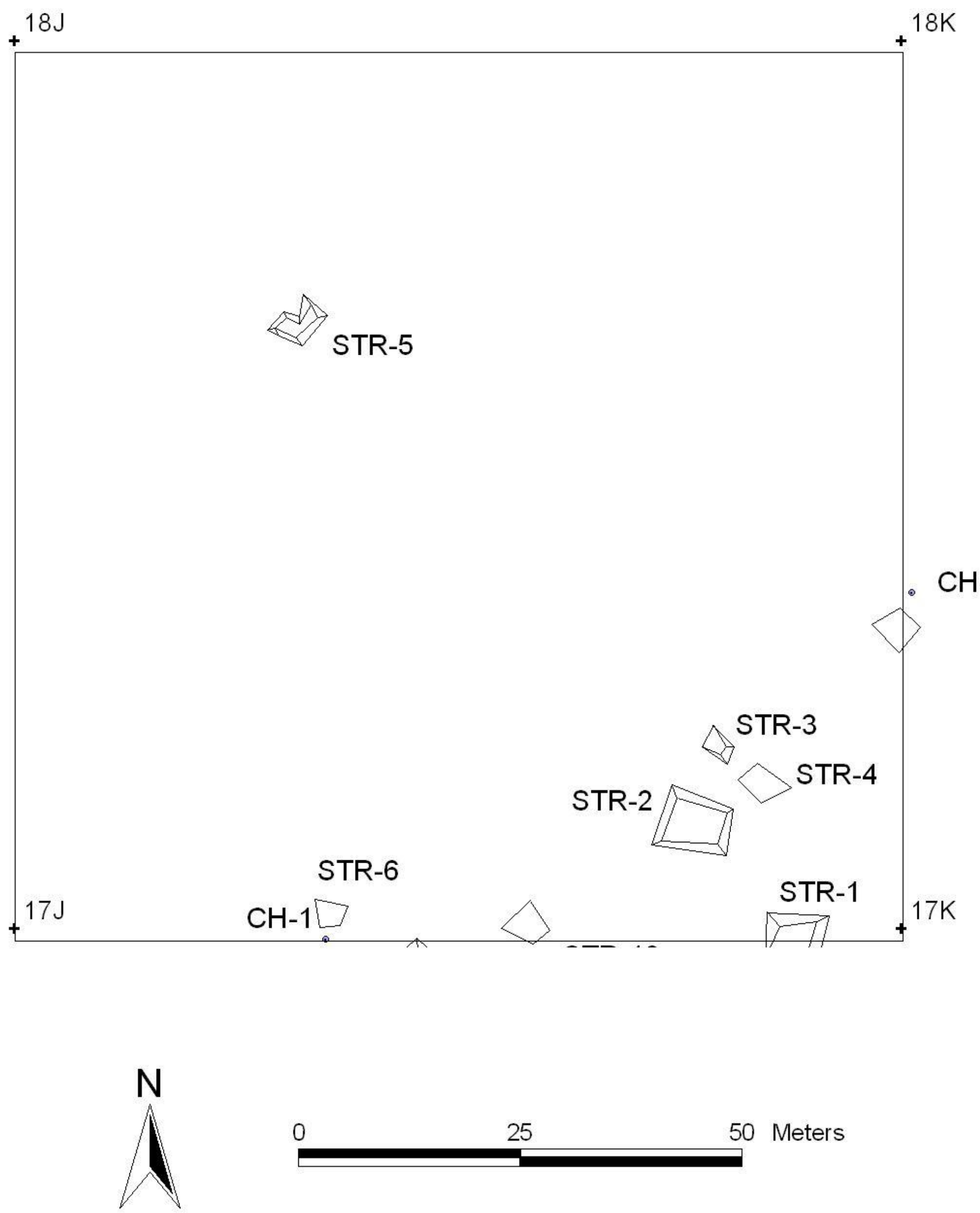


Figure B.161. Map of Section 17J.

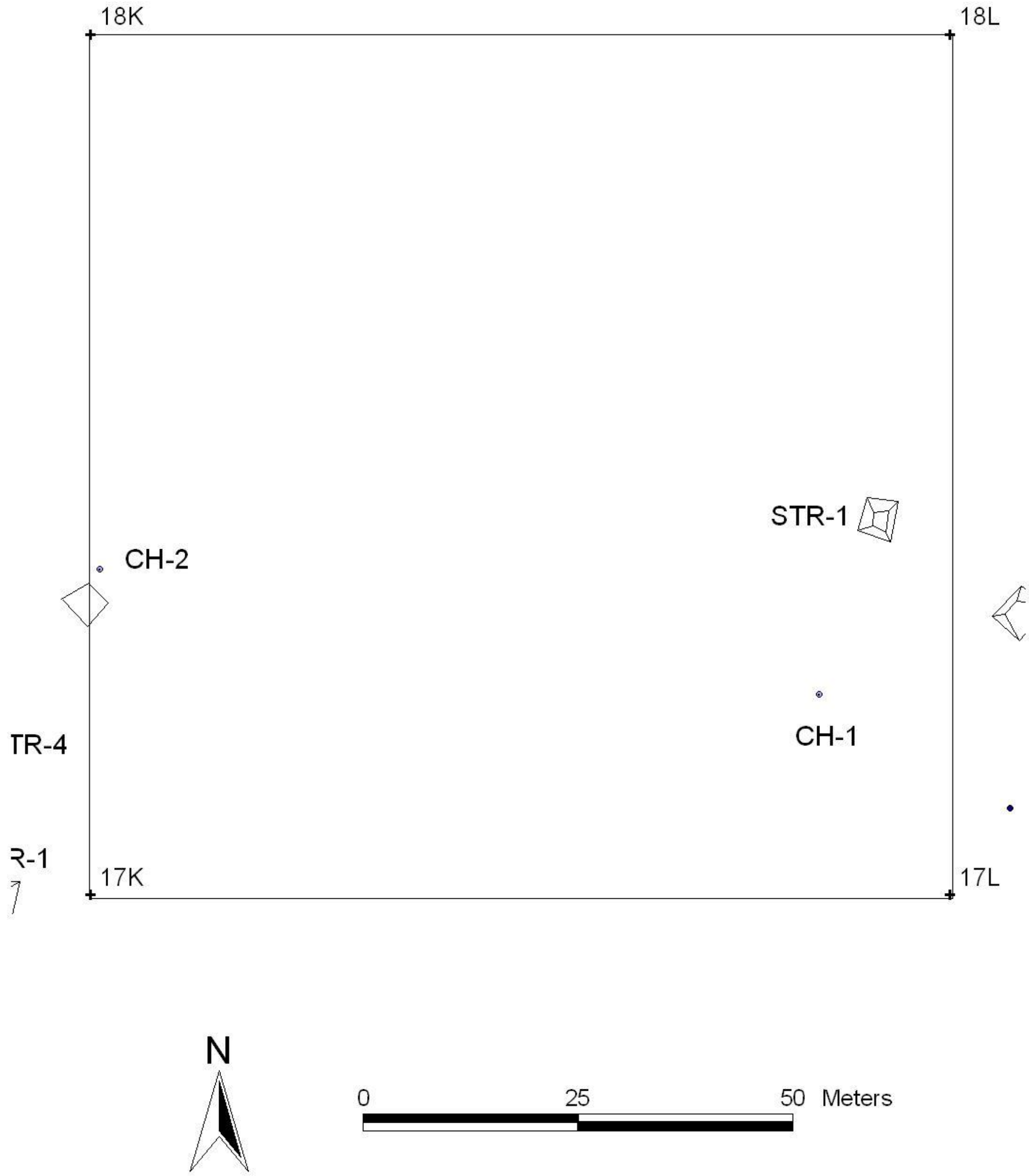


Figure B.162. Map of Section 17K.

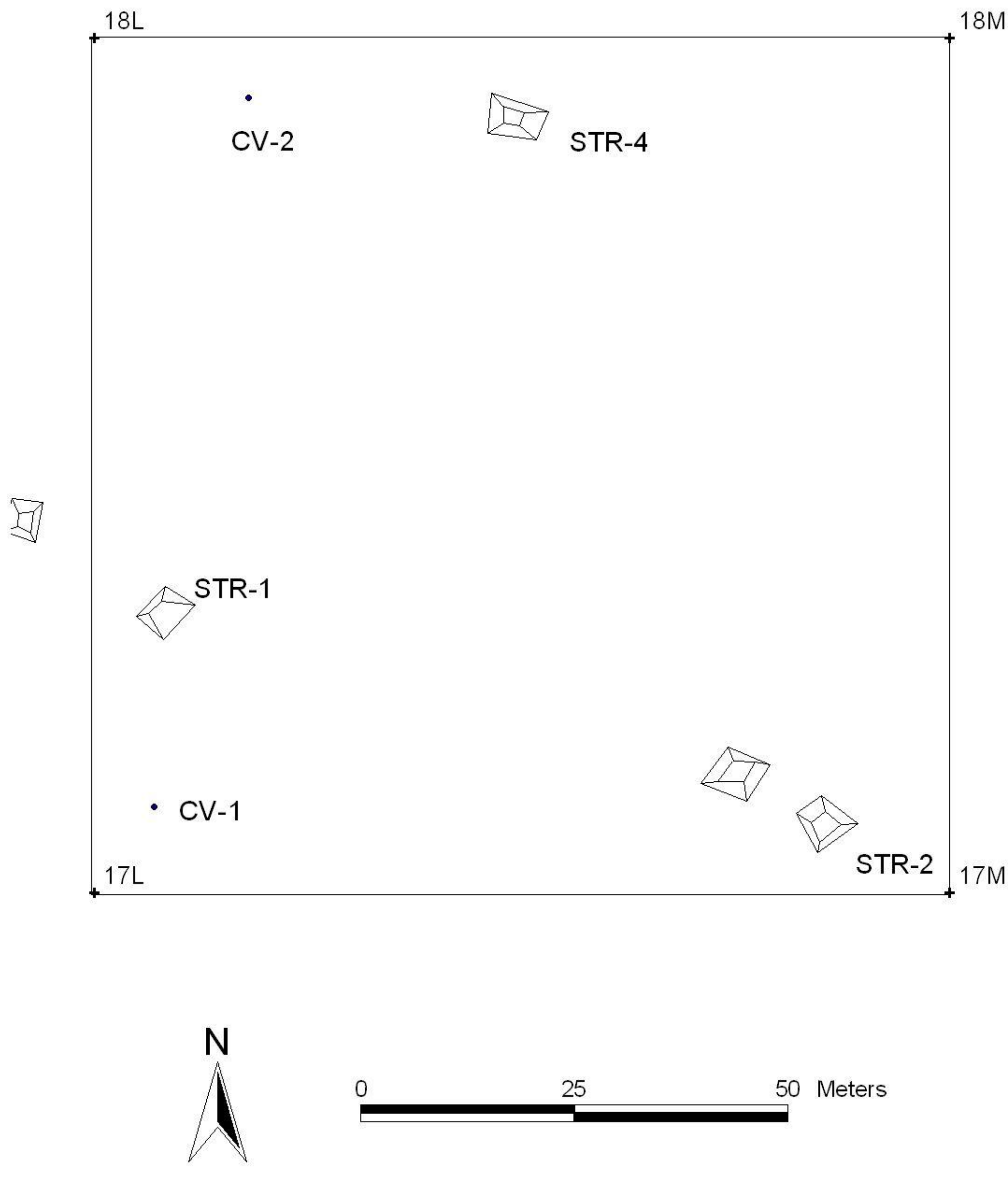


Figure B.163. Map of Section 17L.

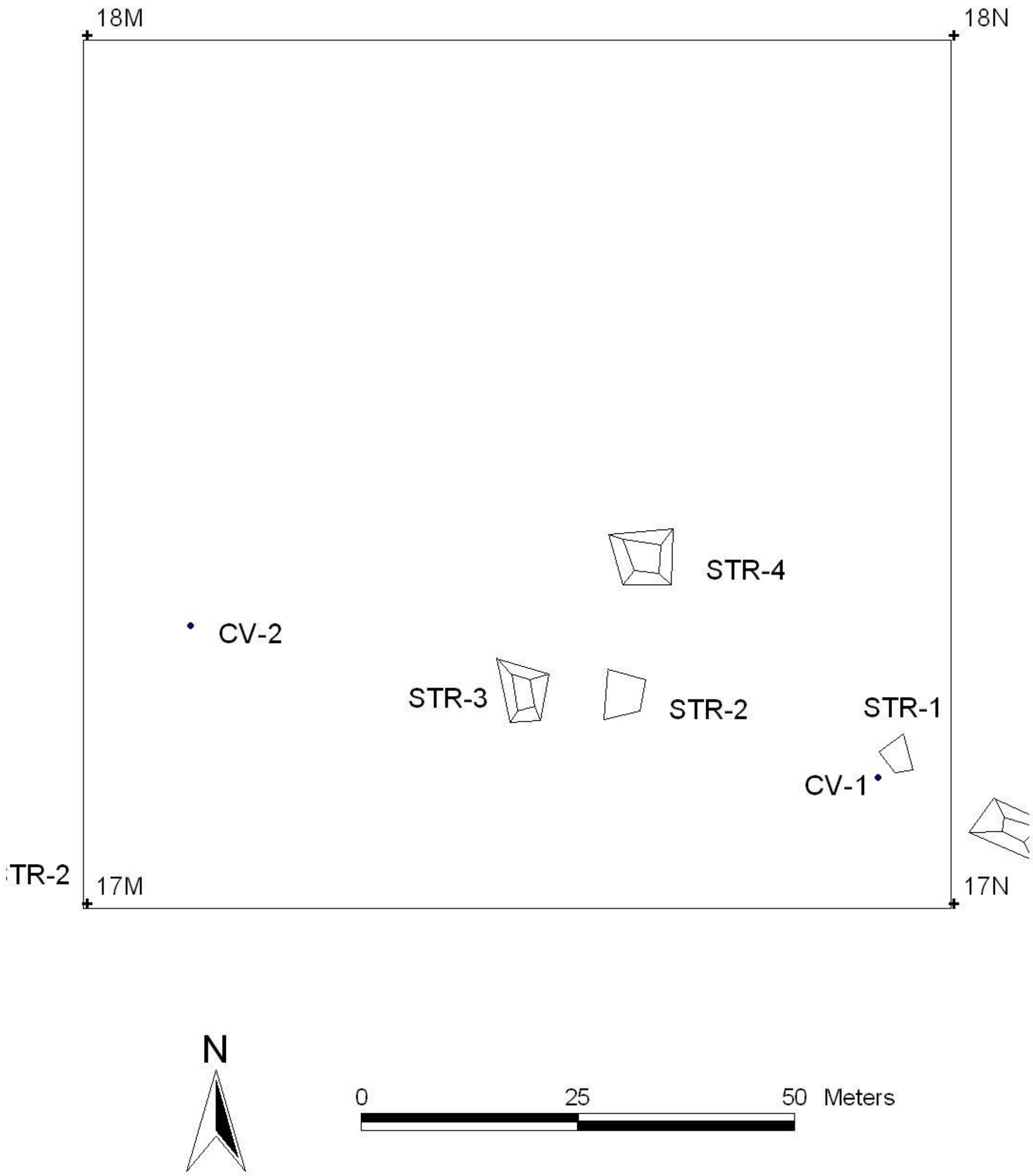


Figure B.164. Map of Section 17M.

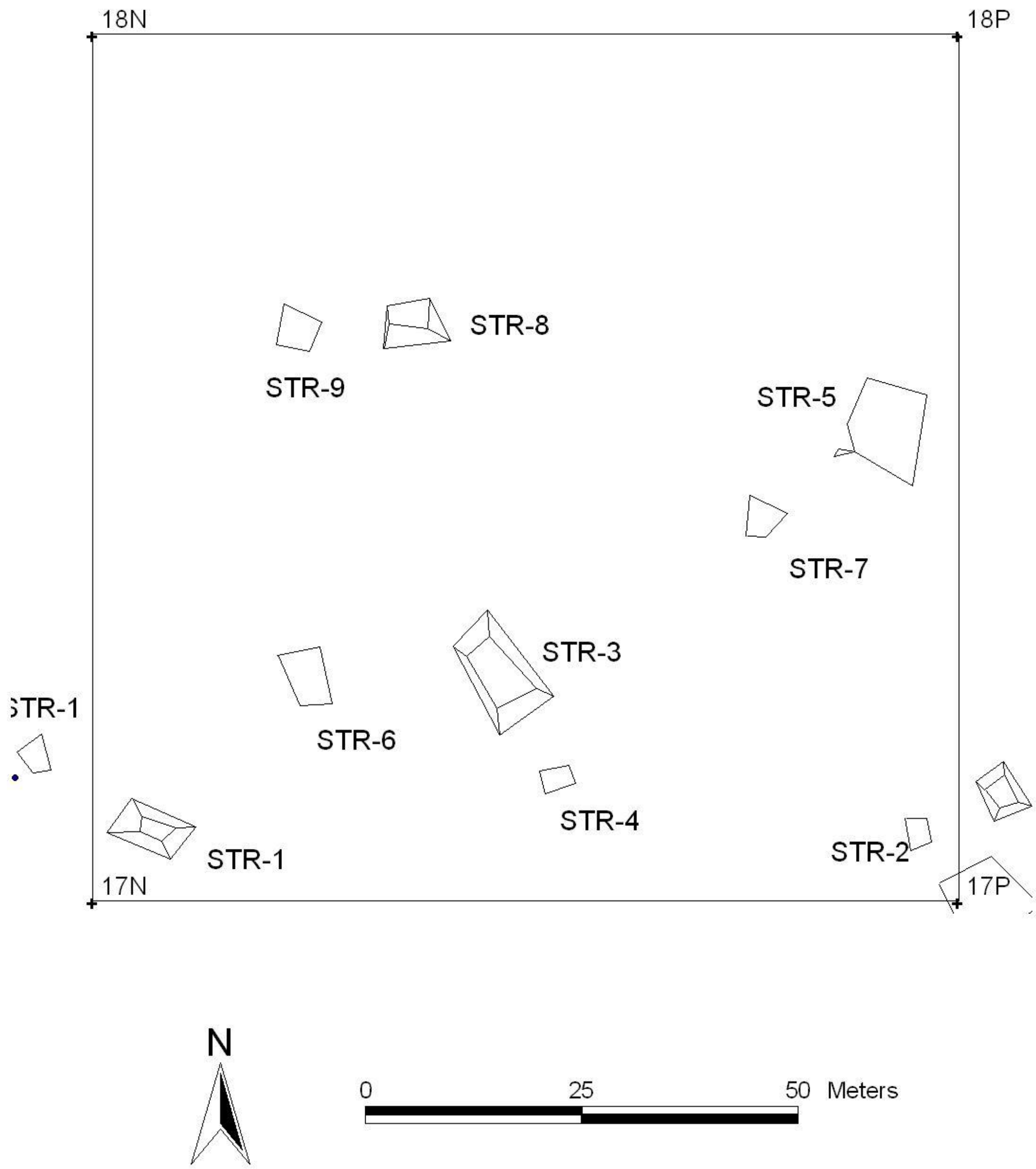


Figure B.165. Map of Section 17N.

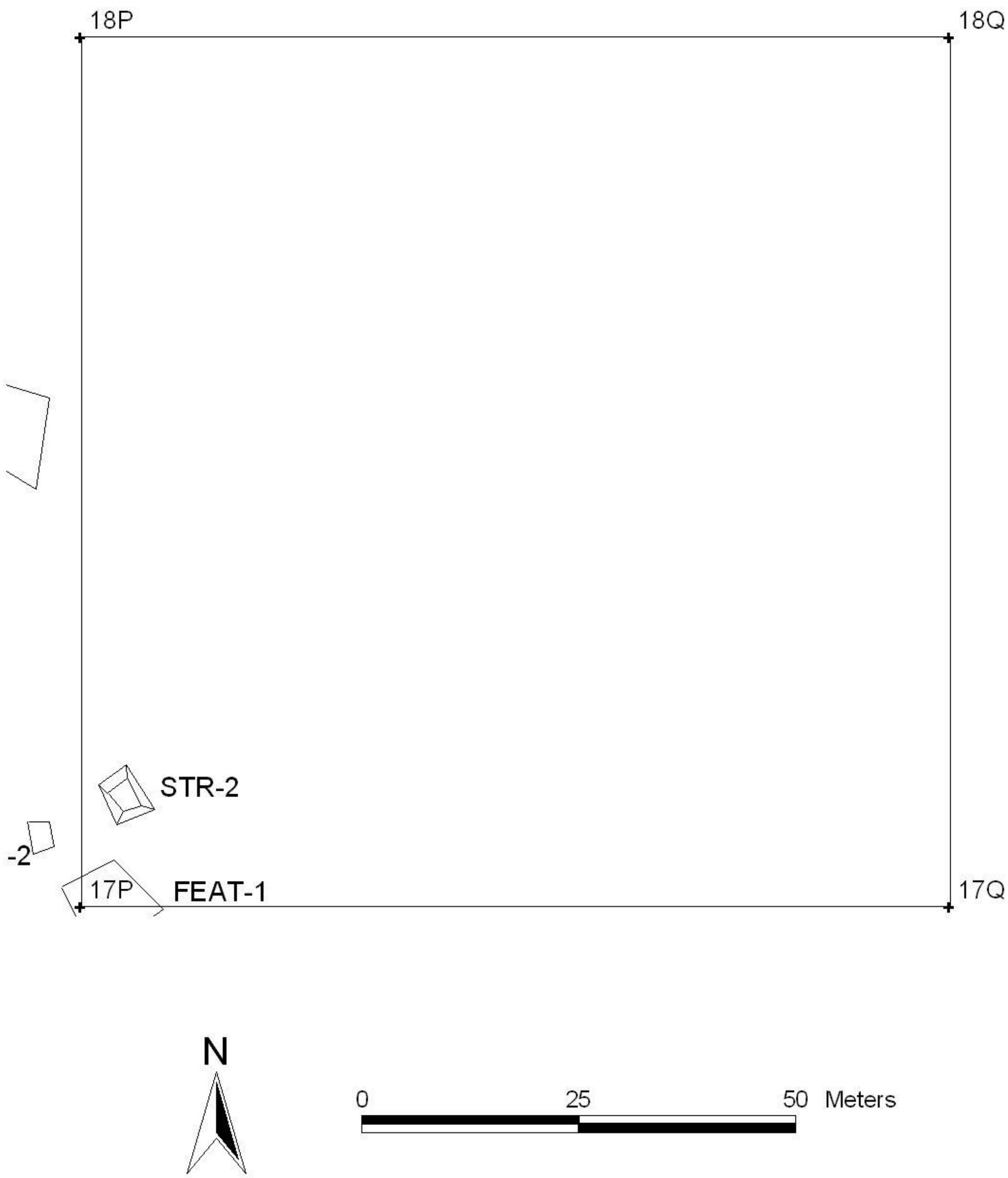


Figure B.166. Map of Section 17P.

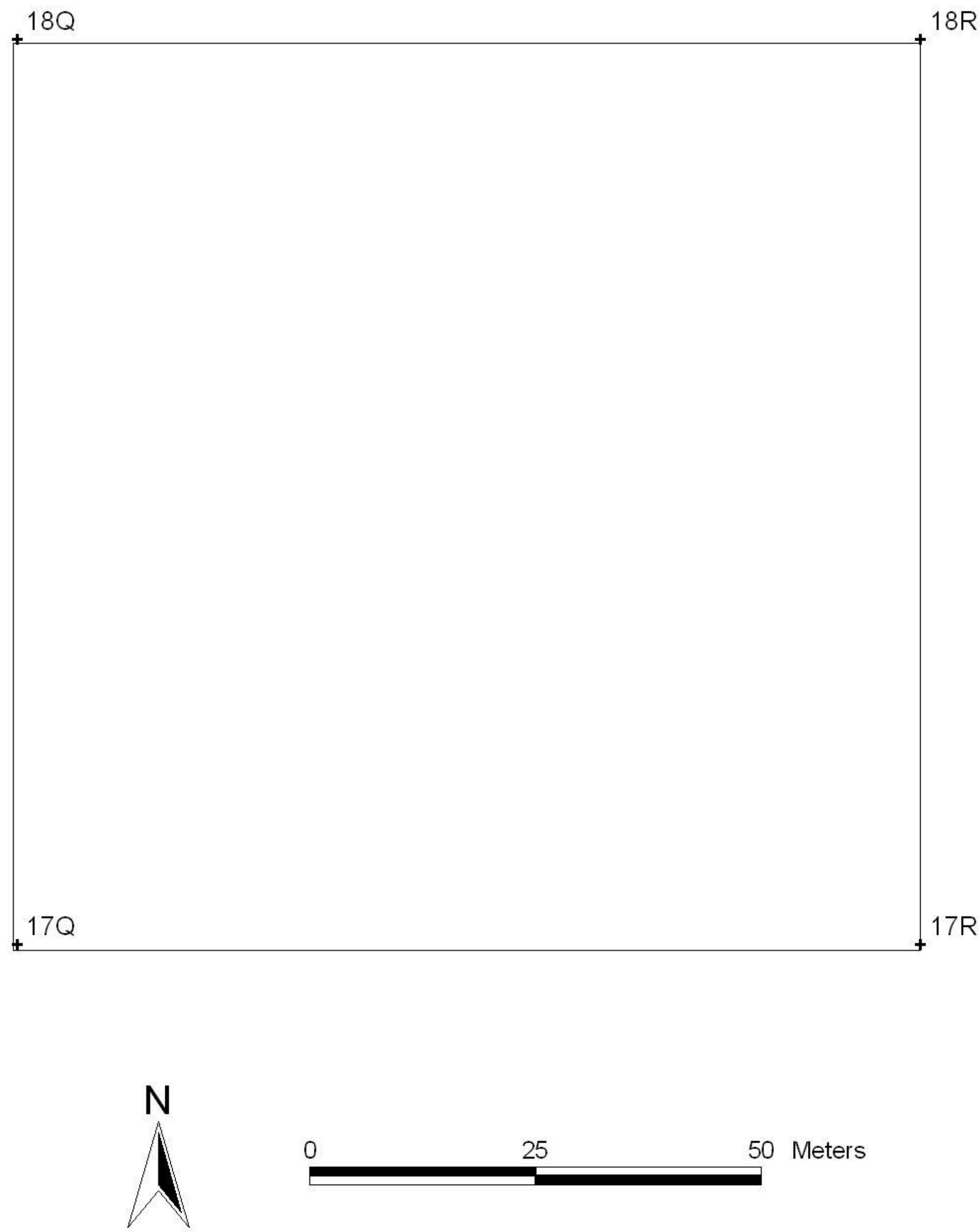
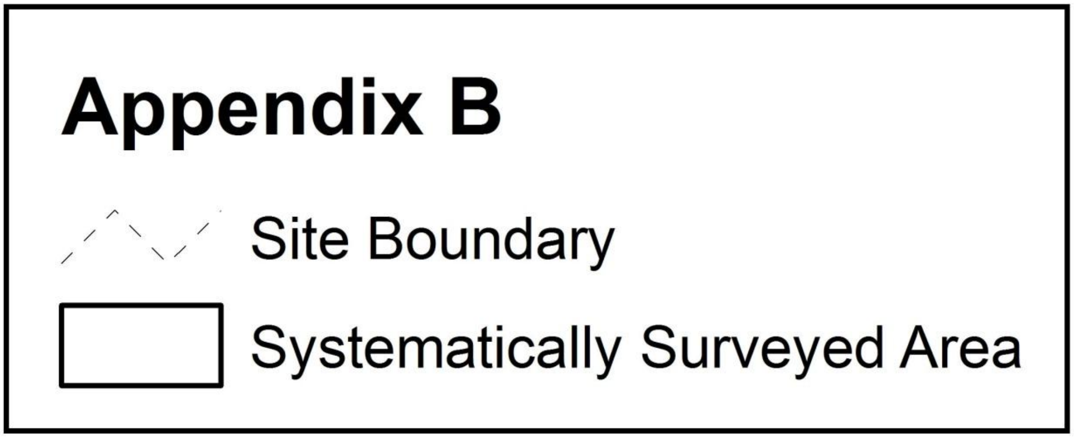

18Q
18R
17Q
17R
N
0
25
50 Meters

Figure B



.167. Map of Section 17Q.

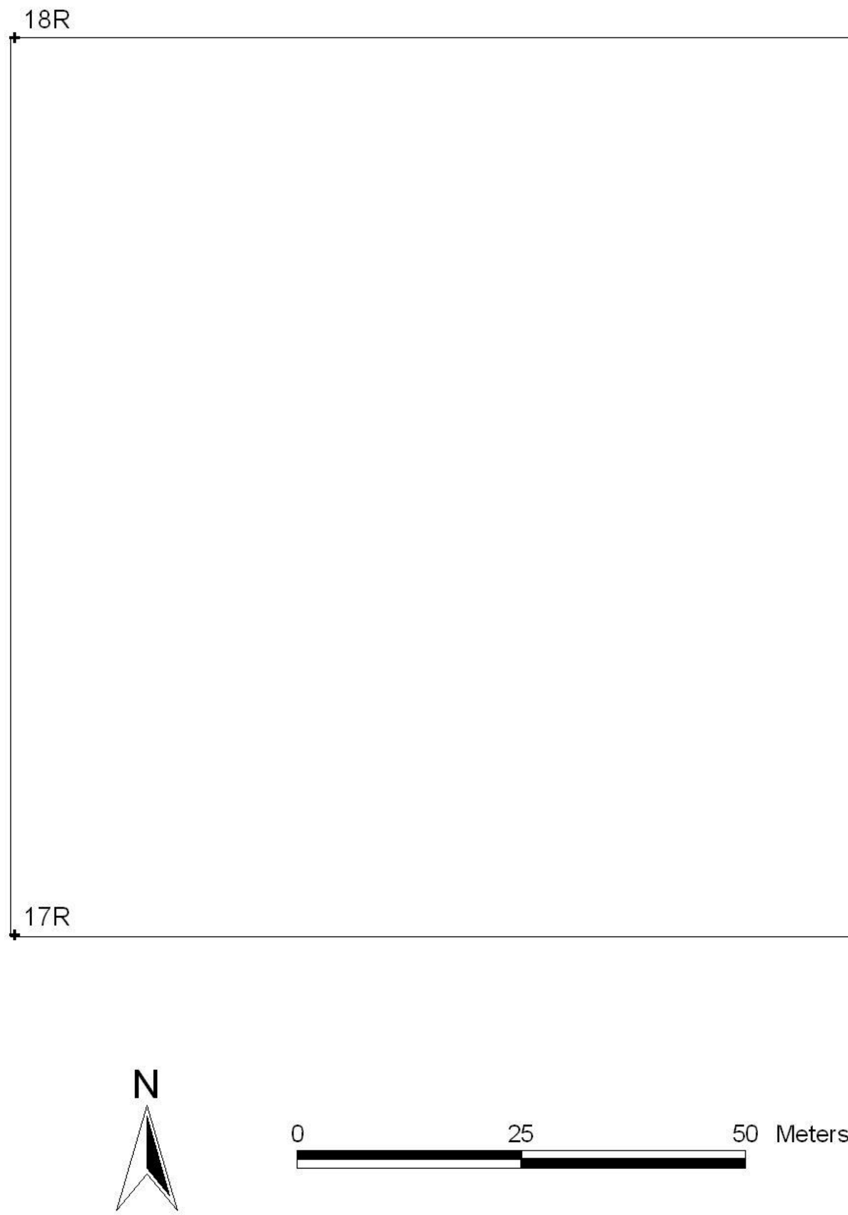


Figure B.168. Map of Section 17R.

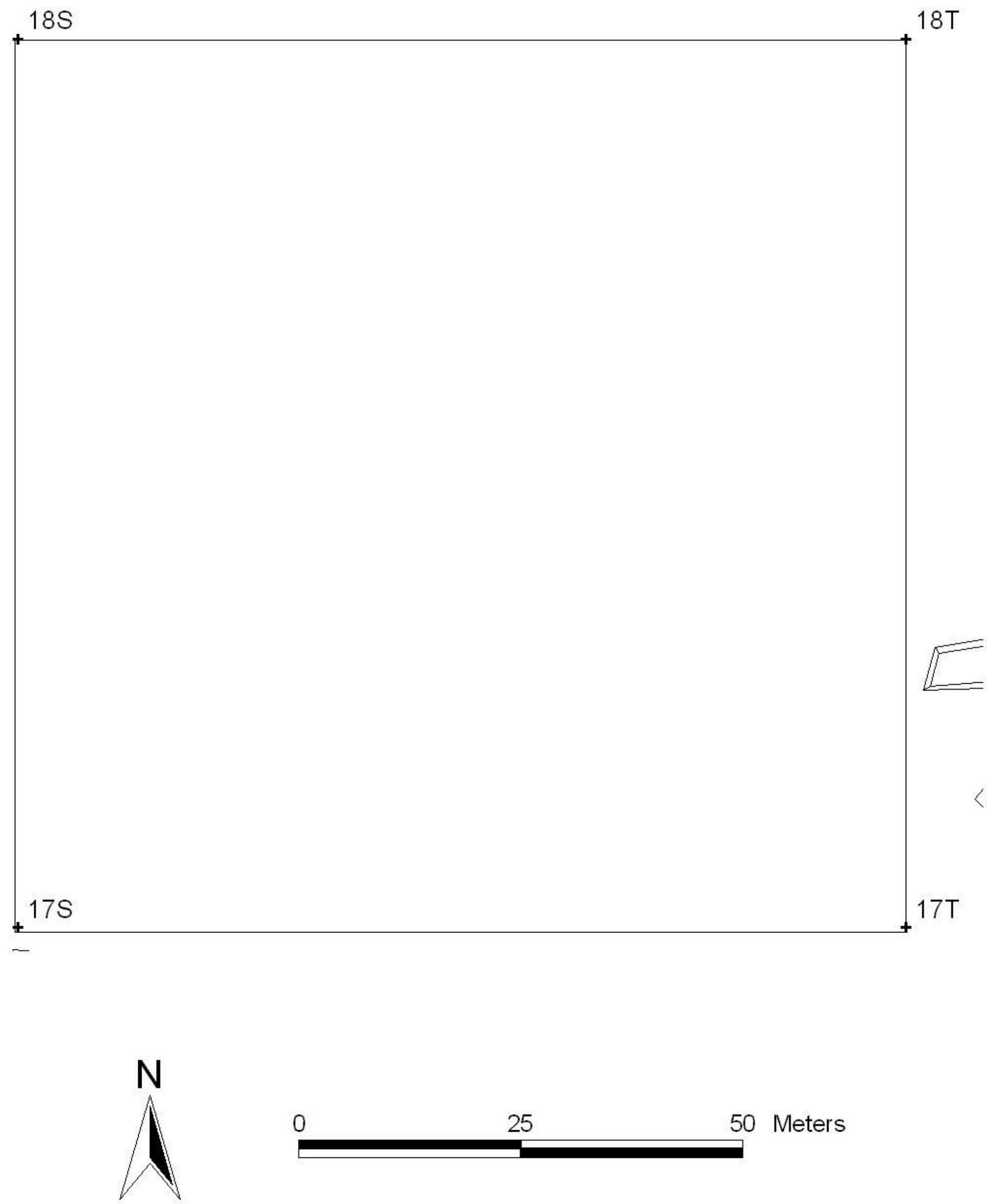


Figure B.169. Map of Section 17S.

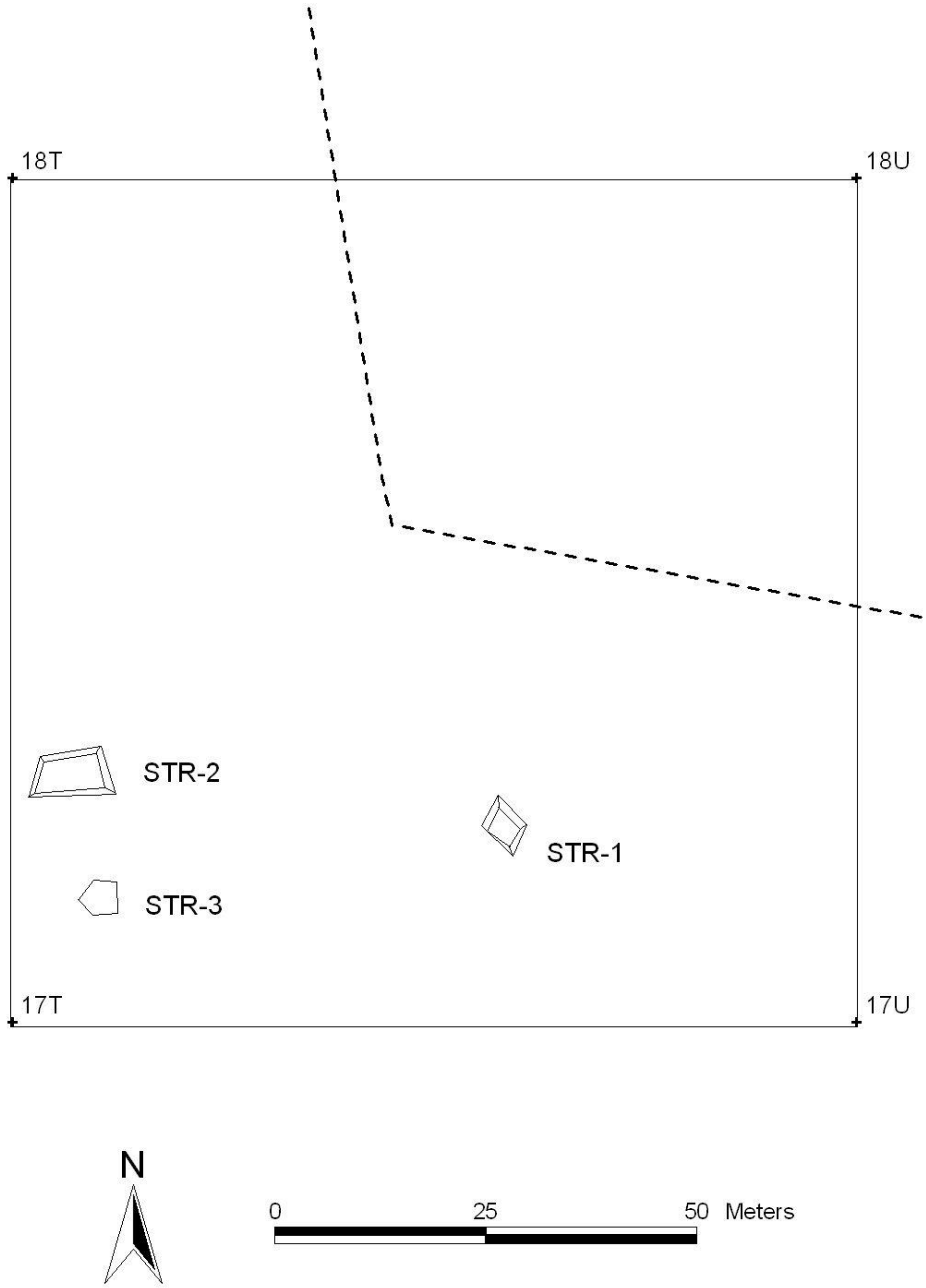


Figure B.170. Map of Section 17T.

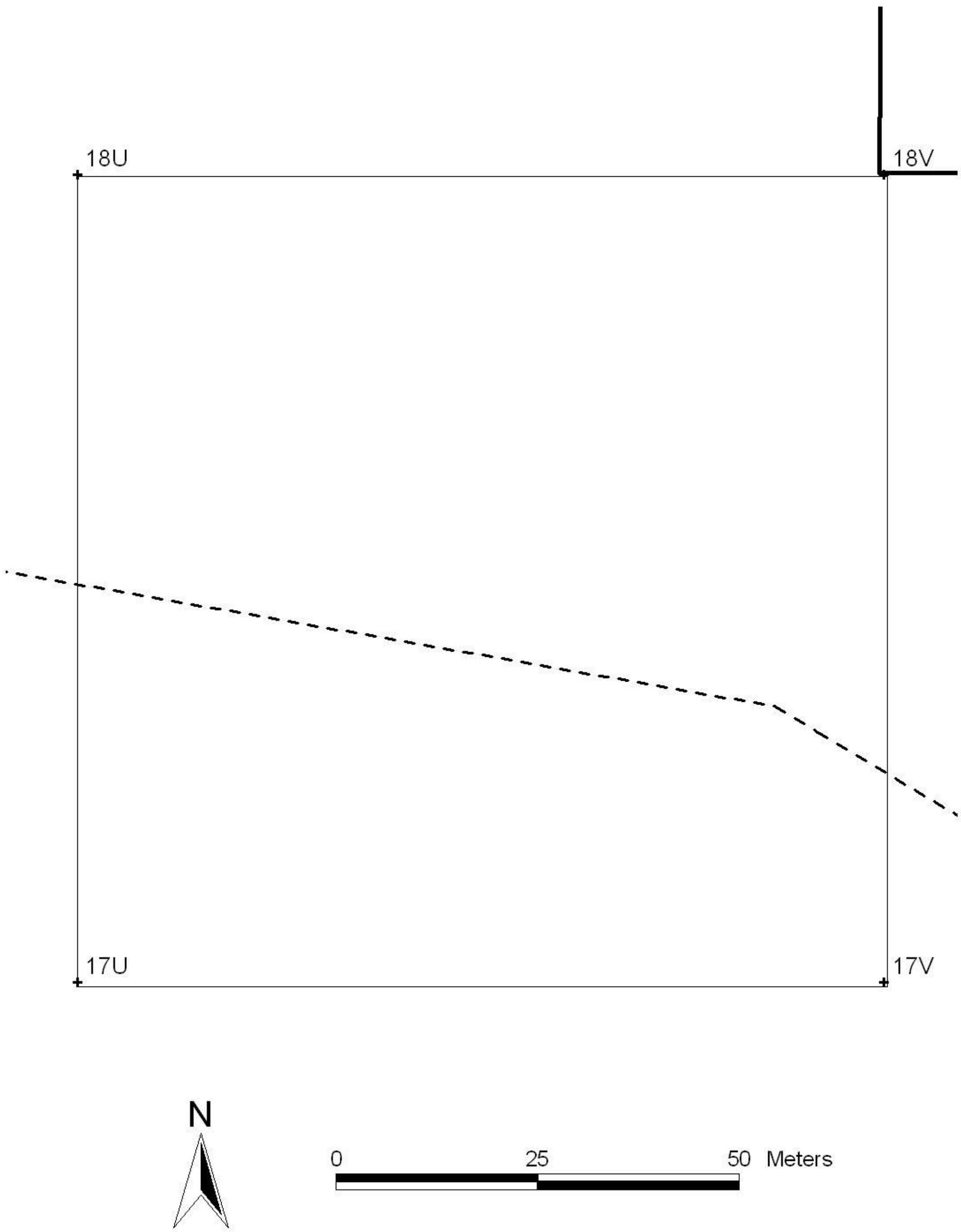


Figure B.171. Map of Section 17U.

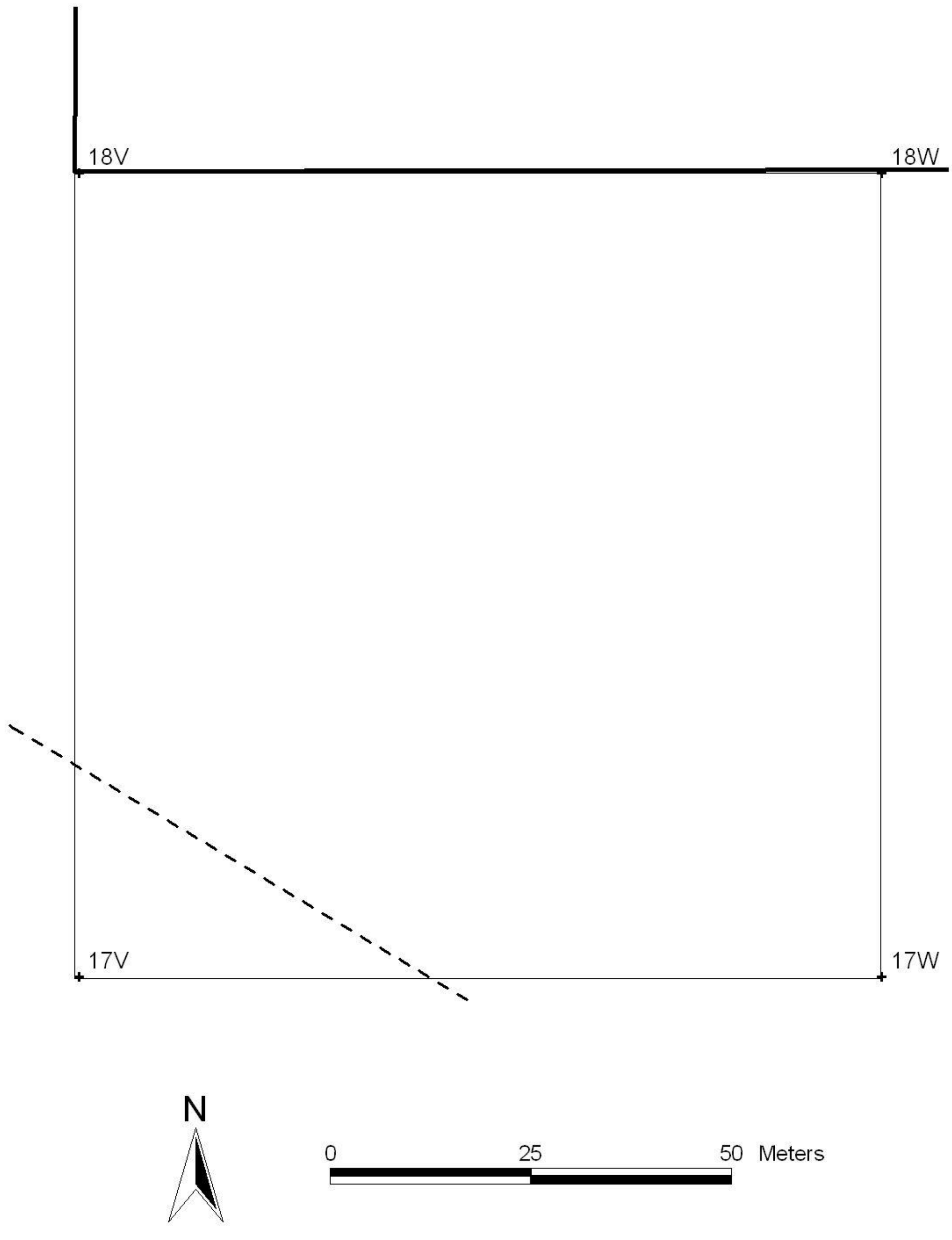


Figure B.172. Map of Section 17V.

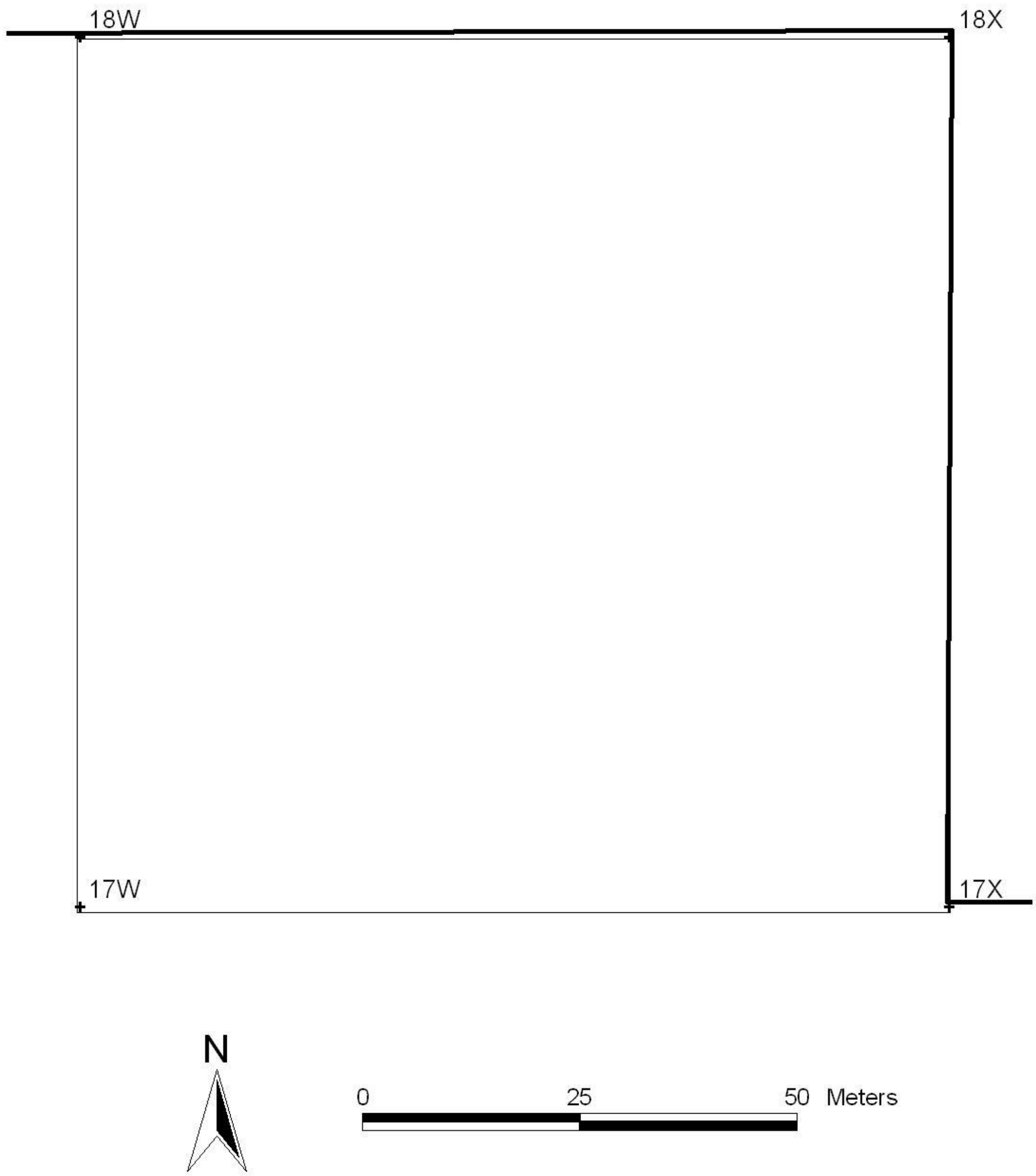


Figure B.173. Map of Section 17W.

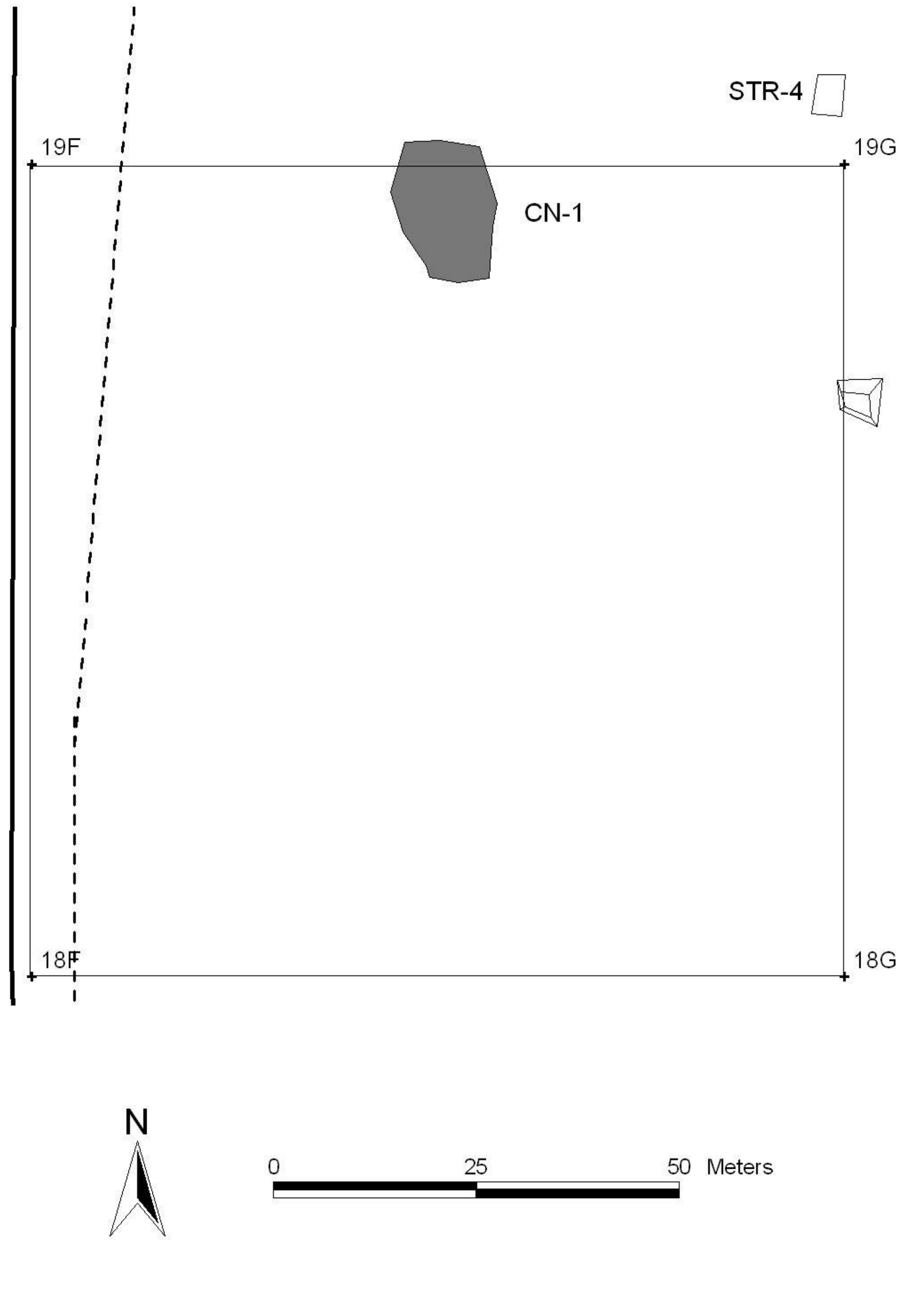


Figure B.174. Map of Section 18F.

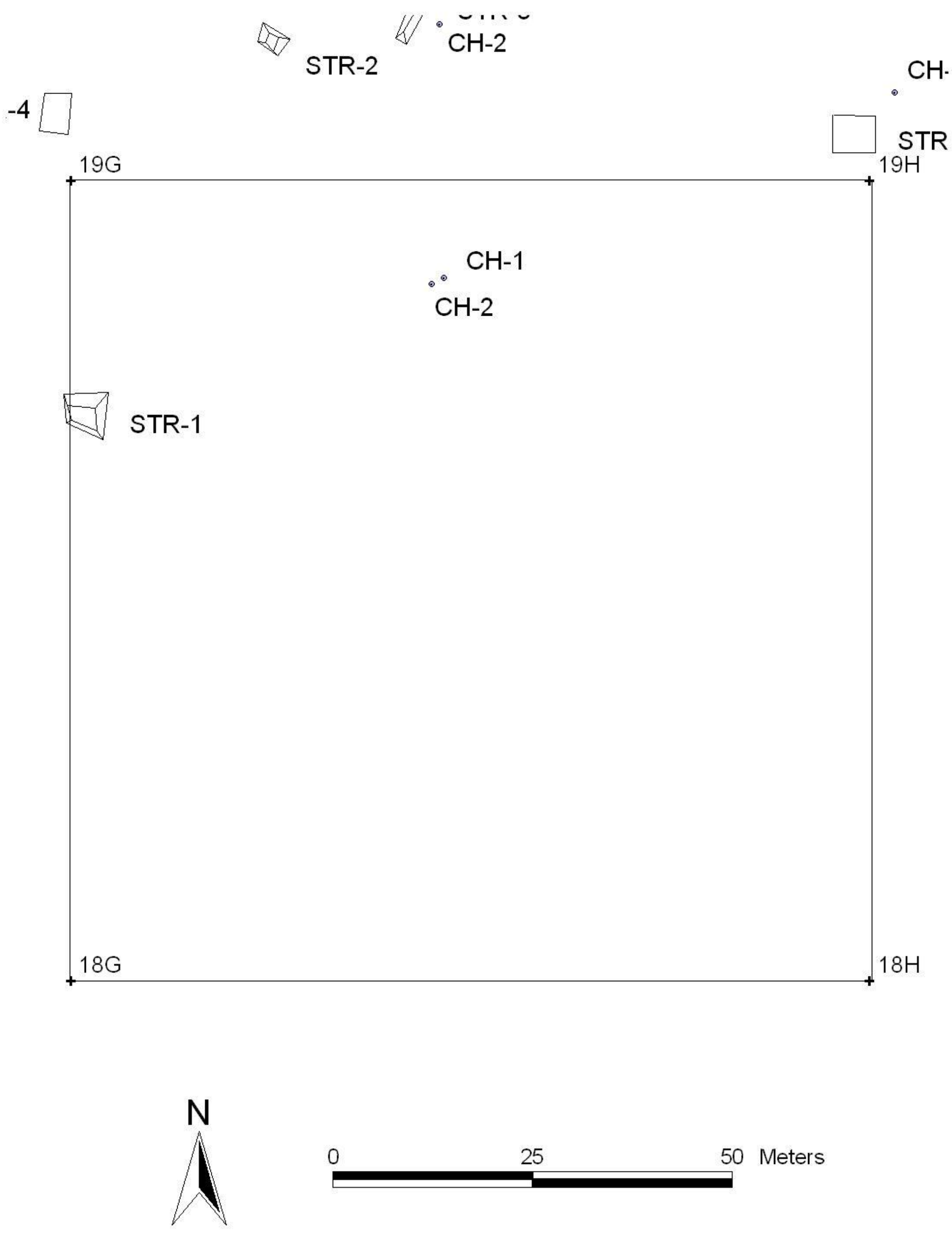


Figure B.175. Map of Section 18G.

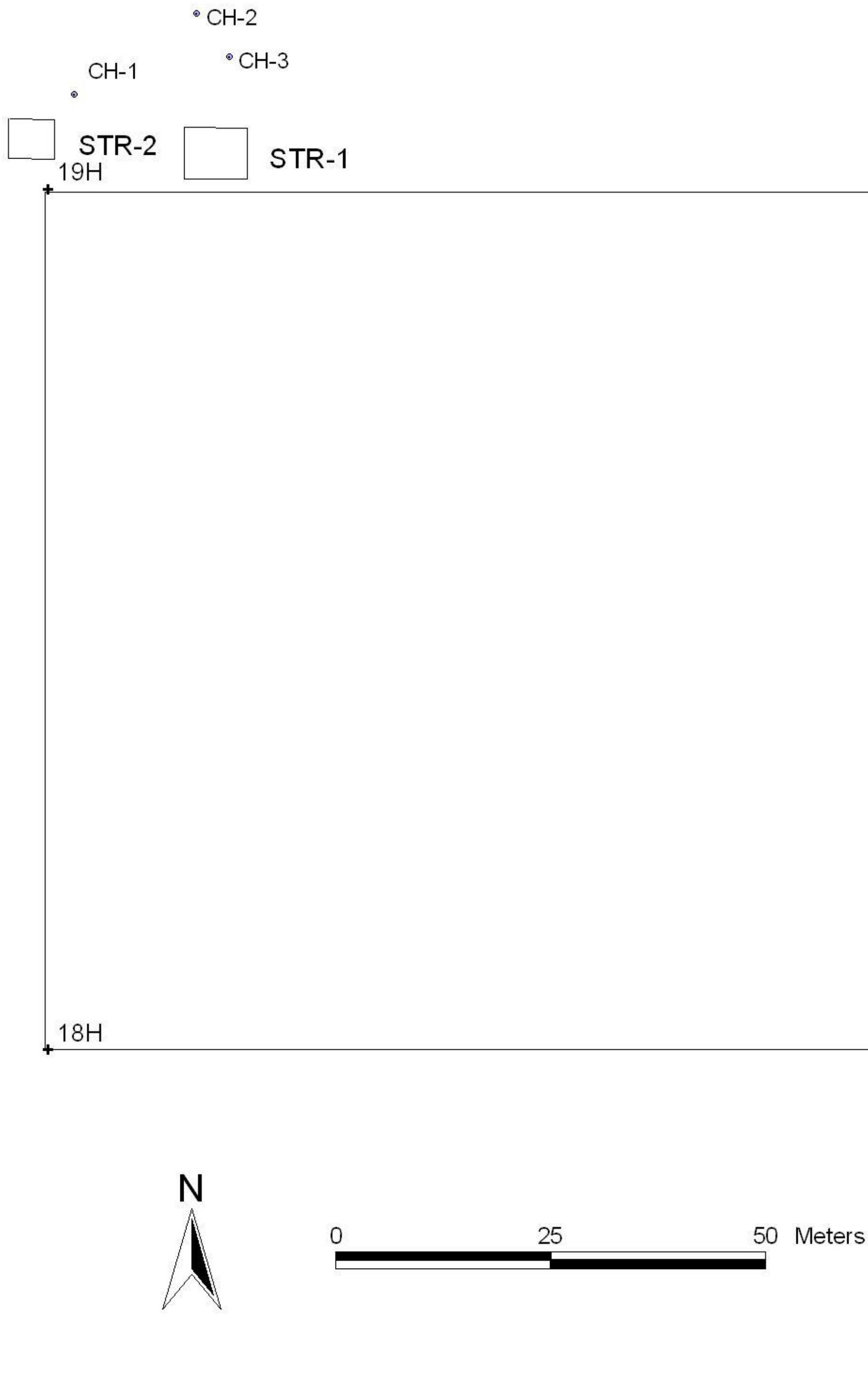


Figure B.176. Map of Section 18H.

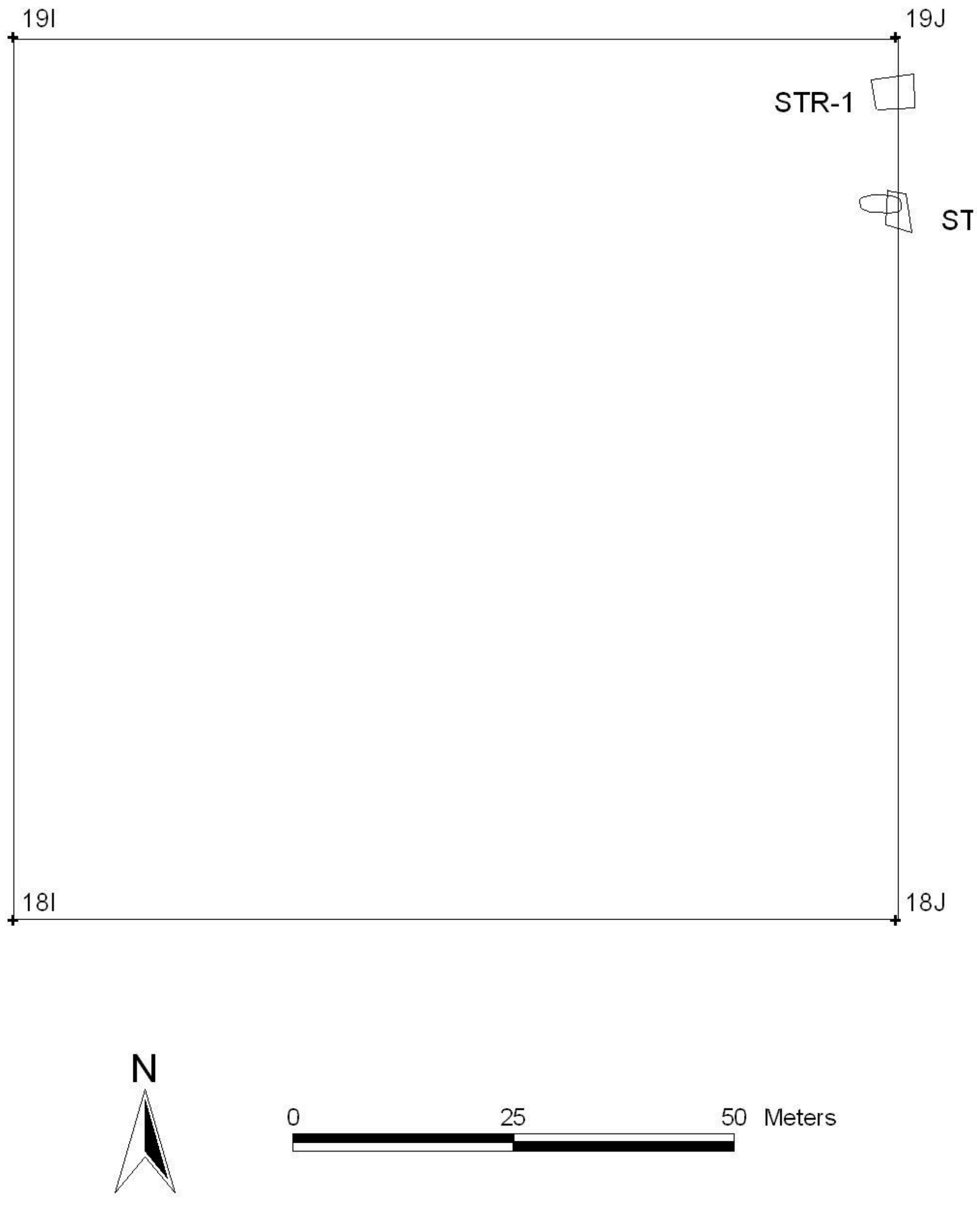


Figure B.177. Map of Section 18I.

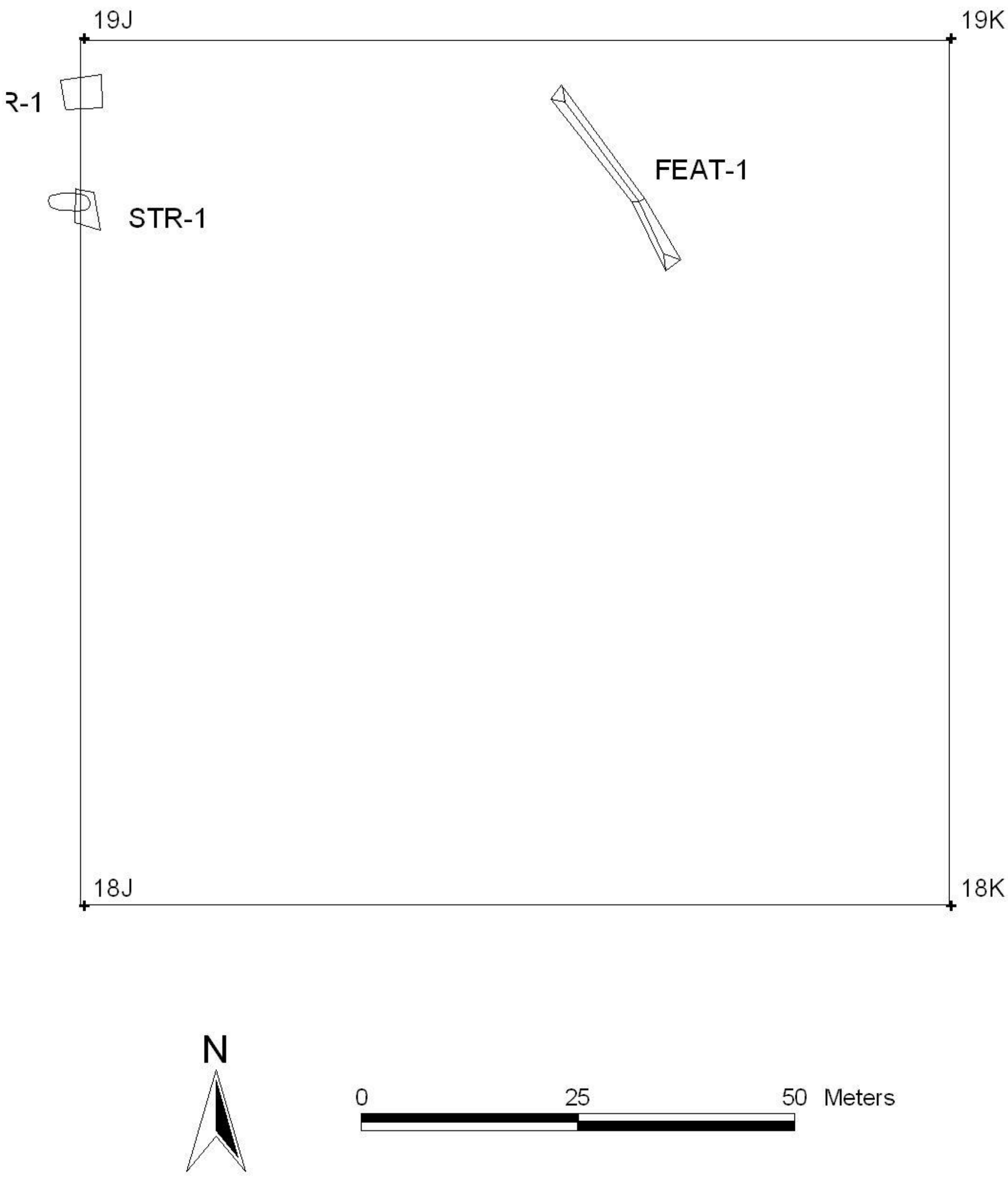


Figure B.178. Map of Section 18J.

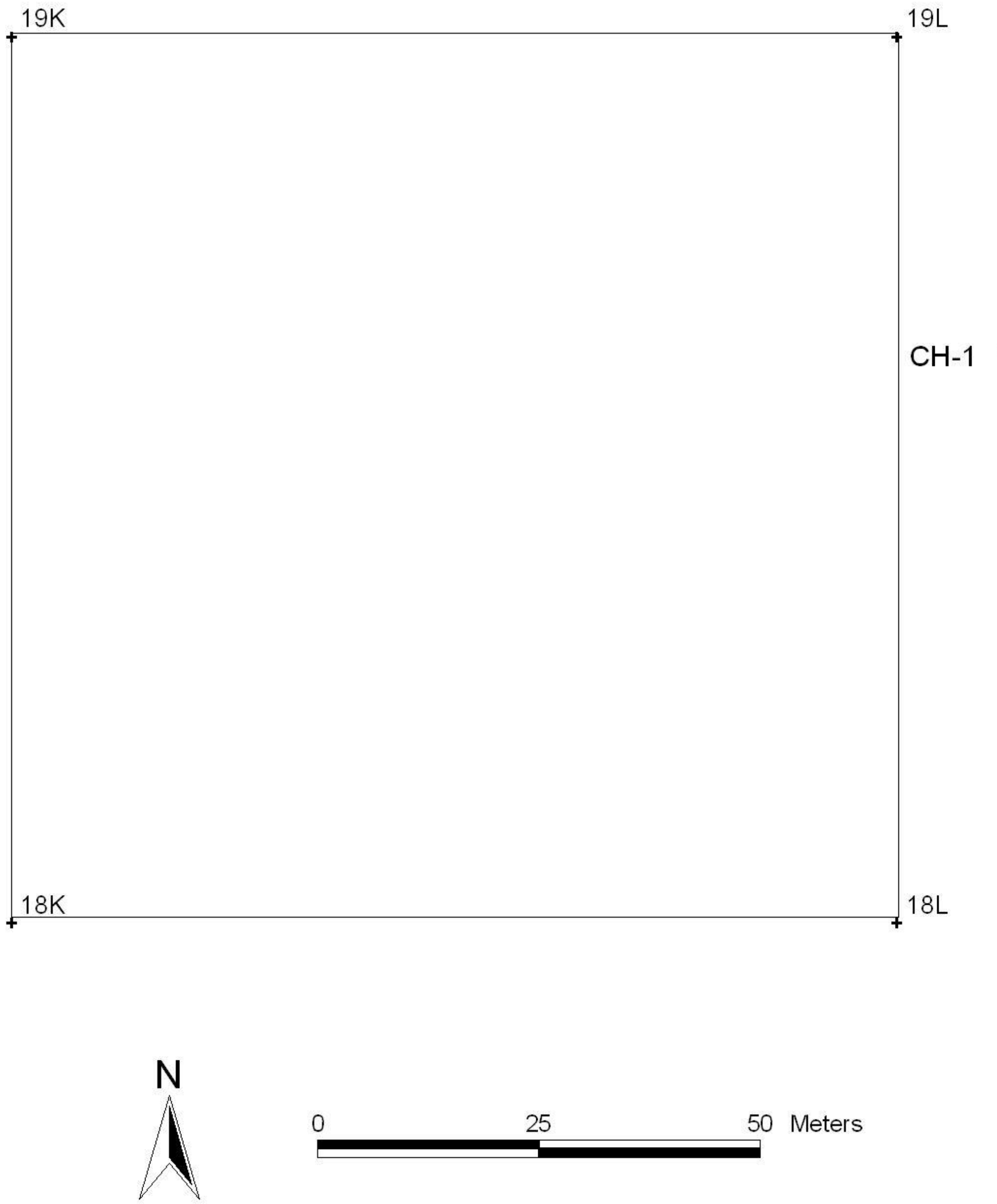


Figure B.179. Map of Section 18K.

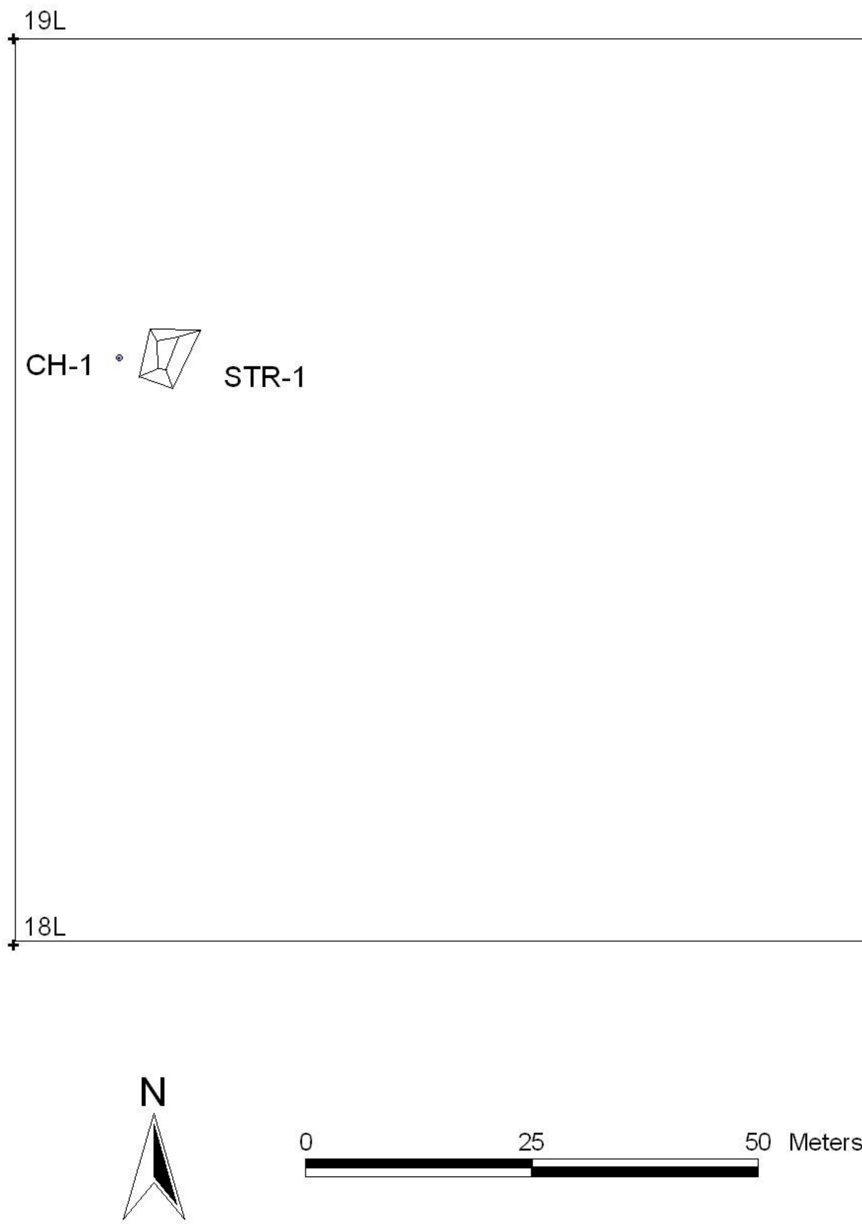


Figure B.180. Map of Section 18L.

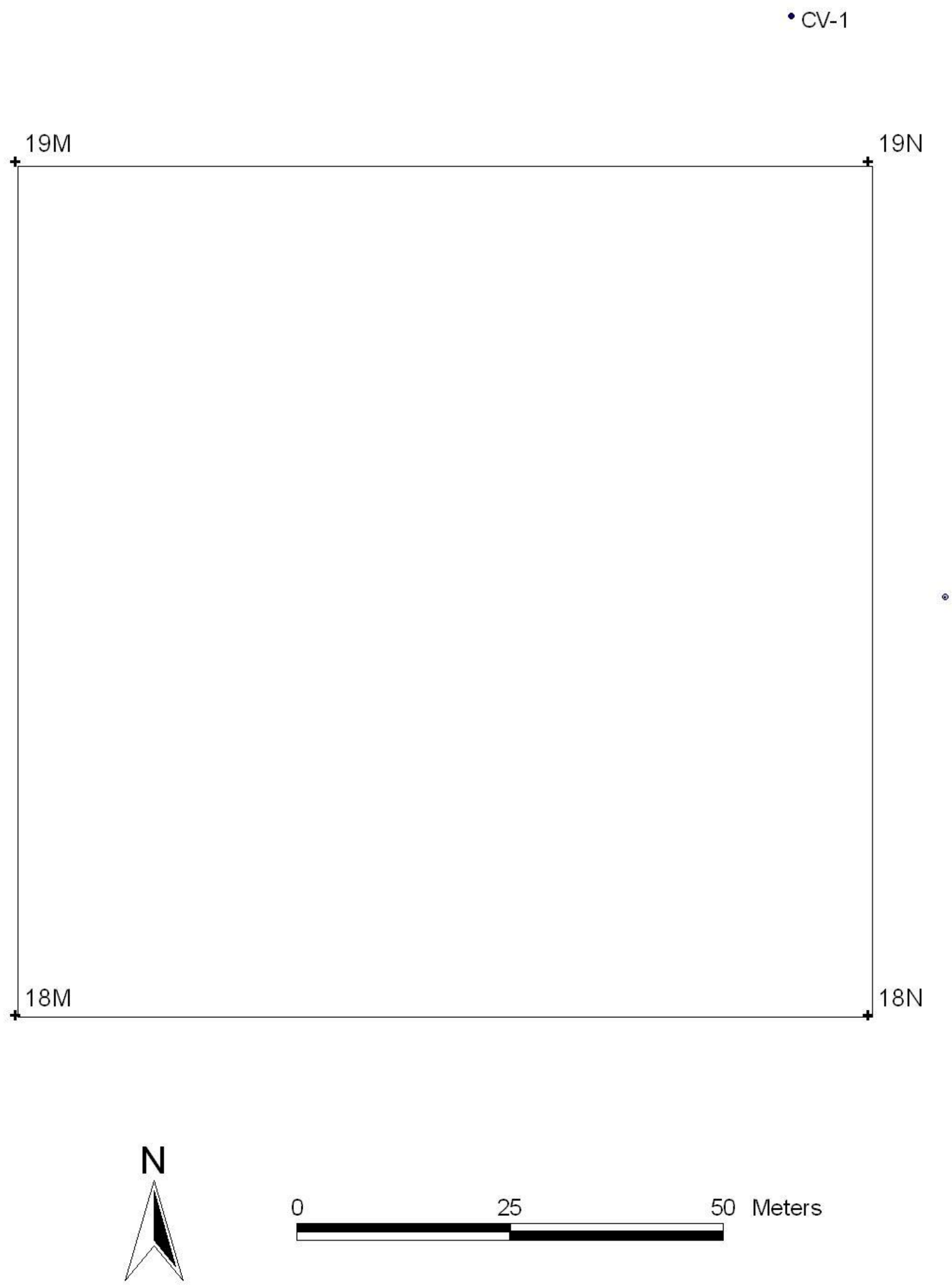


Figure B.181. Map of Section 18M.

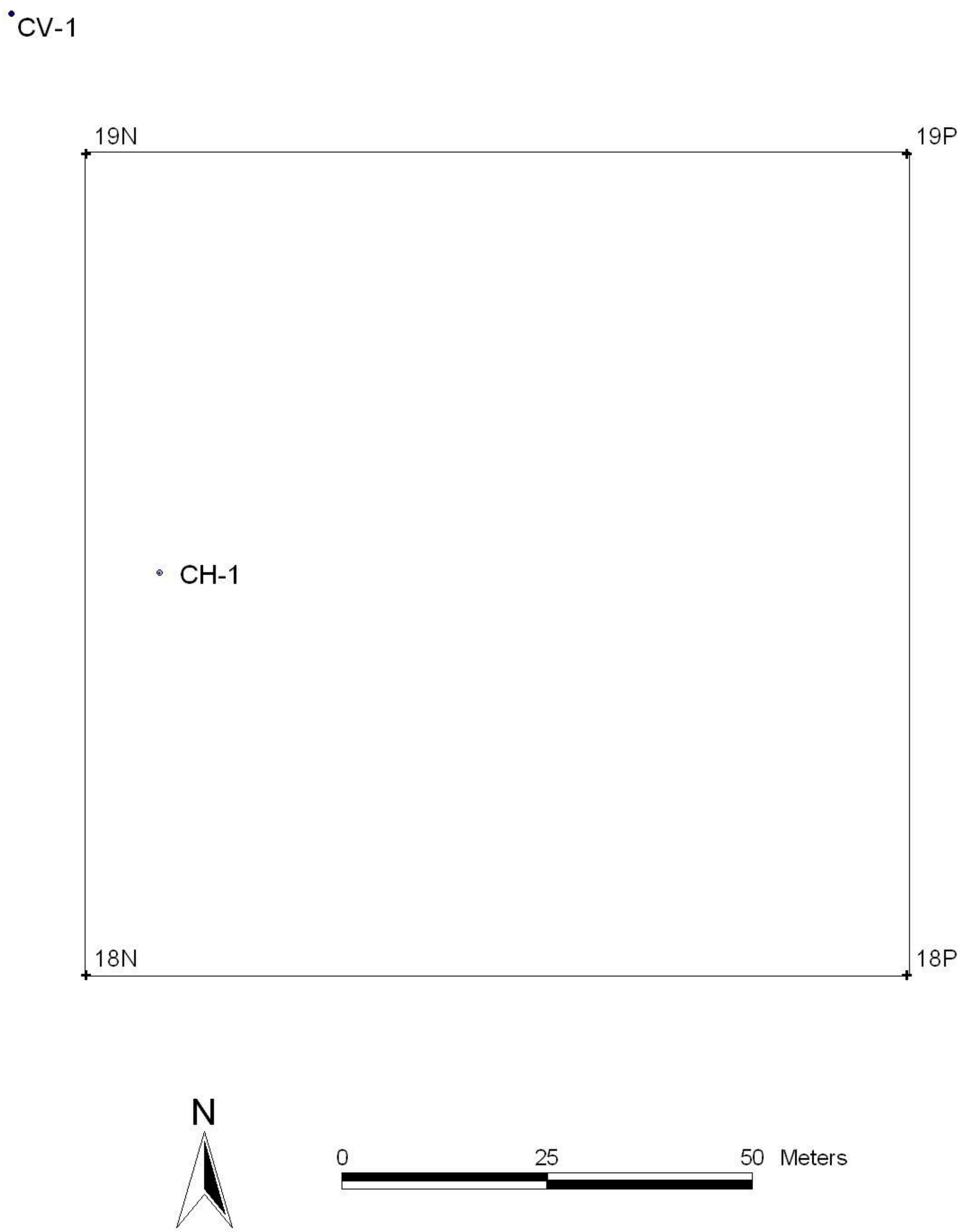


Figure B.182. Map of Section 18N.

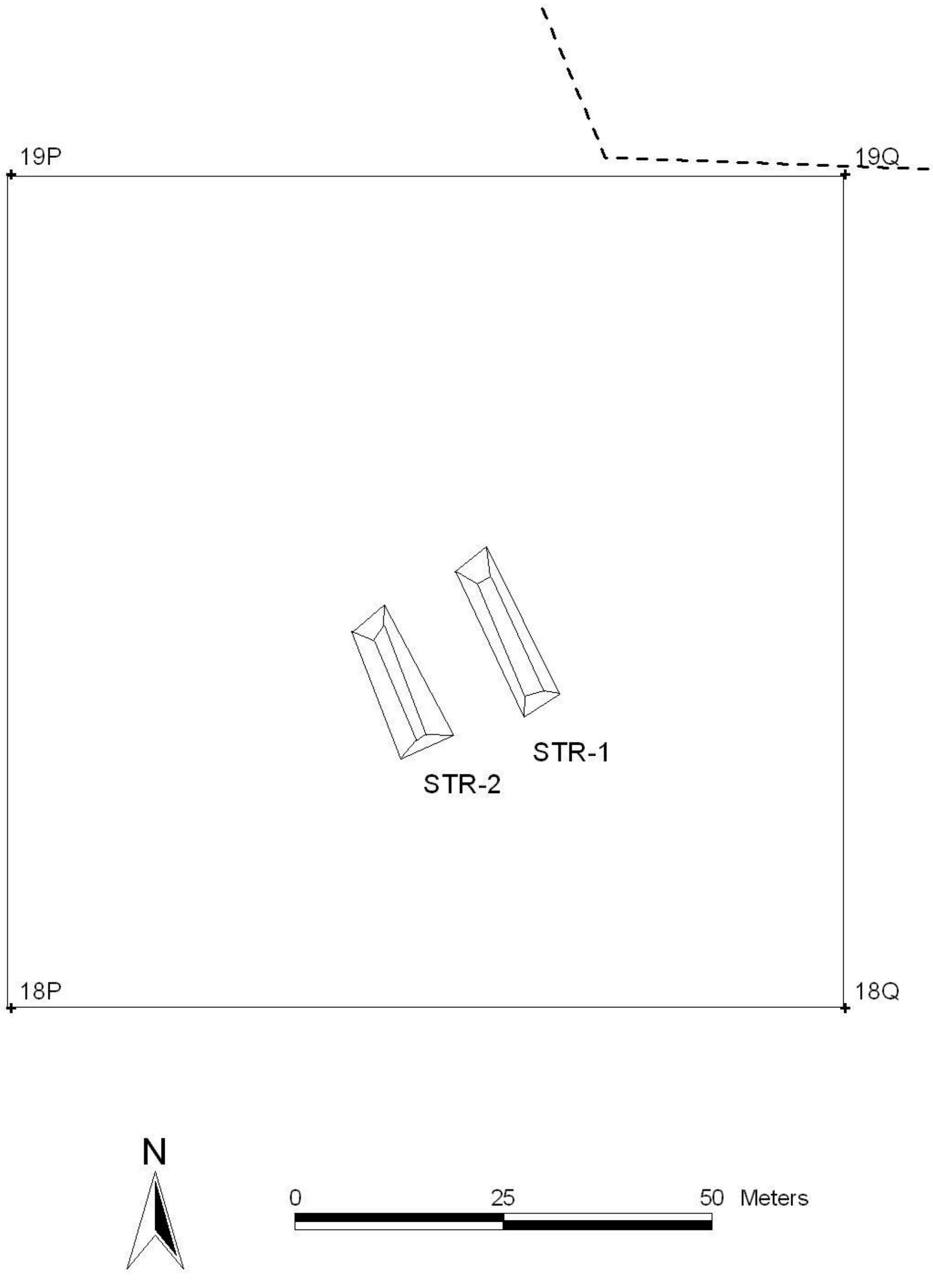


Figure B.183. Map of Section 18P.

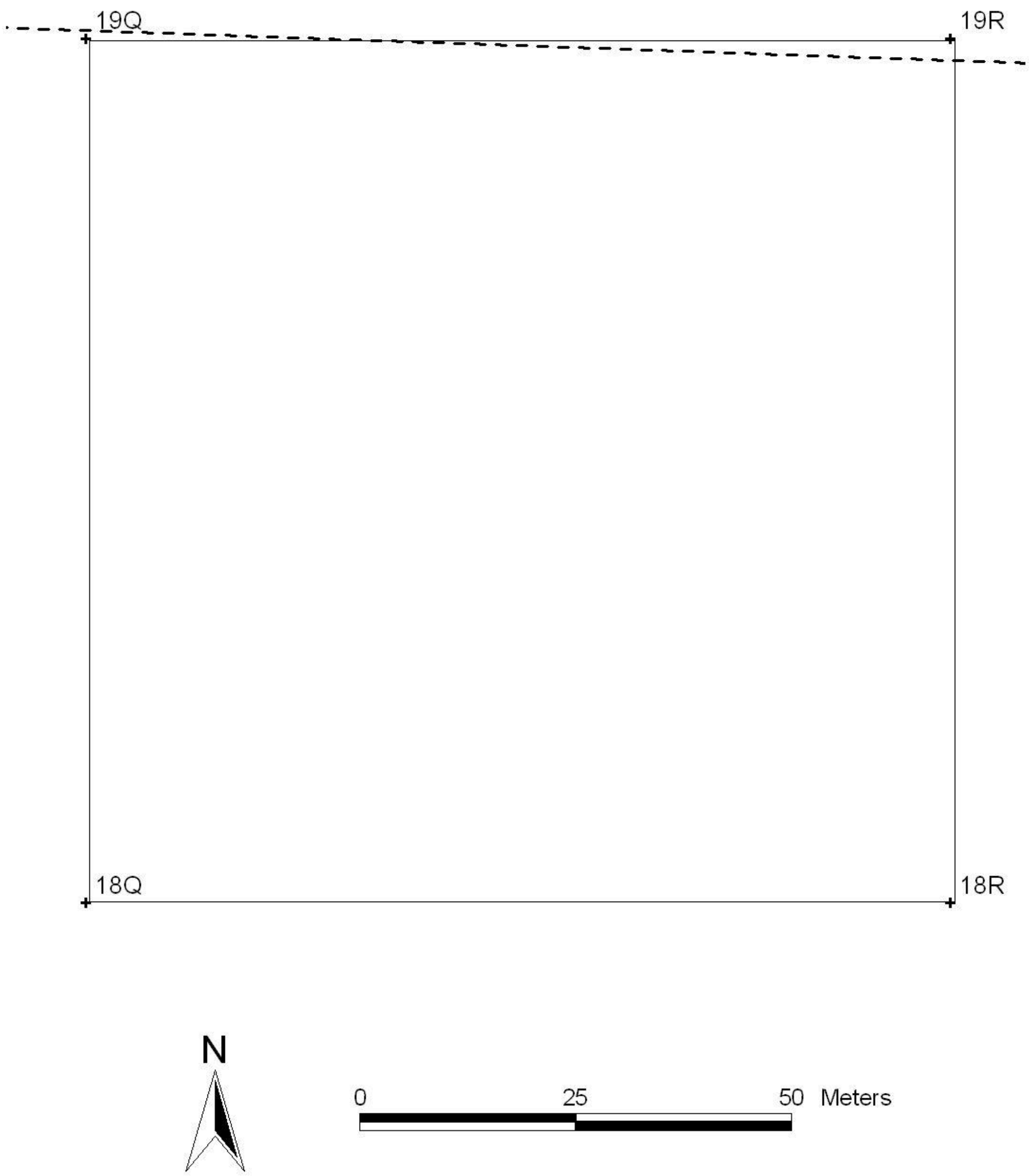


Figure B.184. Map of Section 18Q.

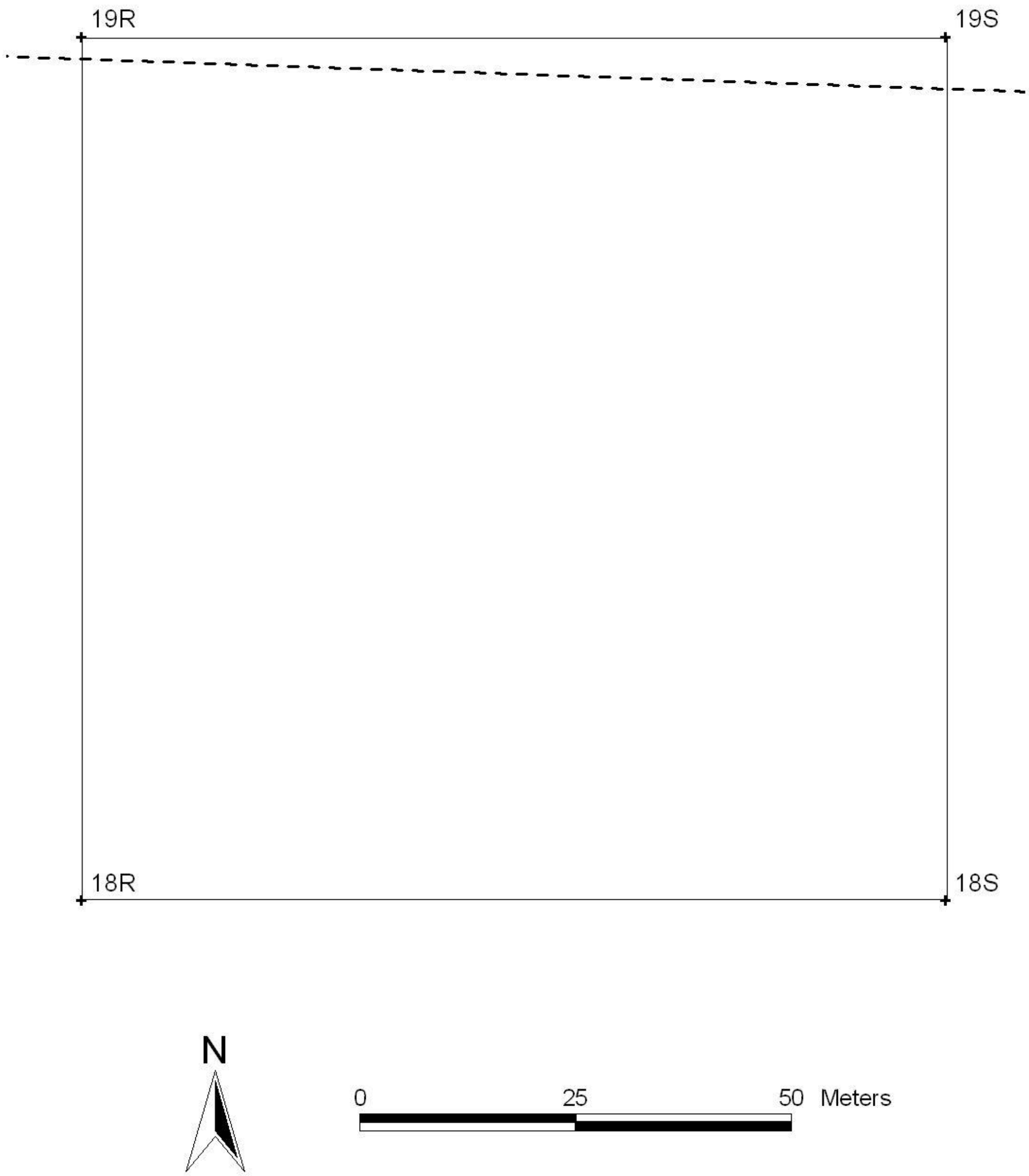


Figure B.185. Map of Section 18R.

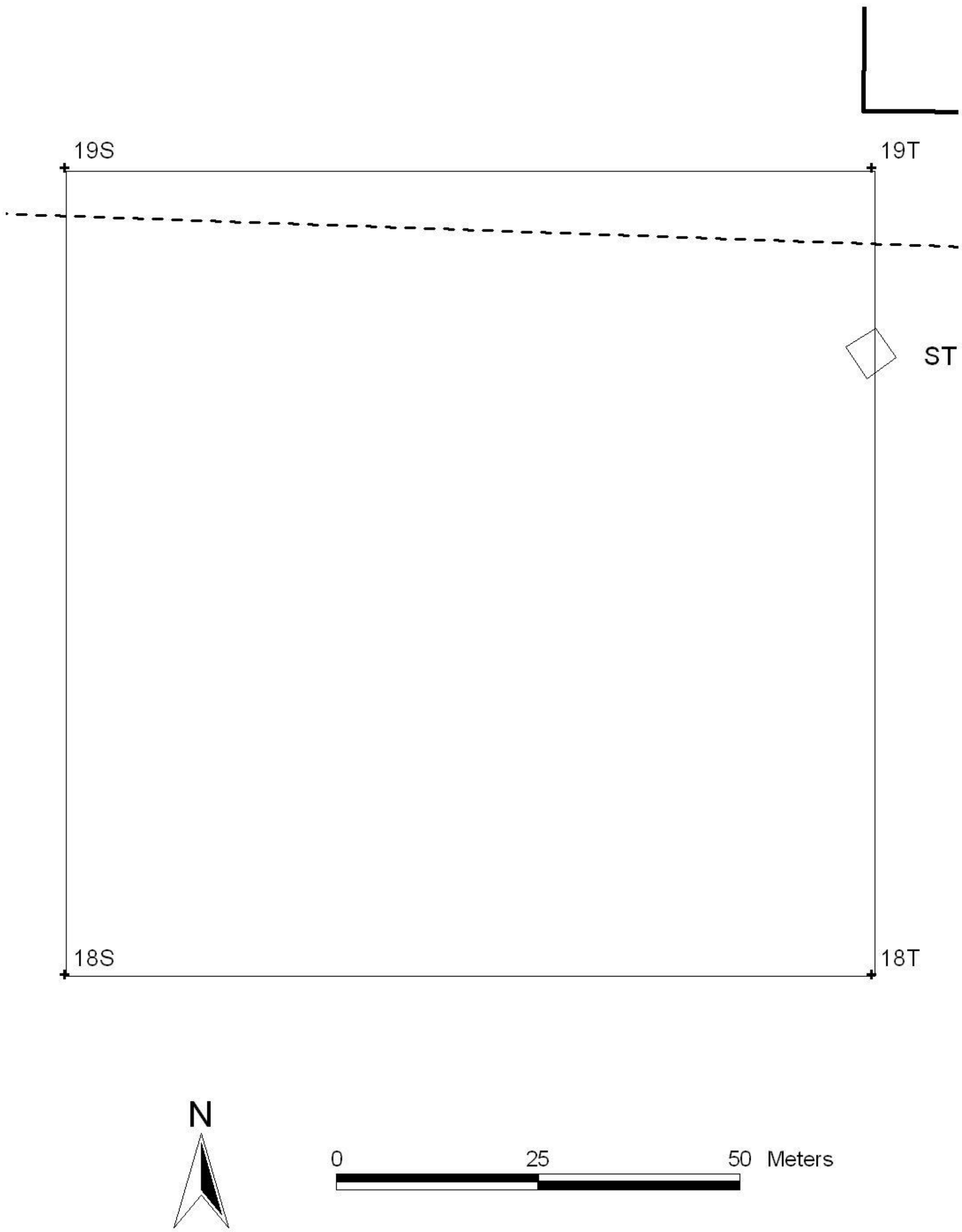


Figure B.186. Map of Section 18S.

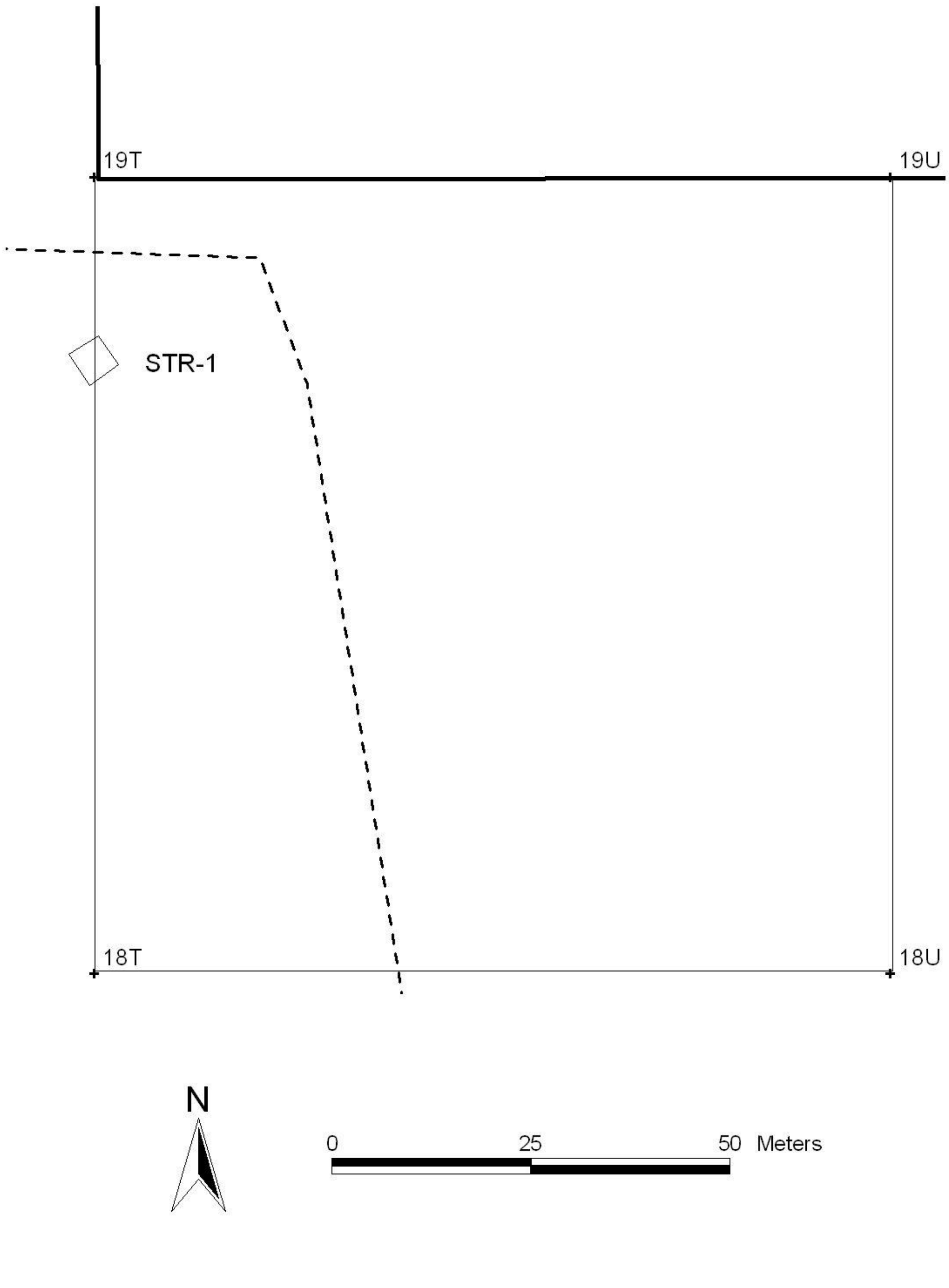


Figure B.187. Map of Section 18T.

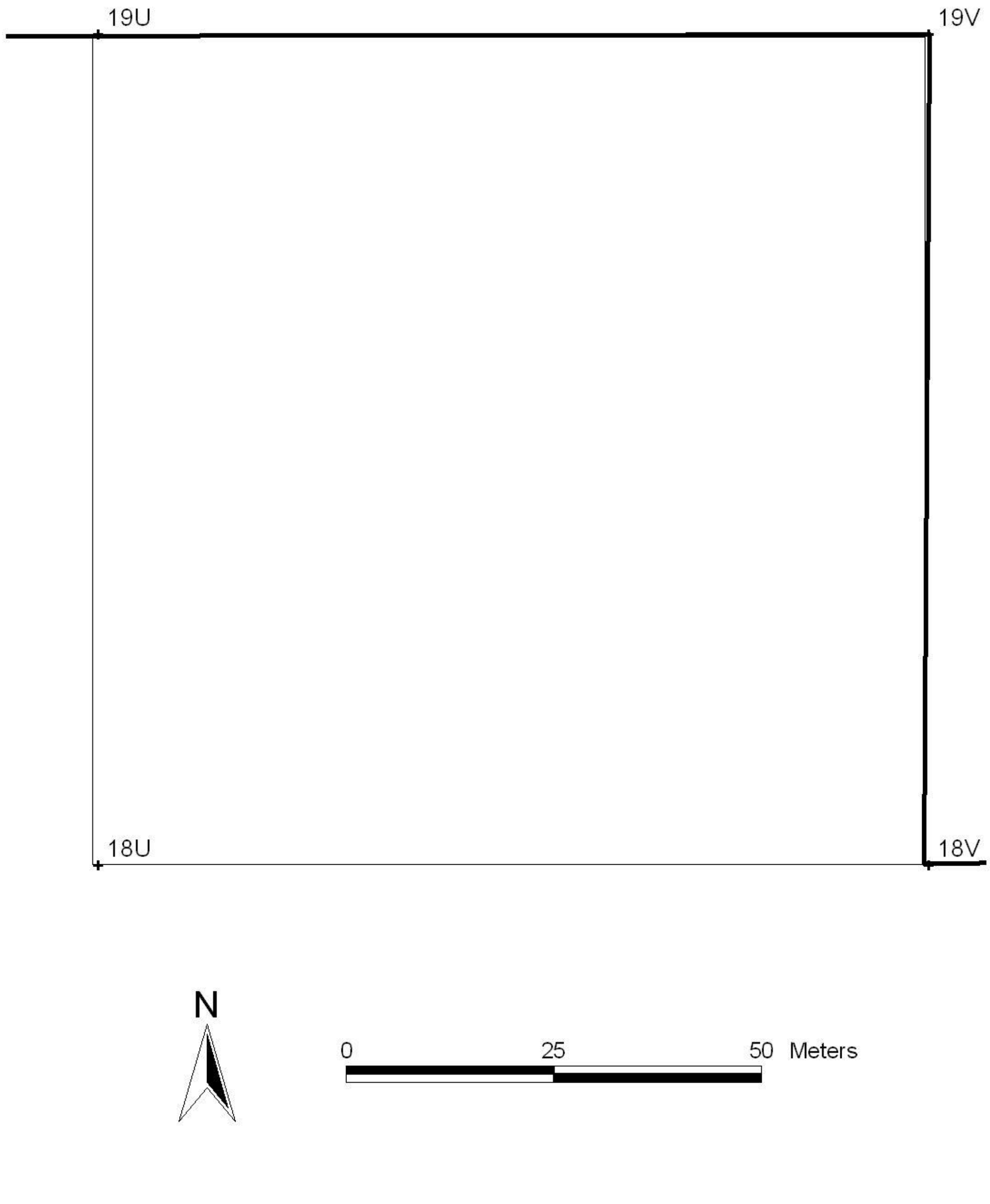


Figure B.188. Map of Section 18U.

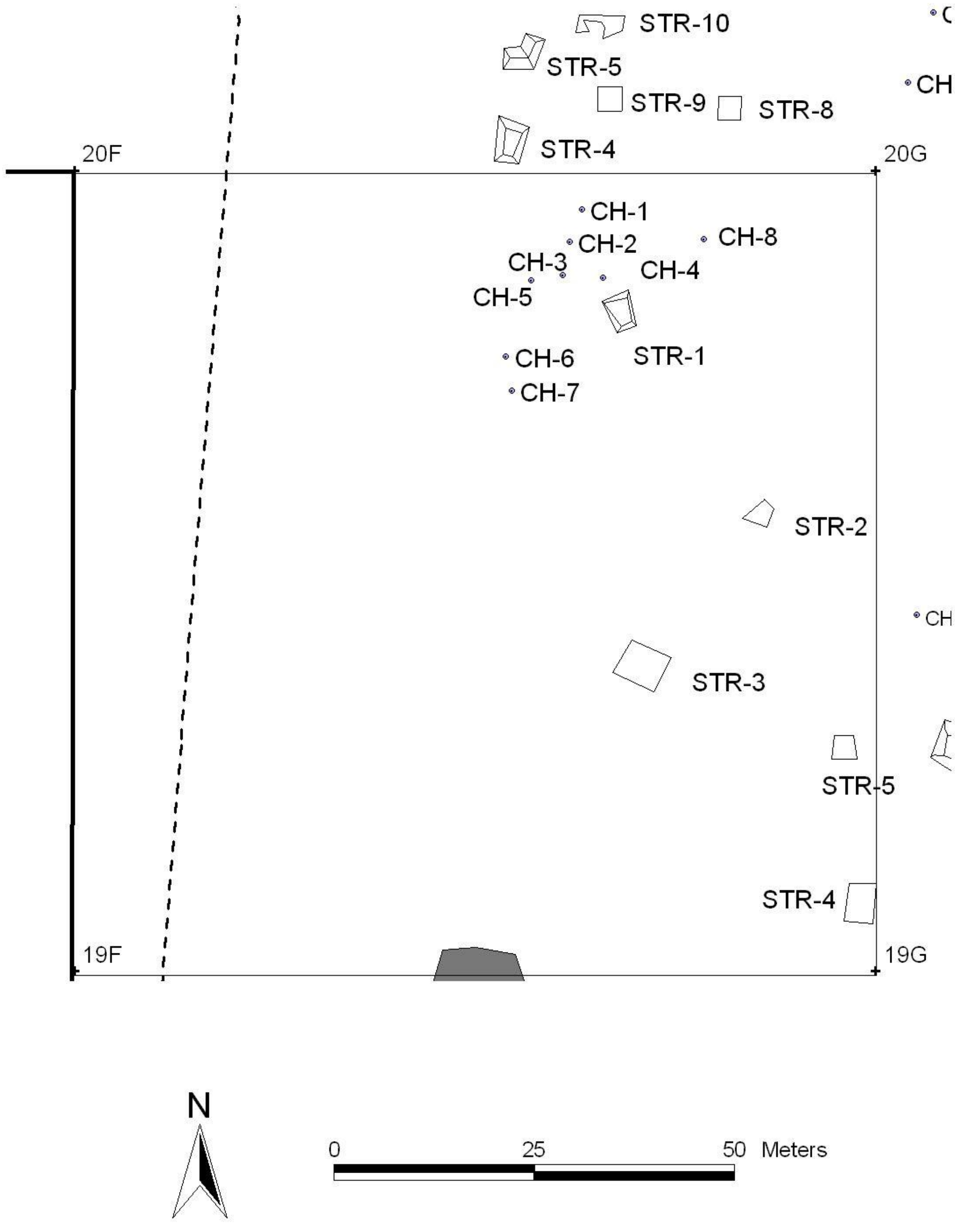


Figure B.189. Map of Section 19F.

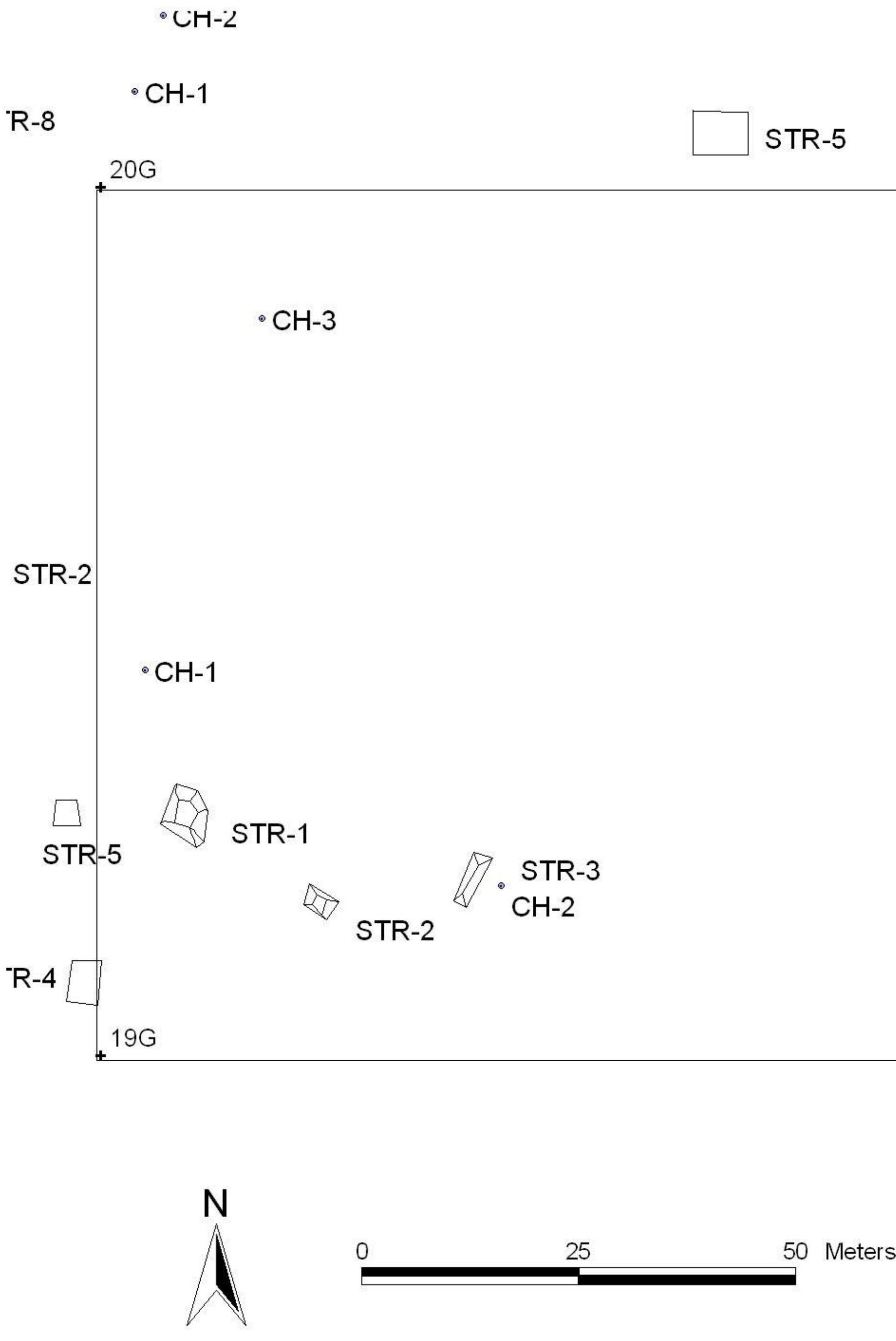


Figure B.190. Map of Section 19G.

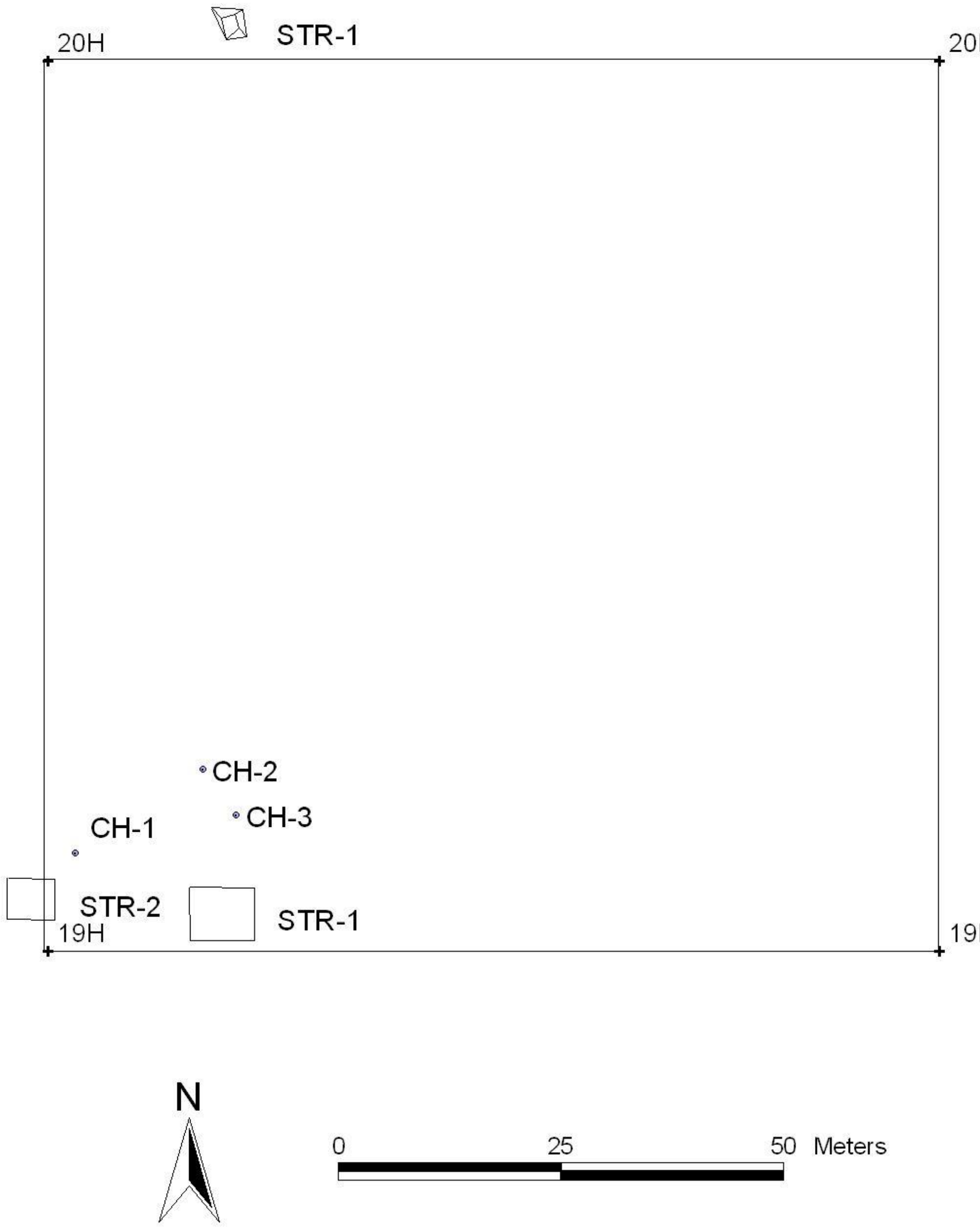


Figure B.191. Map of Section 19H.

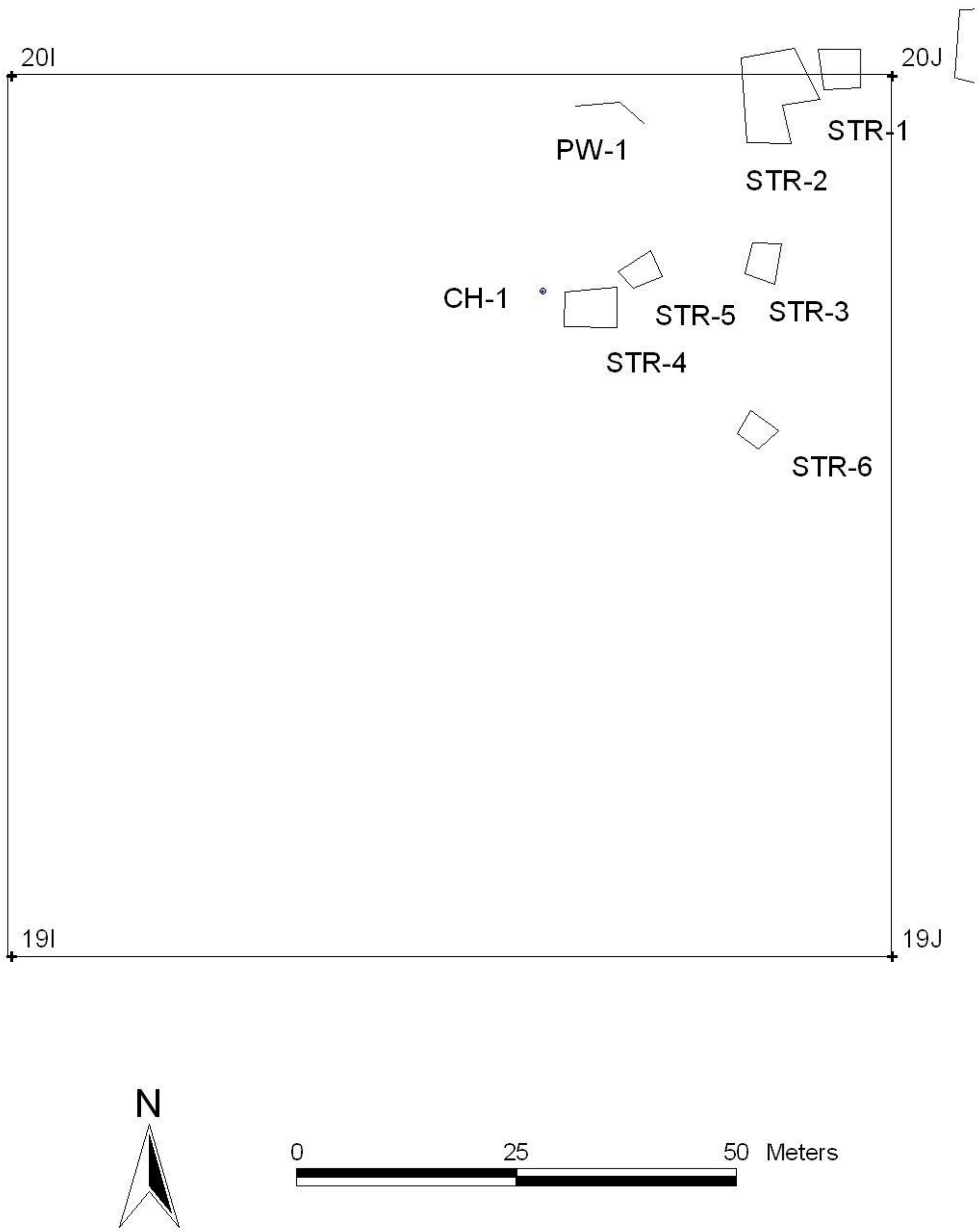


Figure B.192. Map of Section 19I.

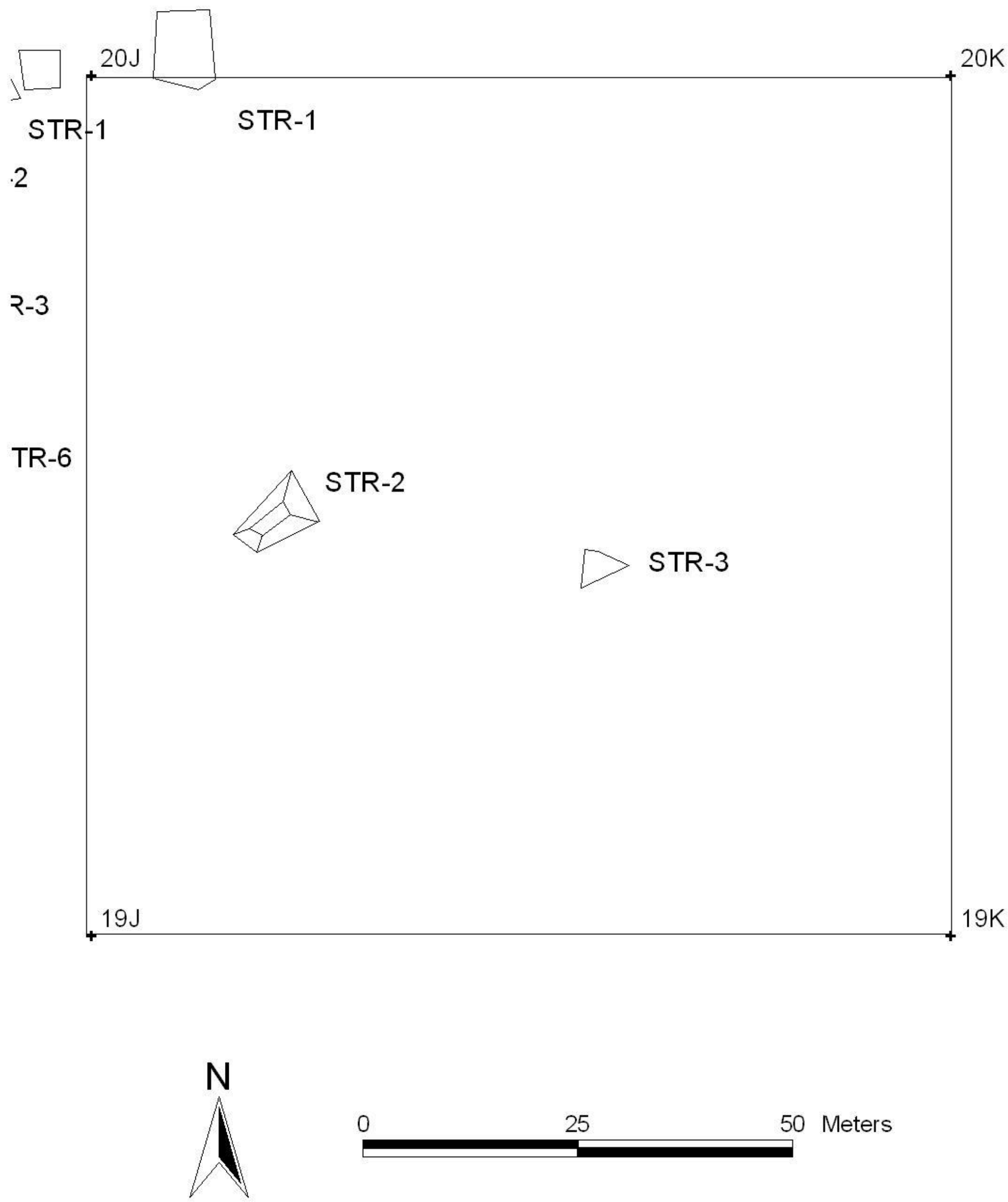


Figure B.193. Map of Section 19J.

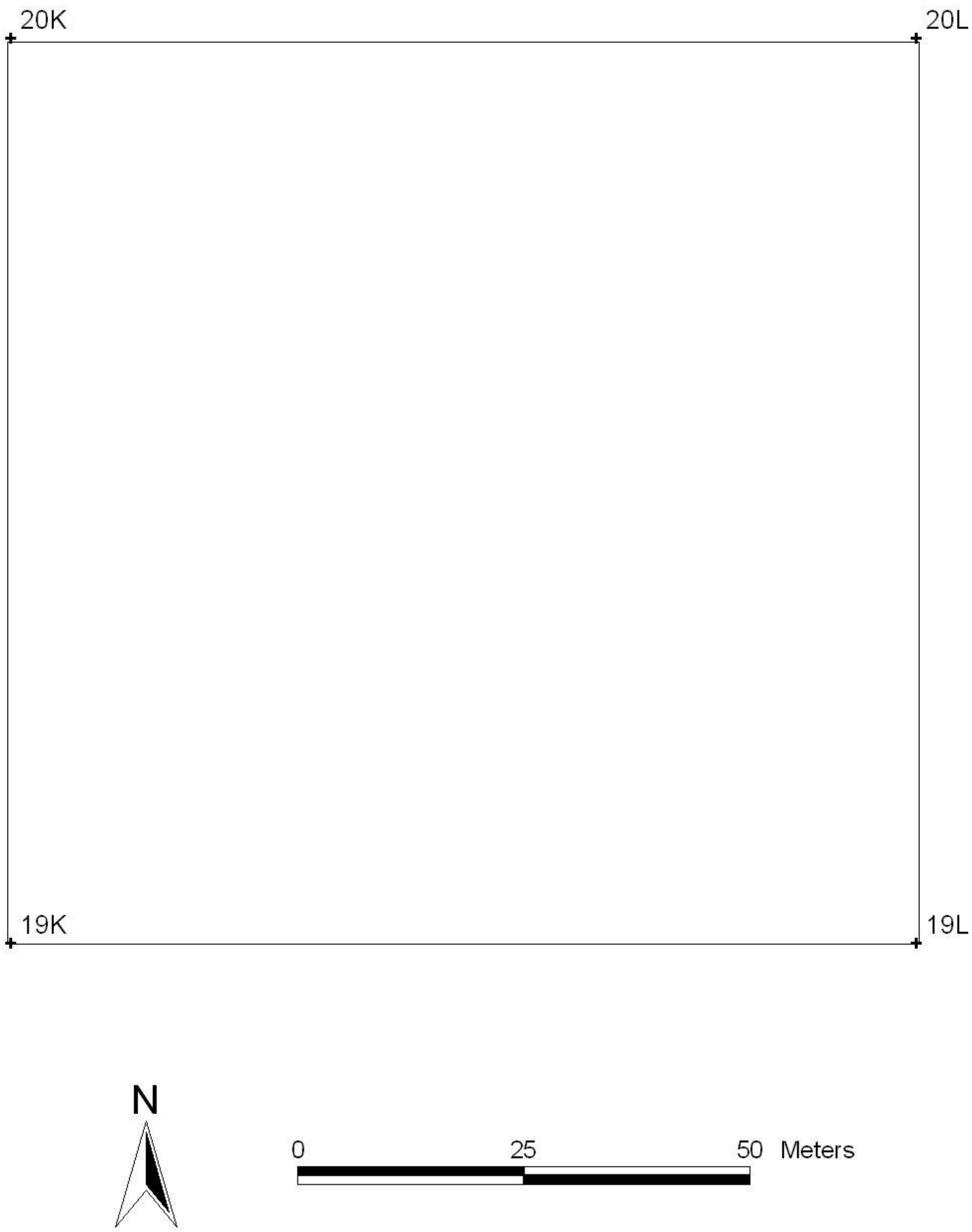


Figure B.194. Map of Section 19K.

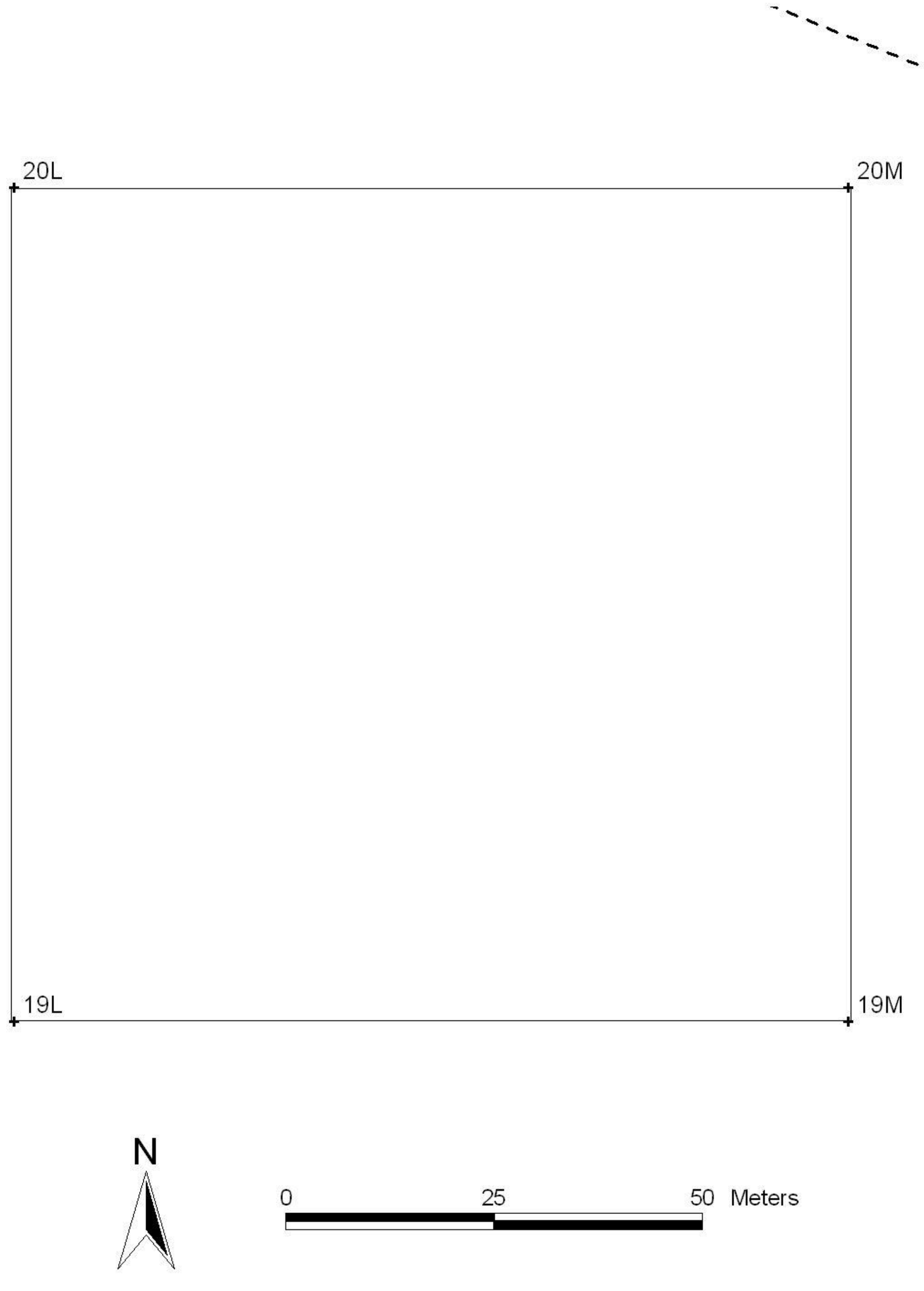


Figure B.195. Map of Section 19L.

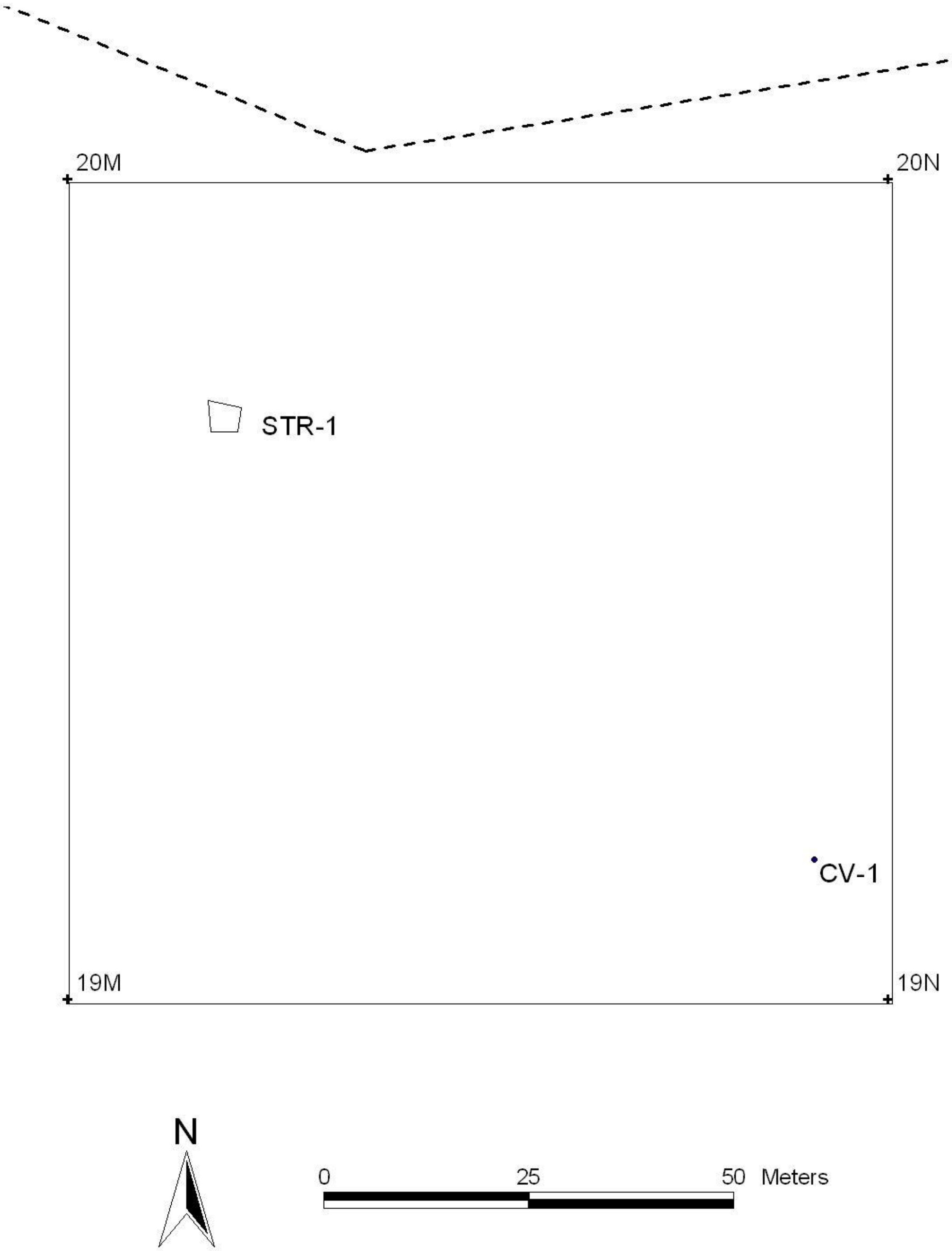


Figure B.196. Map of Section 19M.

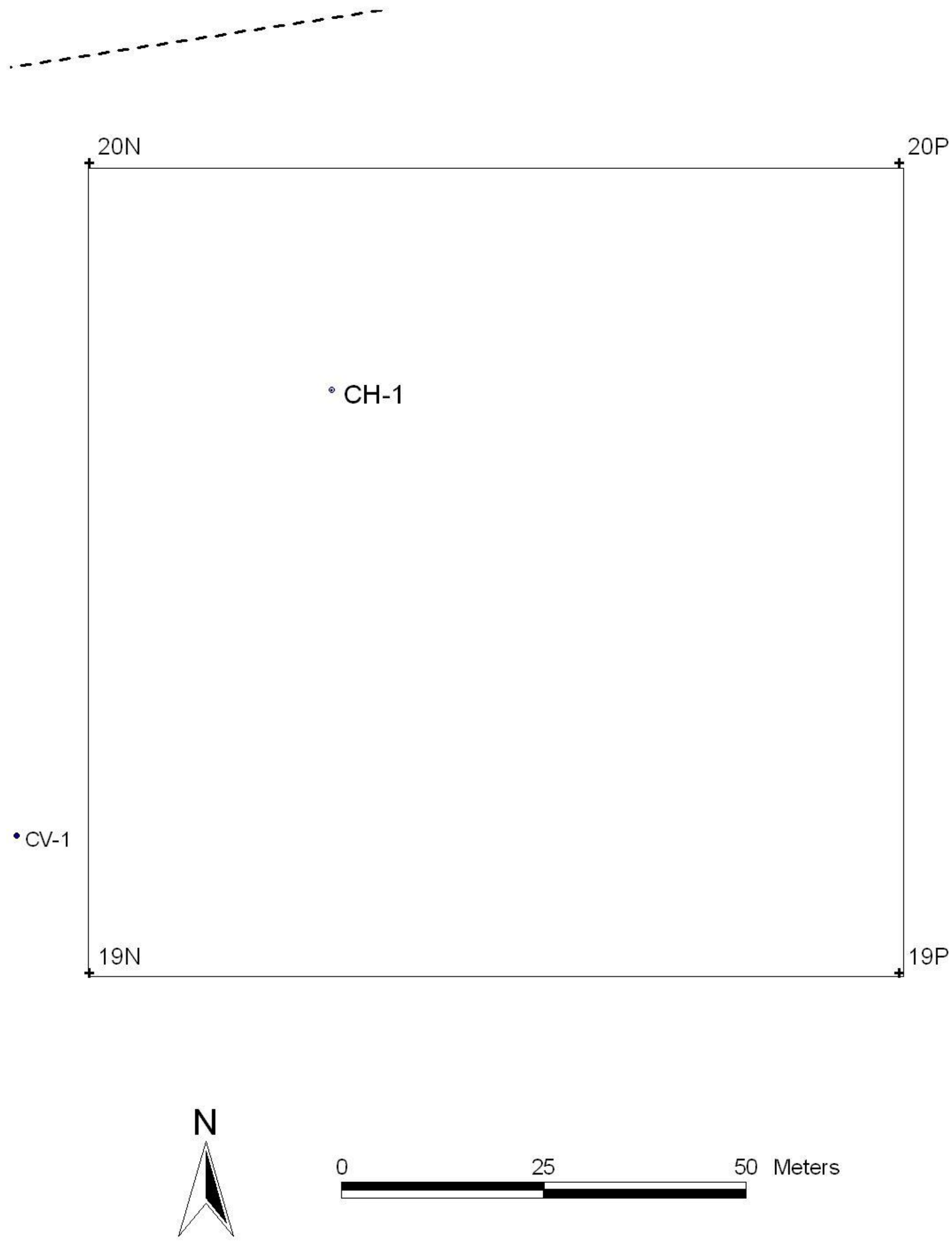


Figure B.197. Map of Section 19N.

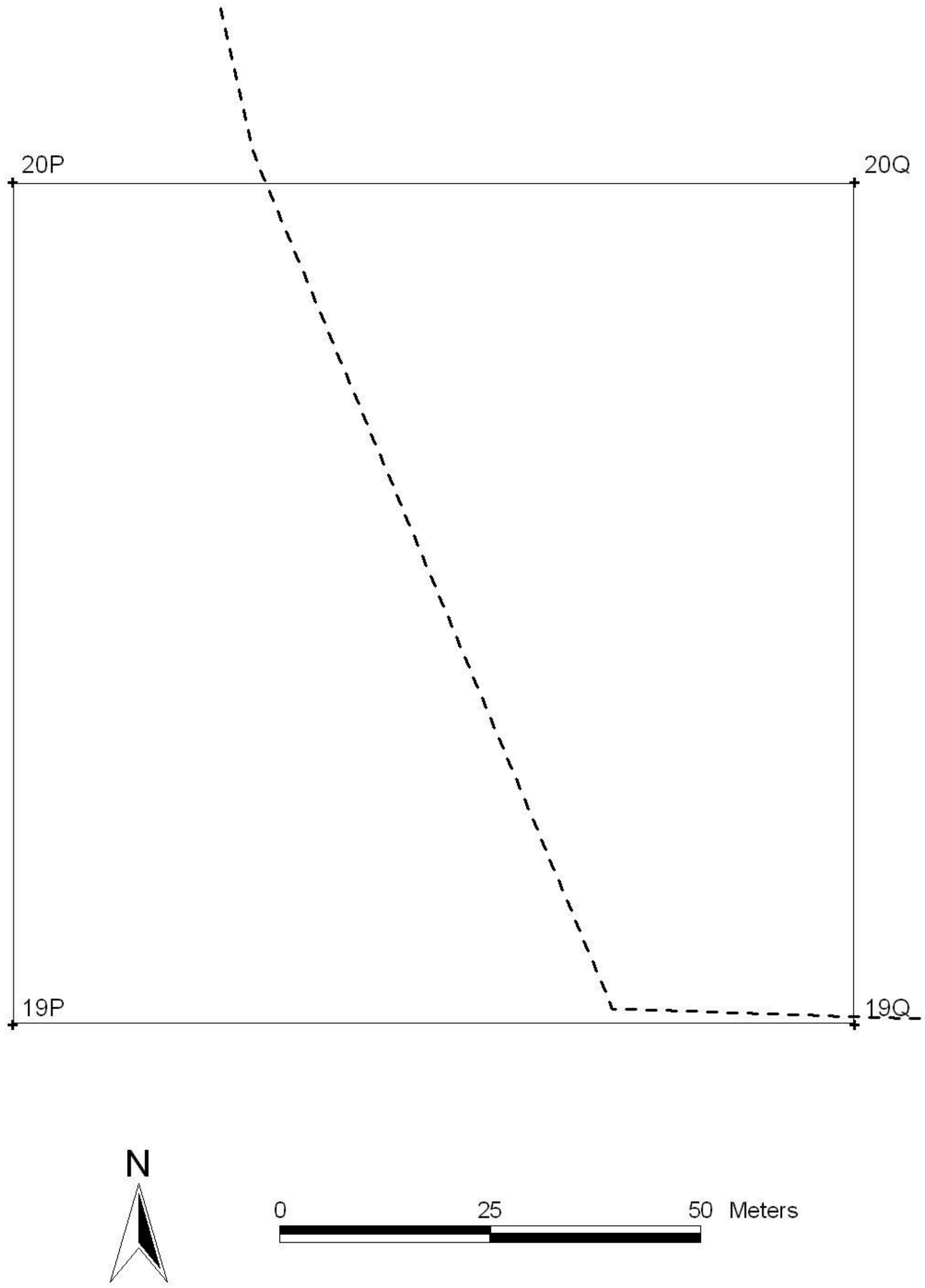


Figure B.198. Map of Section 19P.

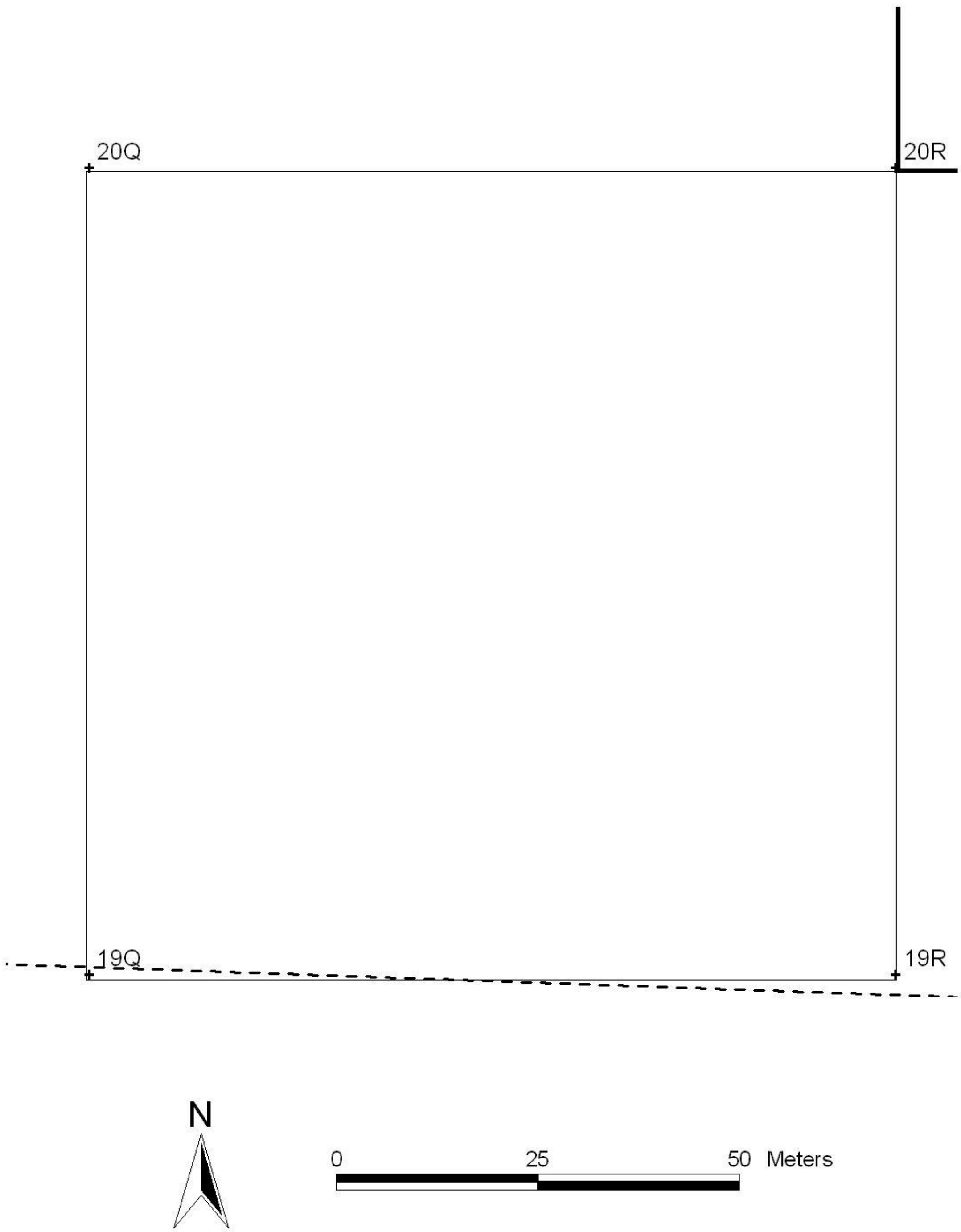


Figure B.199. Map of Section 19Q.

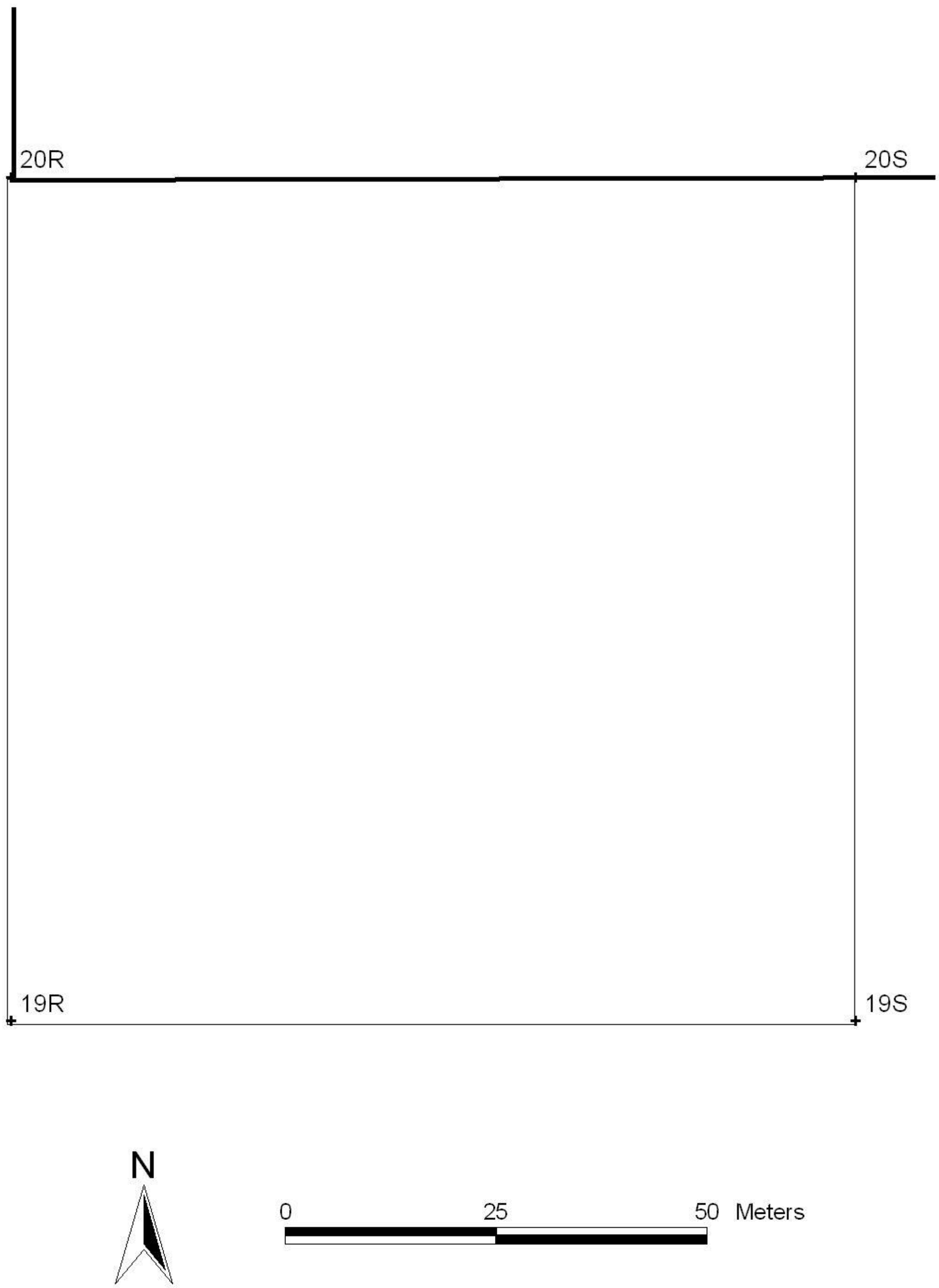


Figure B.200. Map of Section 19R.

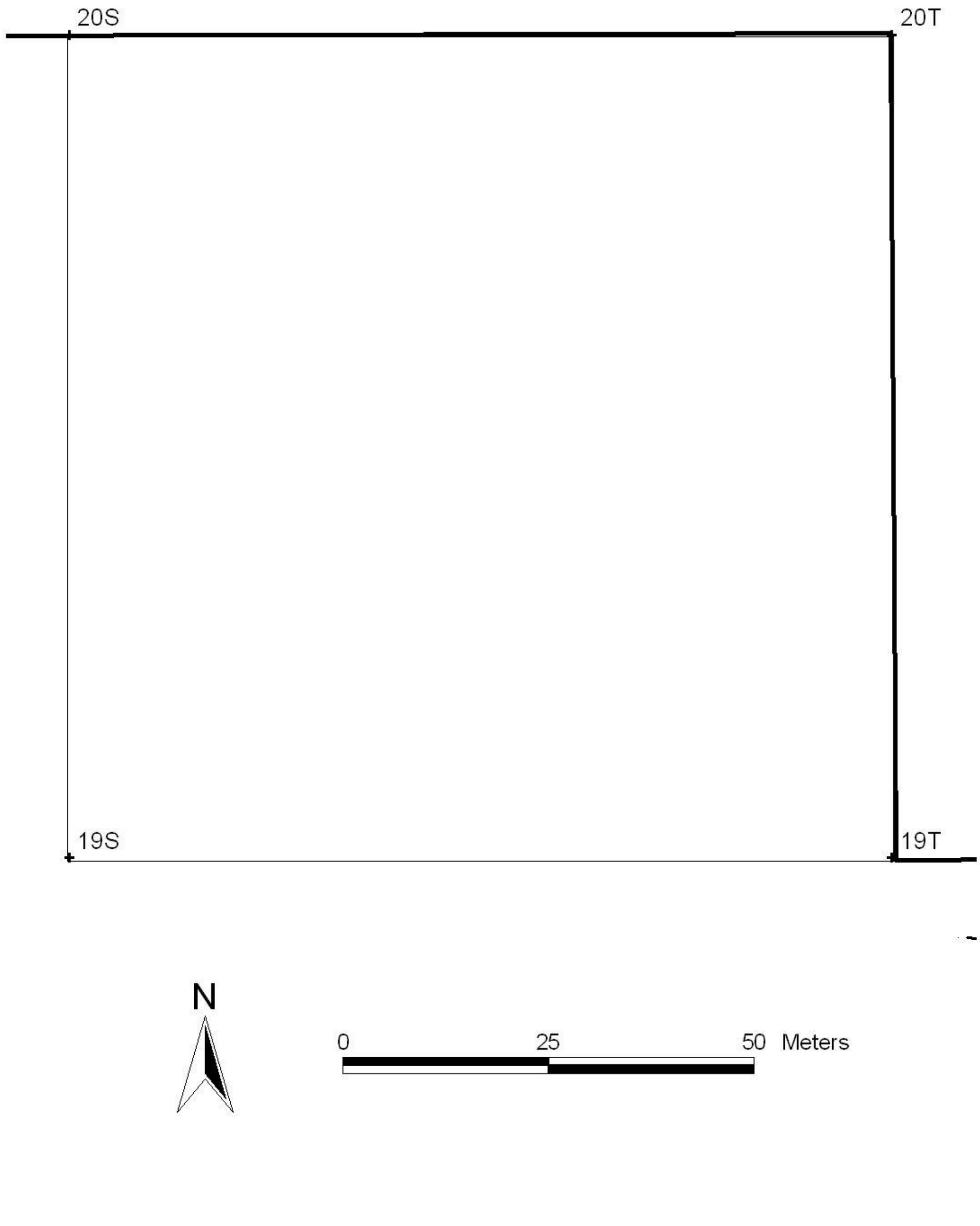


Figure B.201. Map of Section 19S.

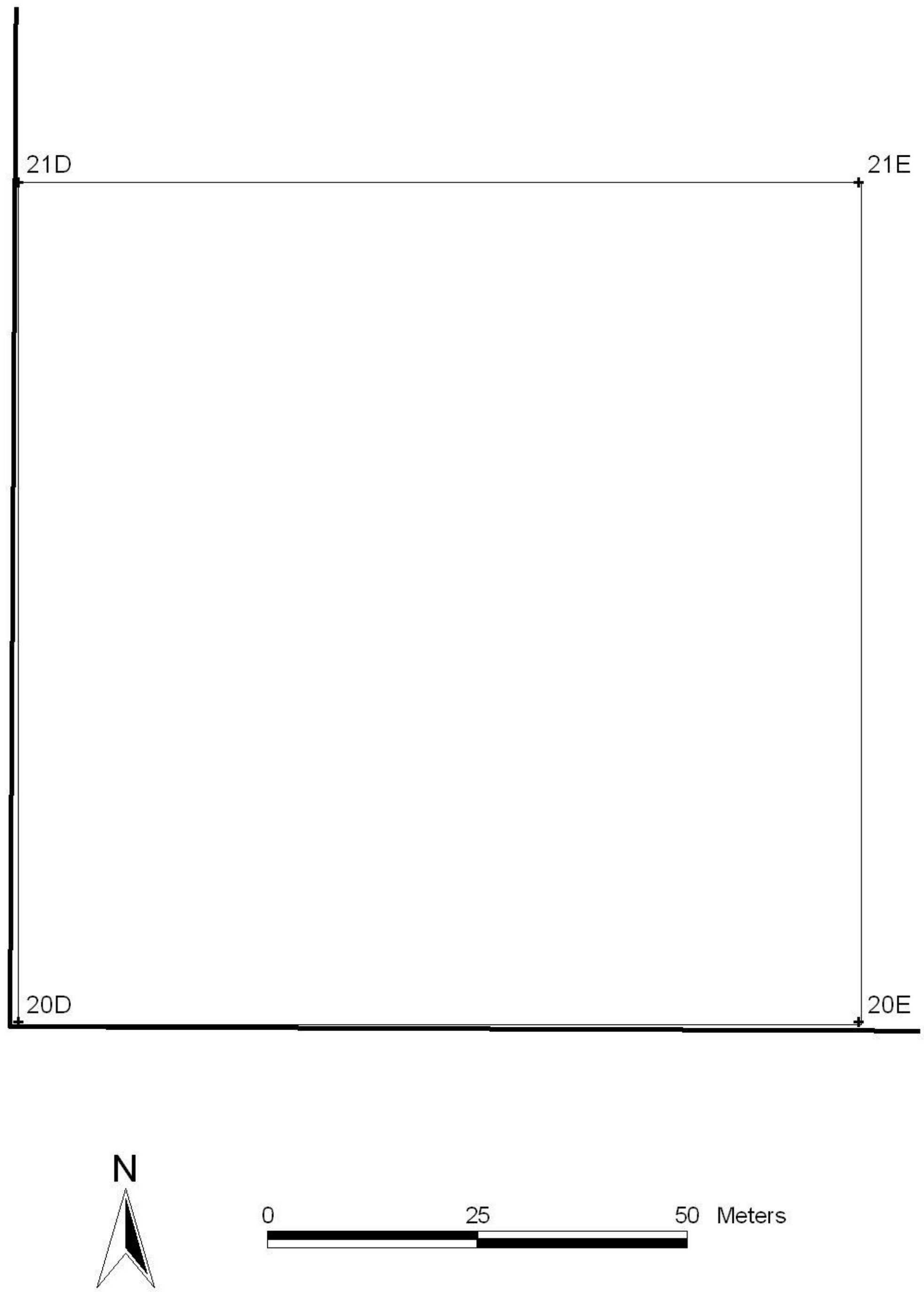


Figure B.202. Map of Section 20D.

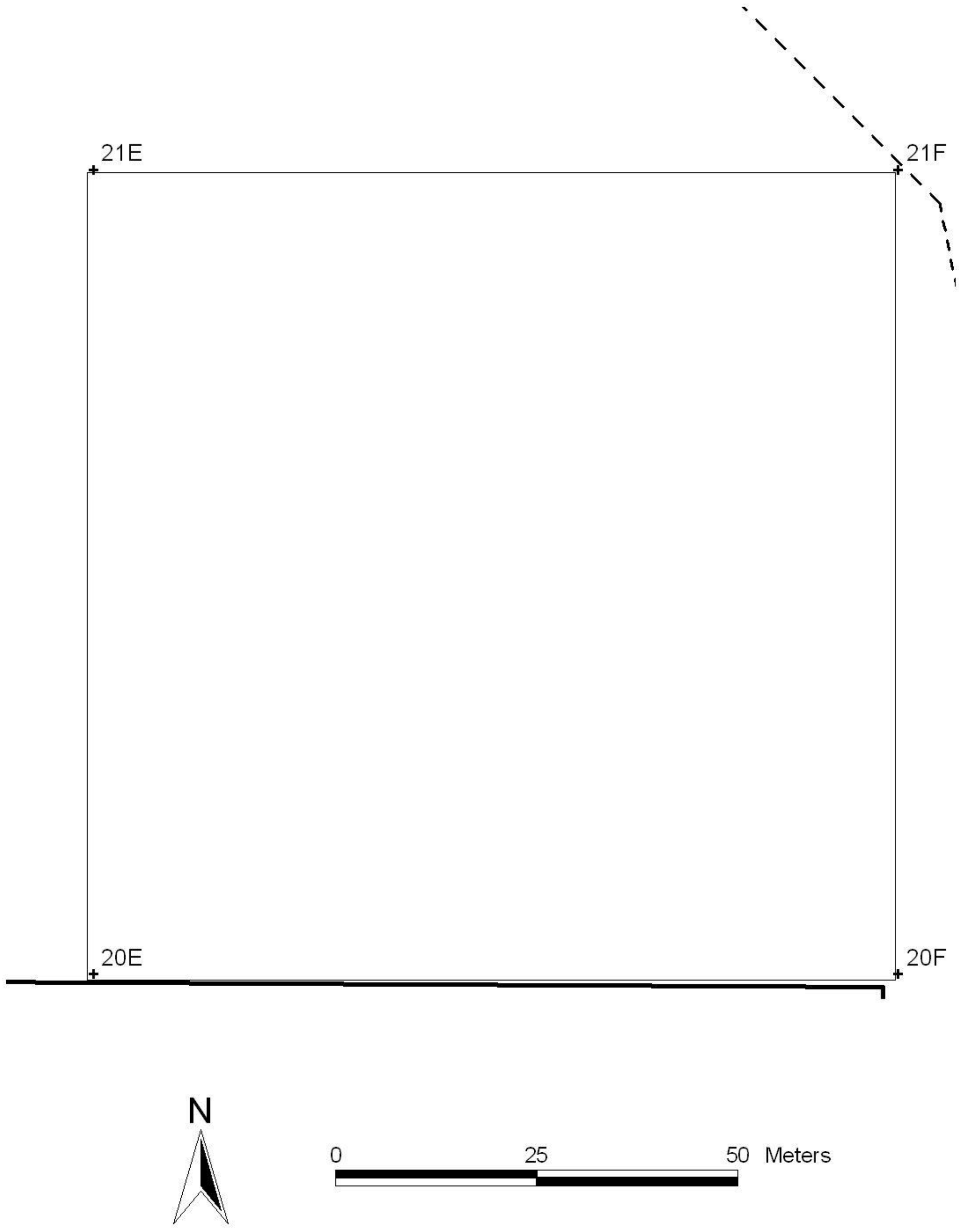


Figure B.203. Map of Section 20E.

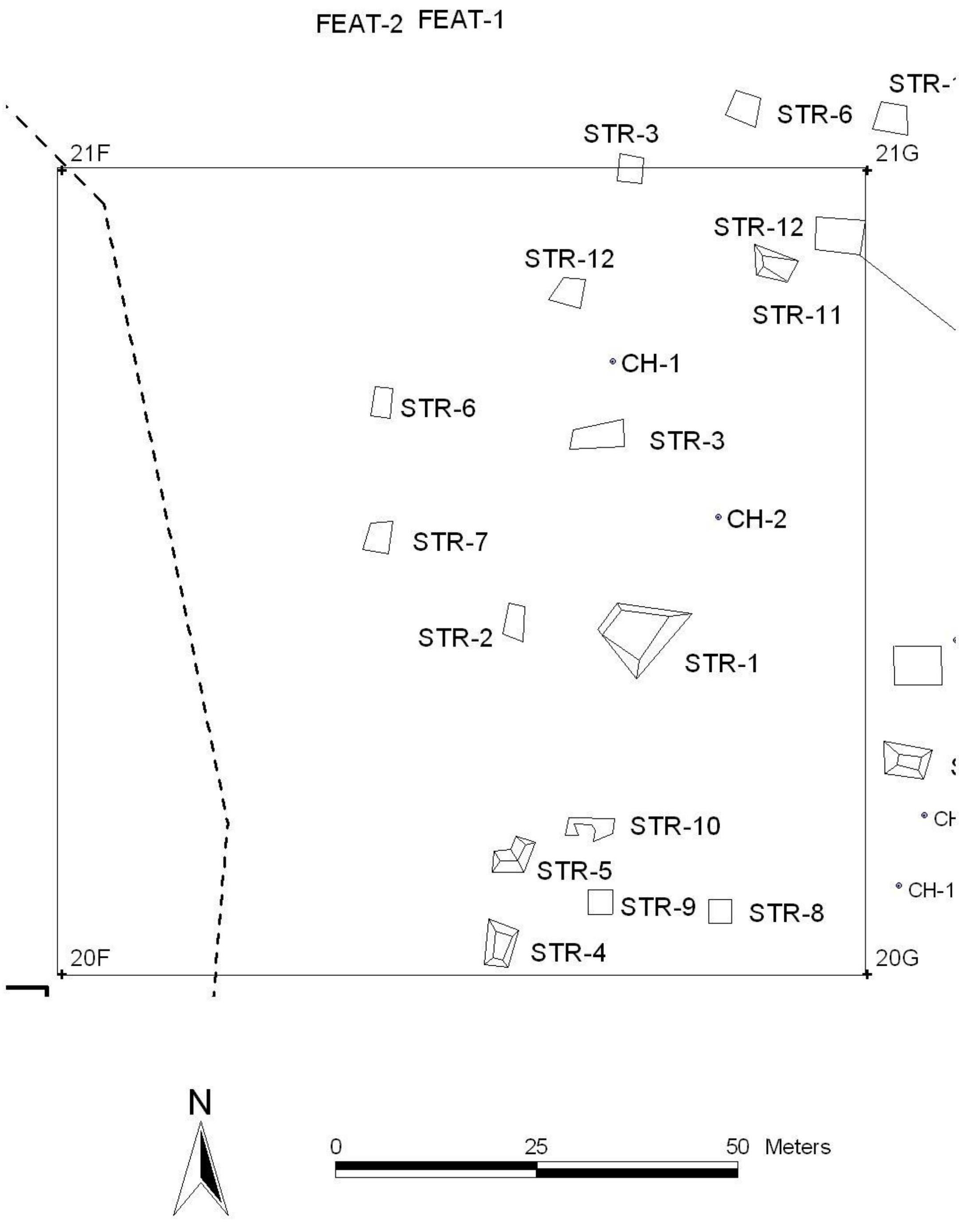


Figure B.204. Map of Section 20F.

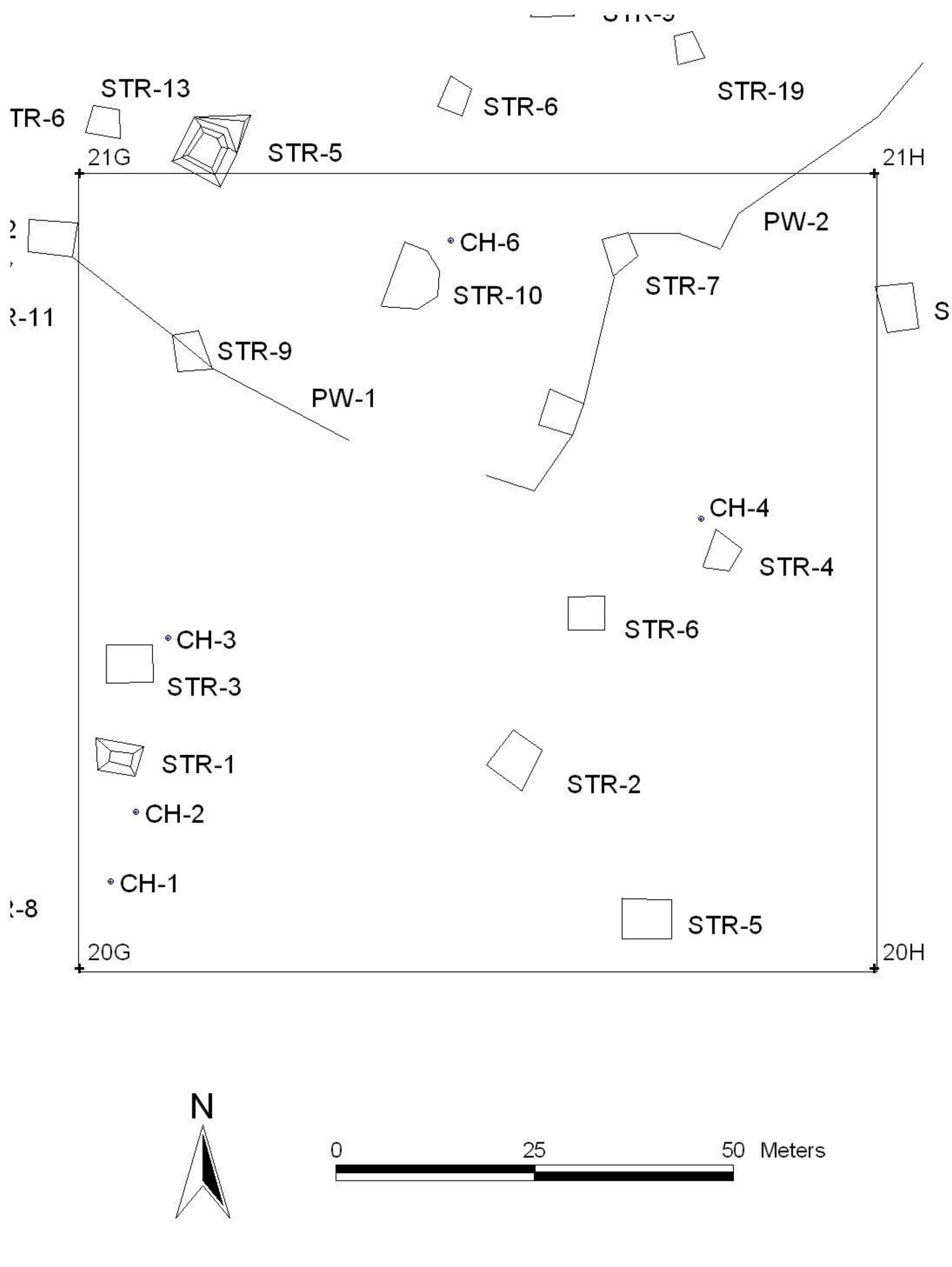


Figure B.205. Map of Section 20G.

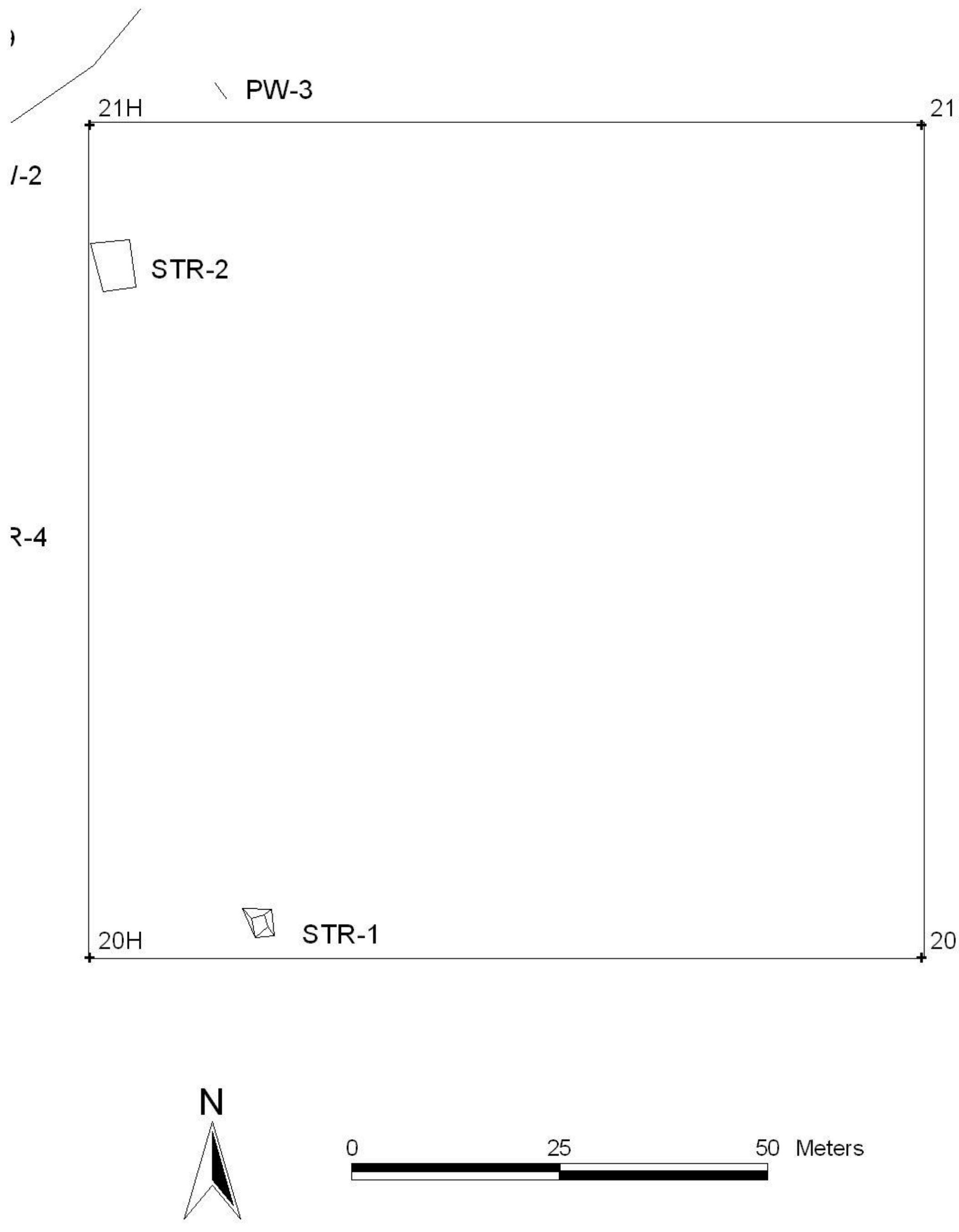


Figure B.206. Map of Section 20H.

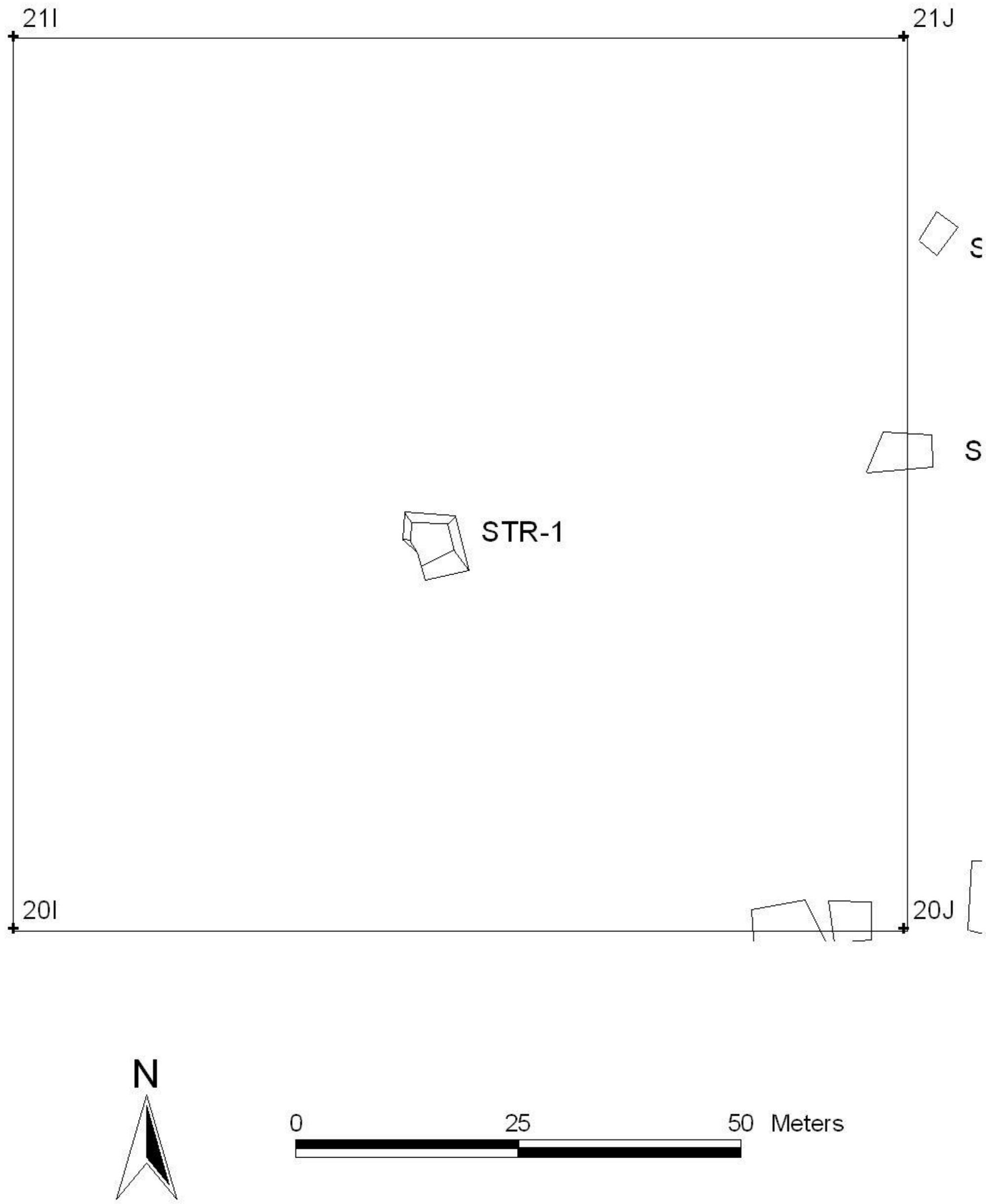


Figure B.207. Map of Section 20I.

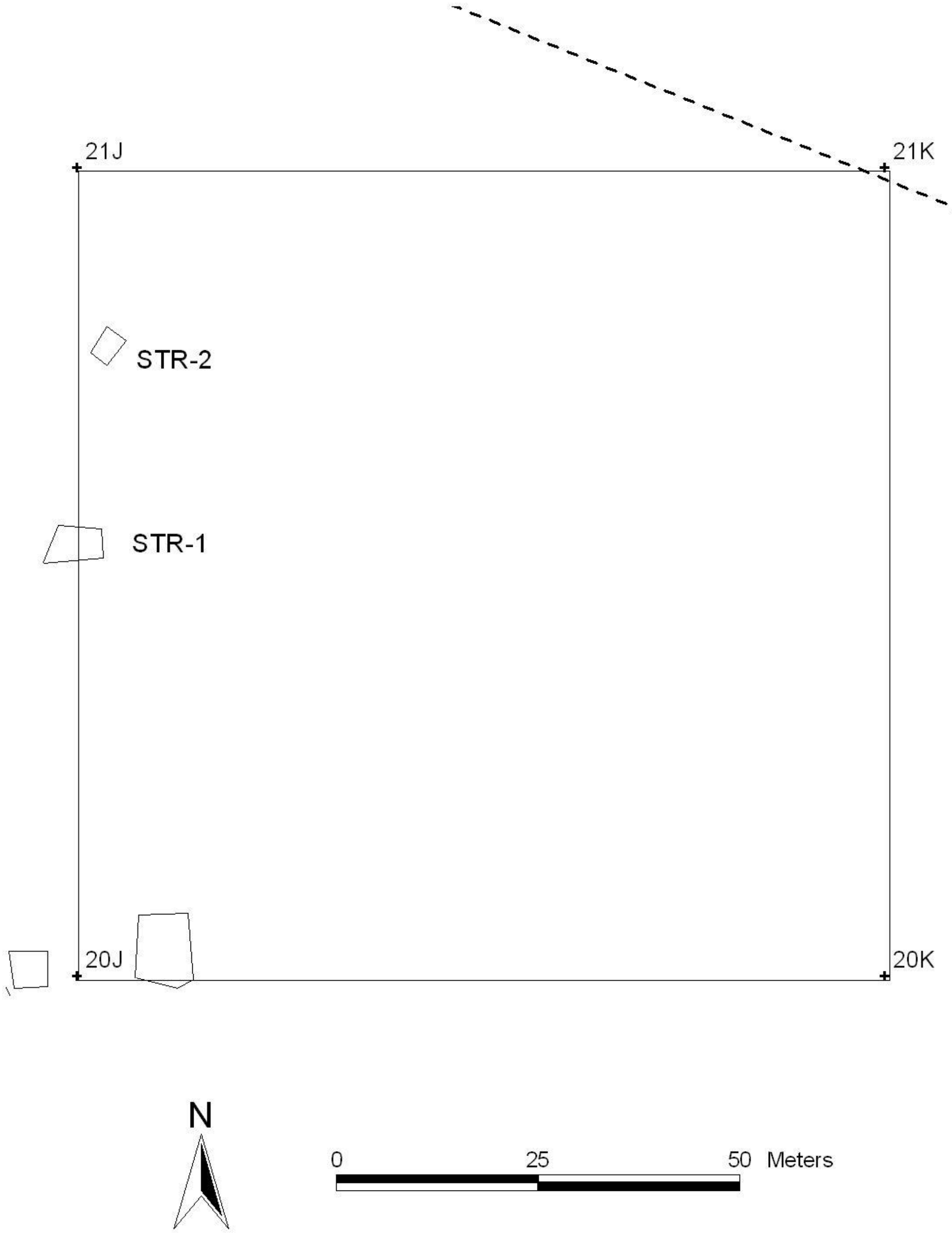


Figure B.208. Map of Section 20J.

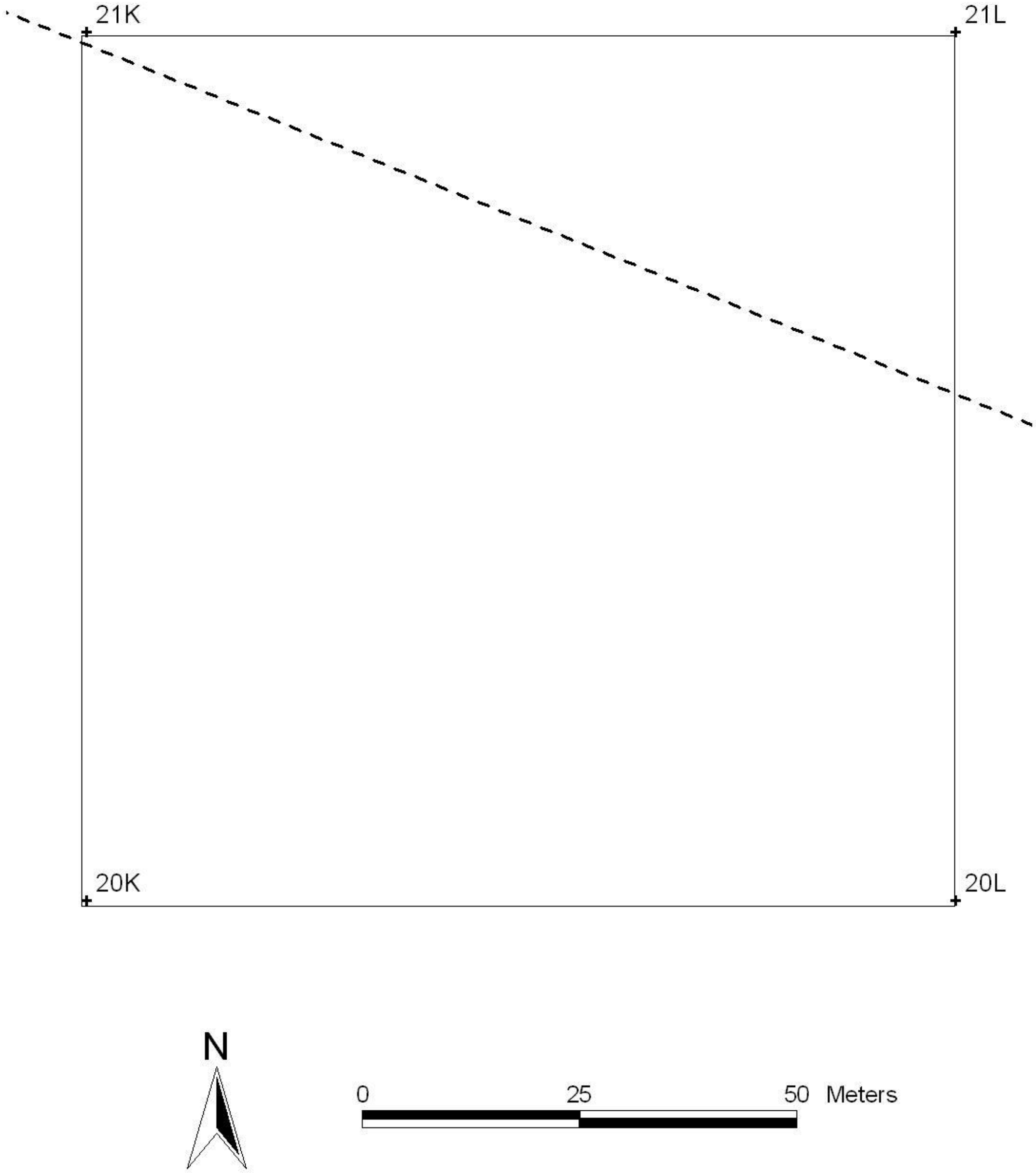


Figure B.209. Map of Section 20K.

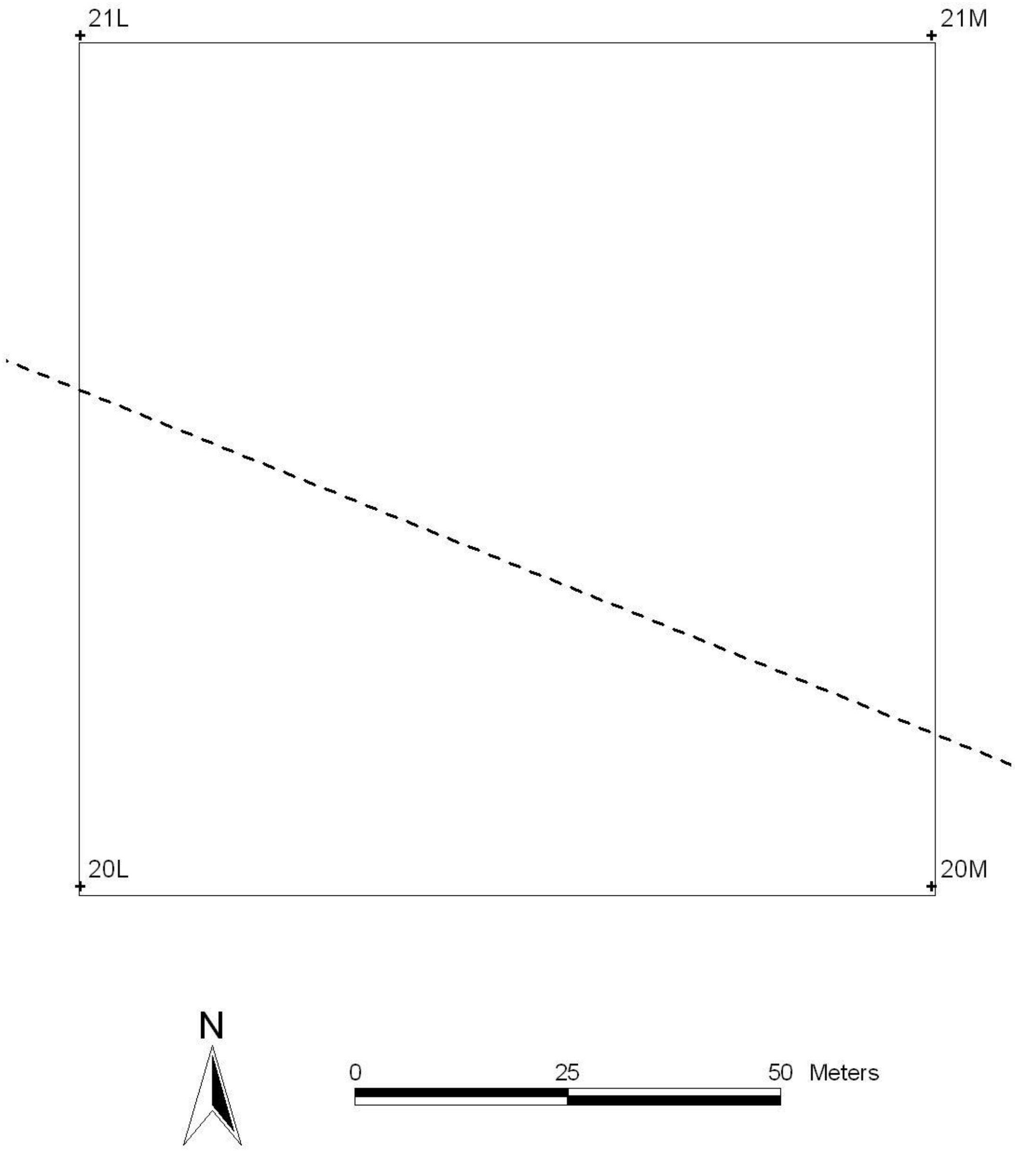


Figure B.210. Map of Section 20L.

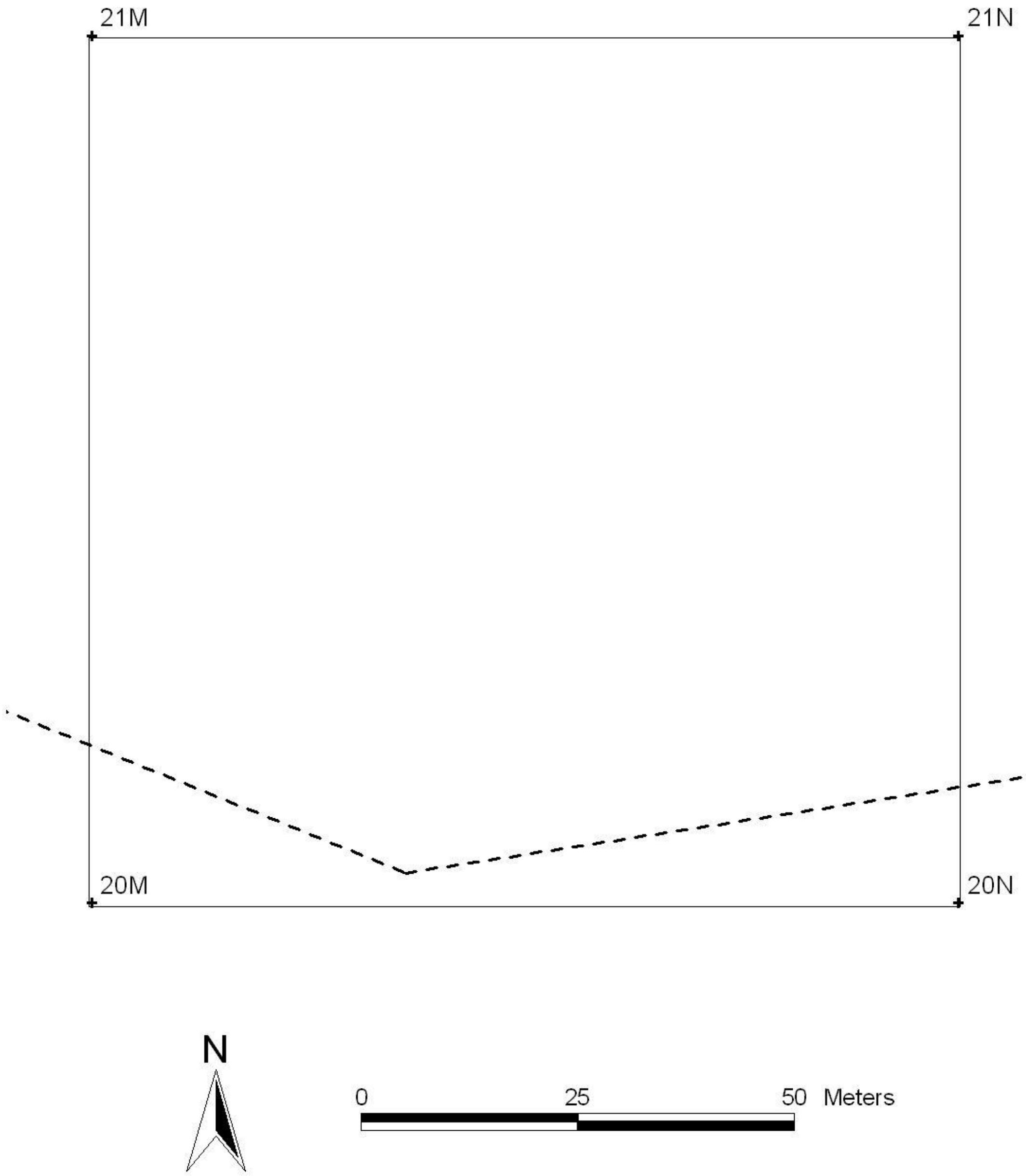


Figure B.211. Map of Section 20M.

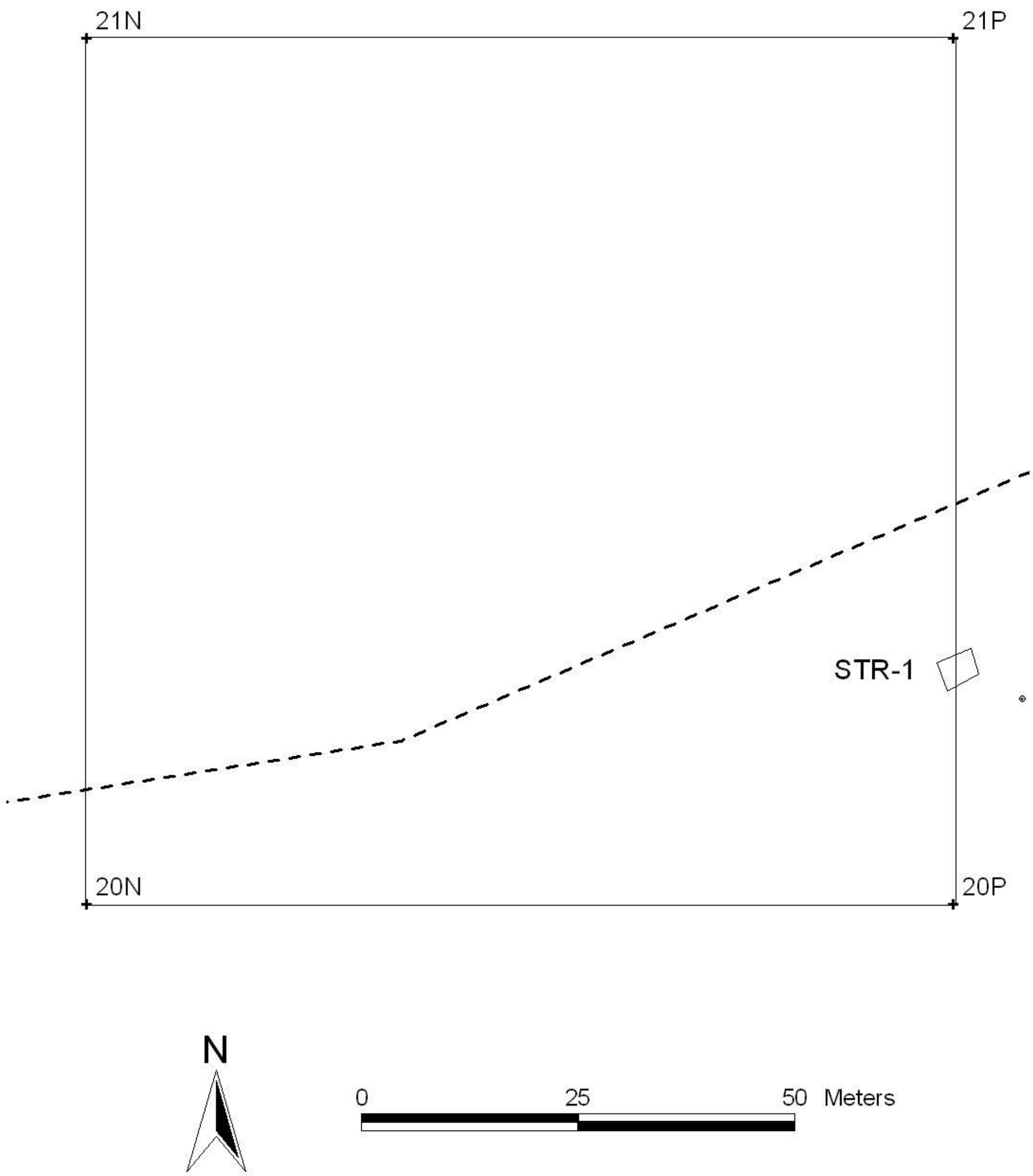


Figure B.212. Map of Section 20N.

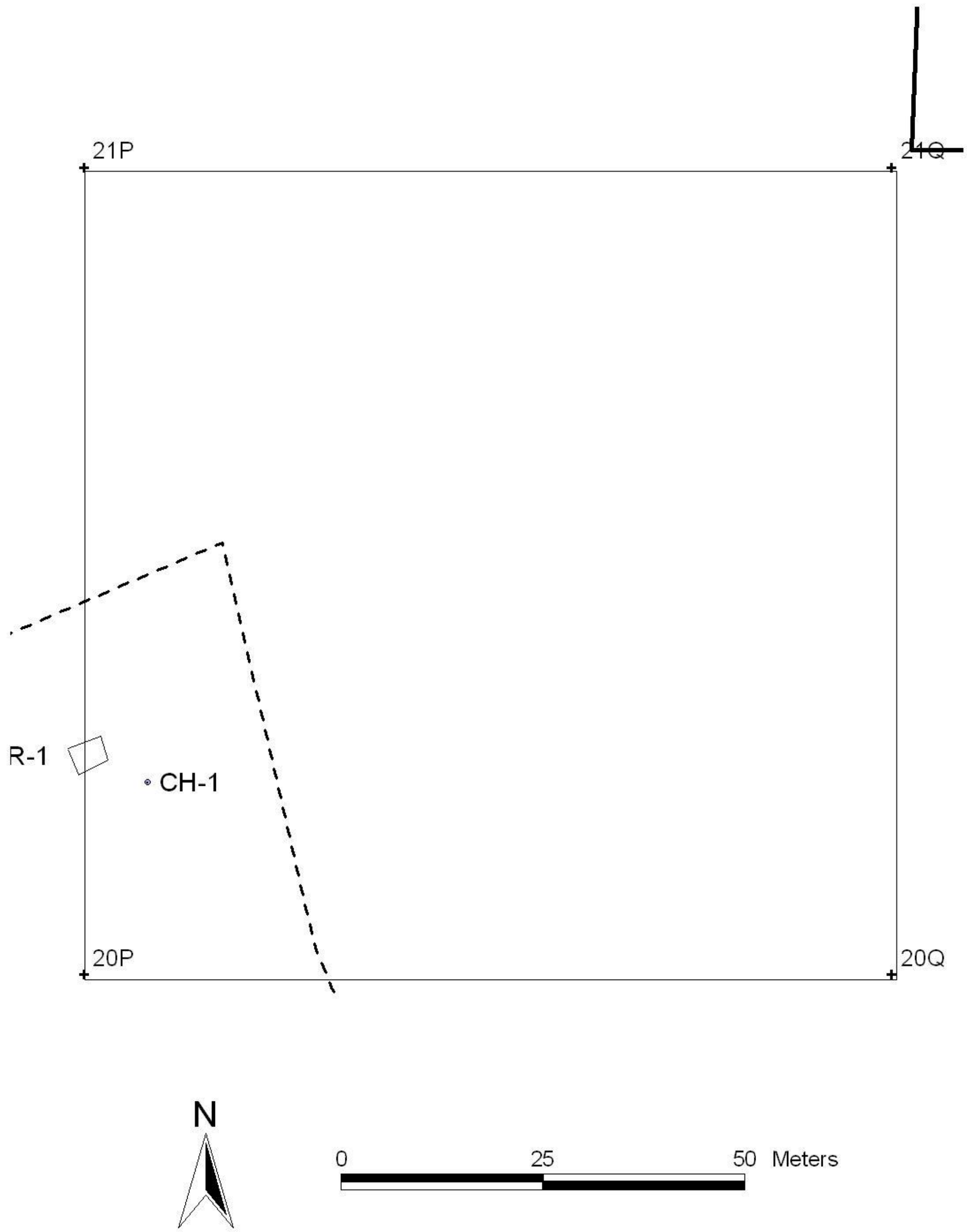


Figure B.213. Map of Section 20P.

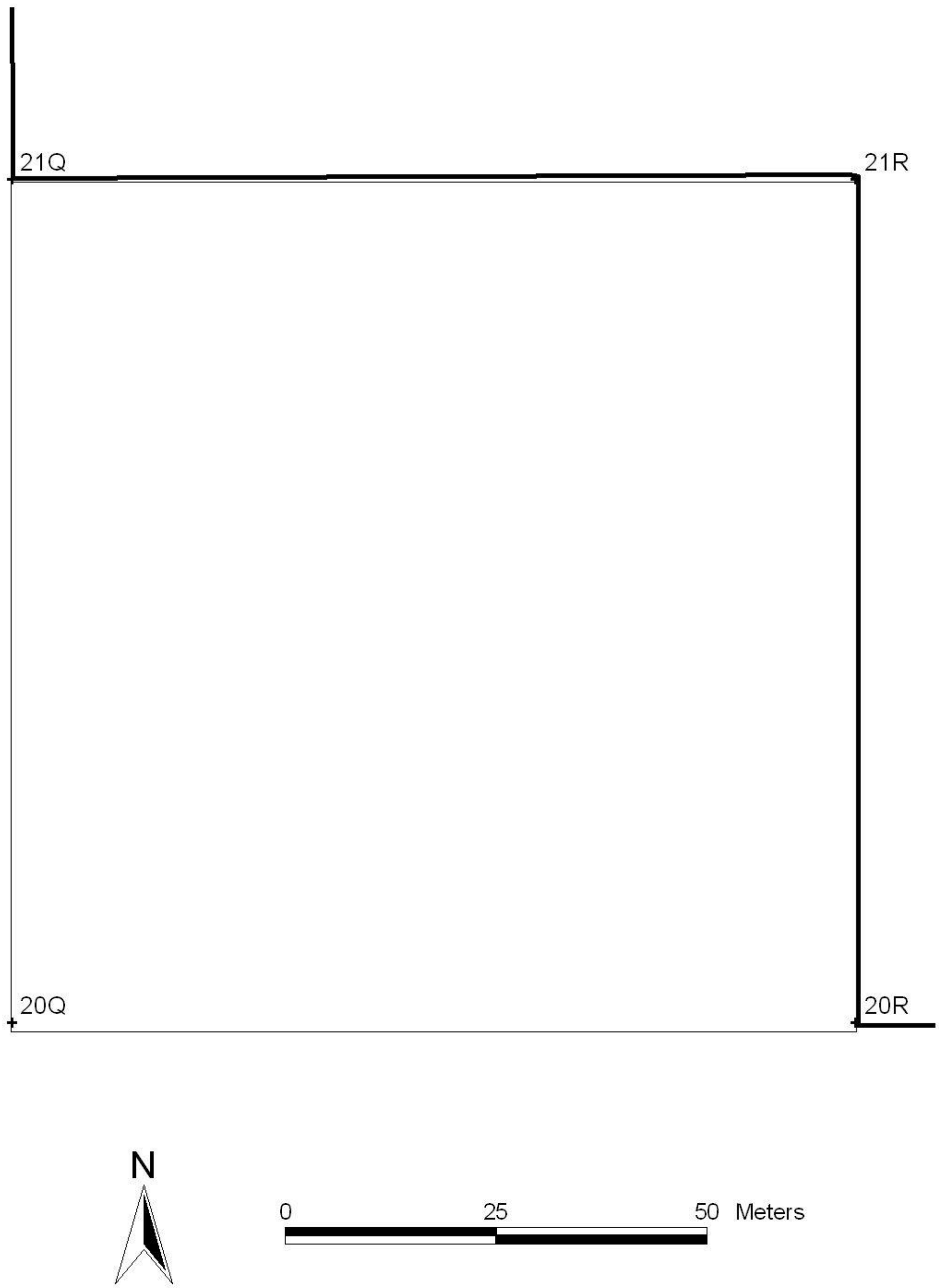


Figure B.214. Map of Section 20Q.

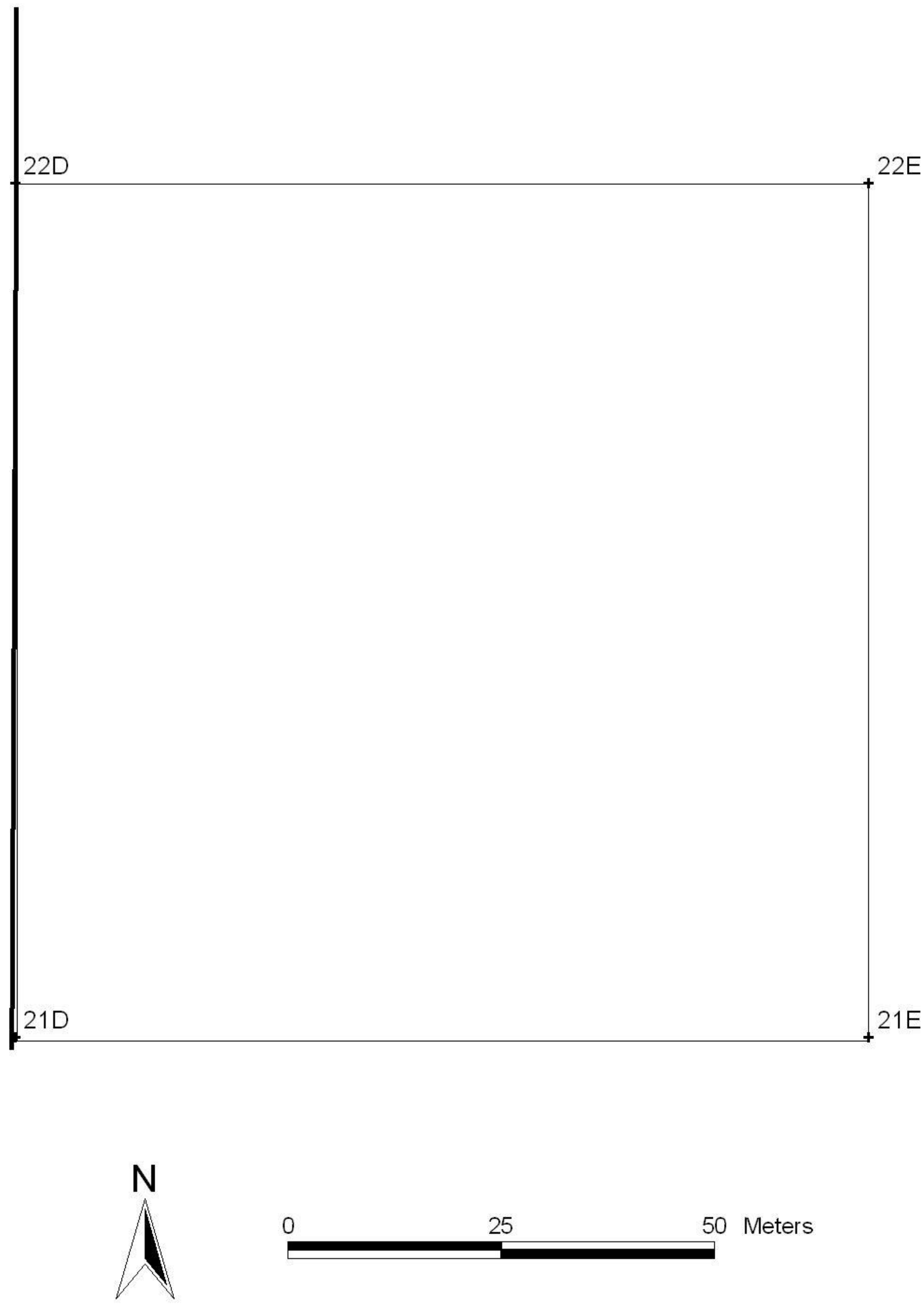


Figure B.215. Map of Section 21D.

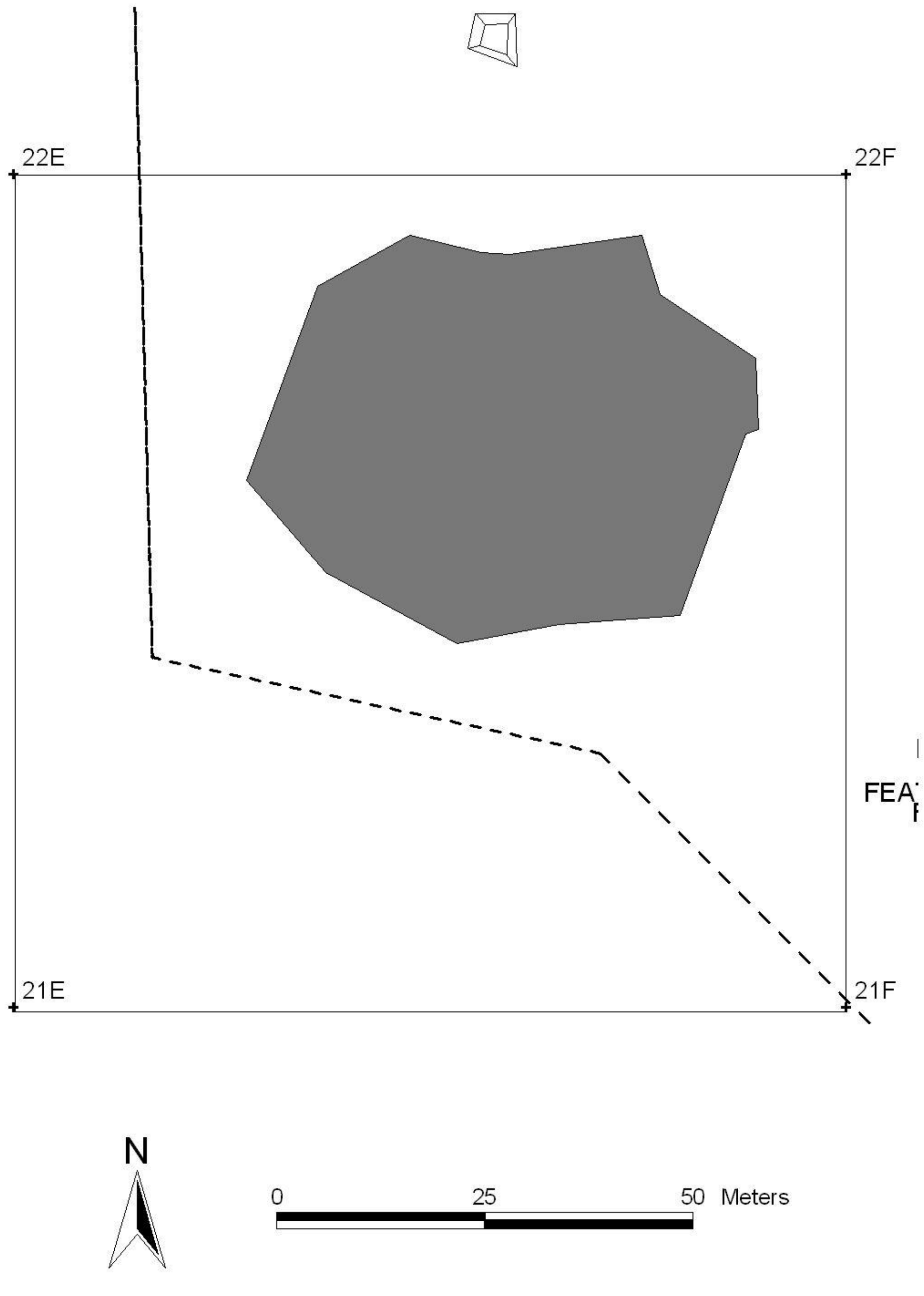


Figure B.216. Map of Section 21E.

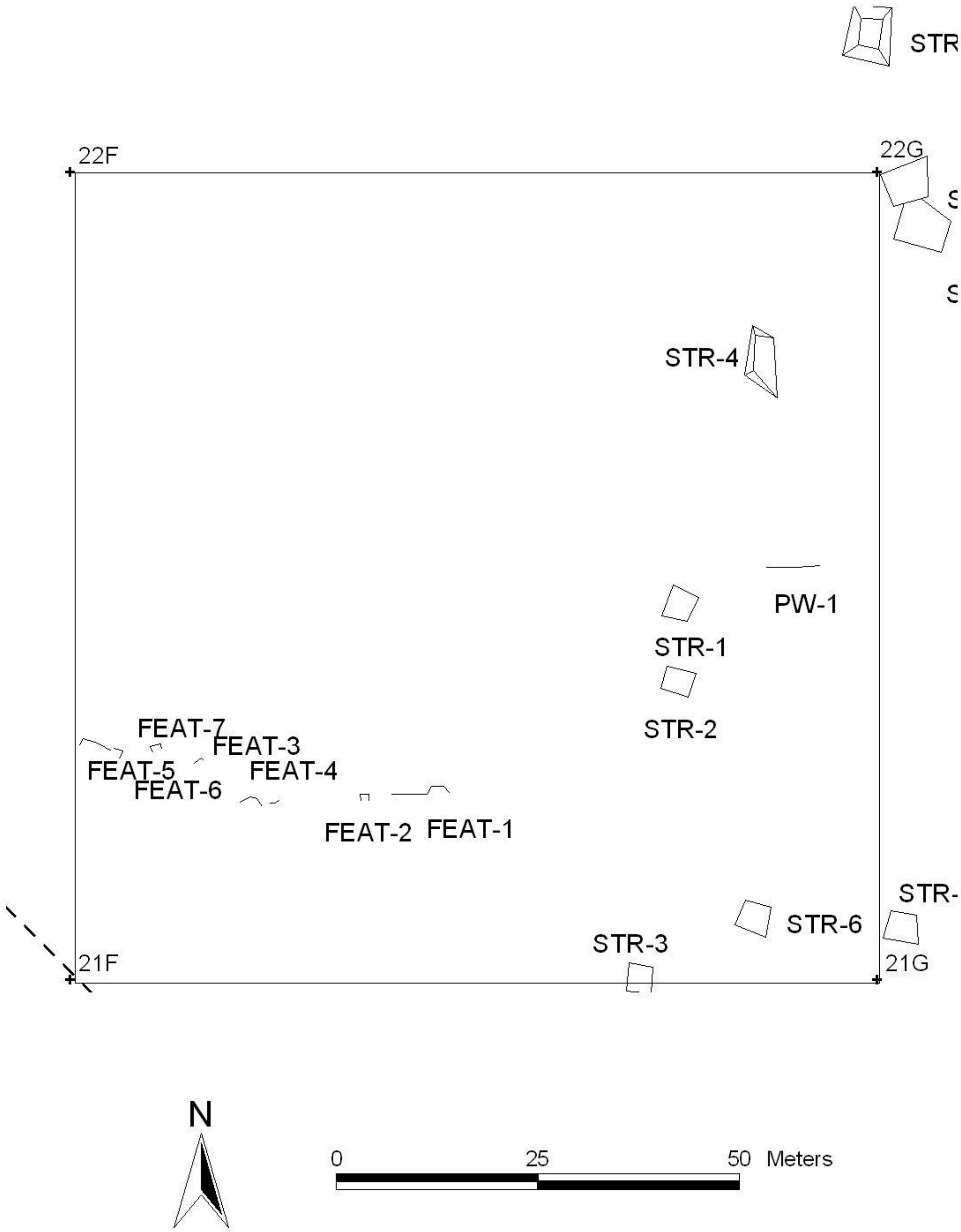


Figure B.217. Map of Section 21F.

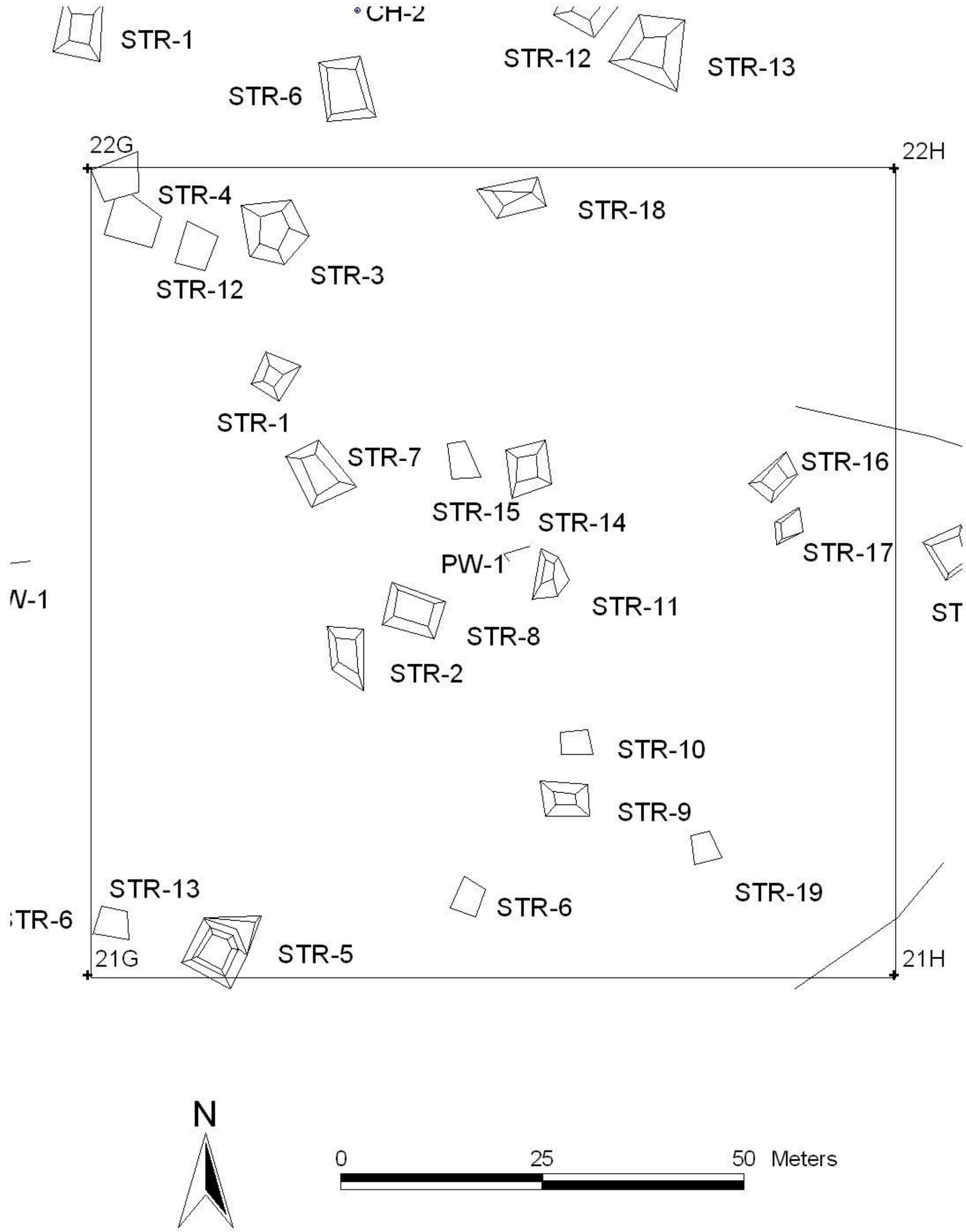


Figure B.218. Map of Section 21G.

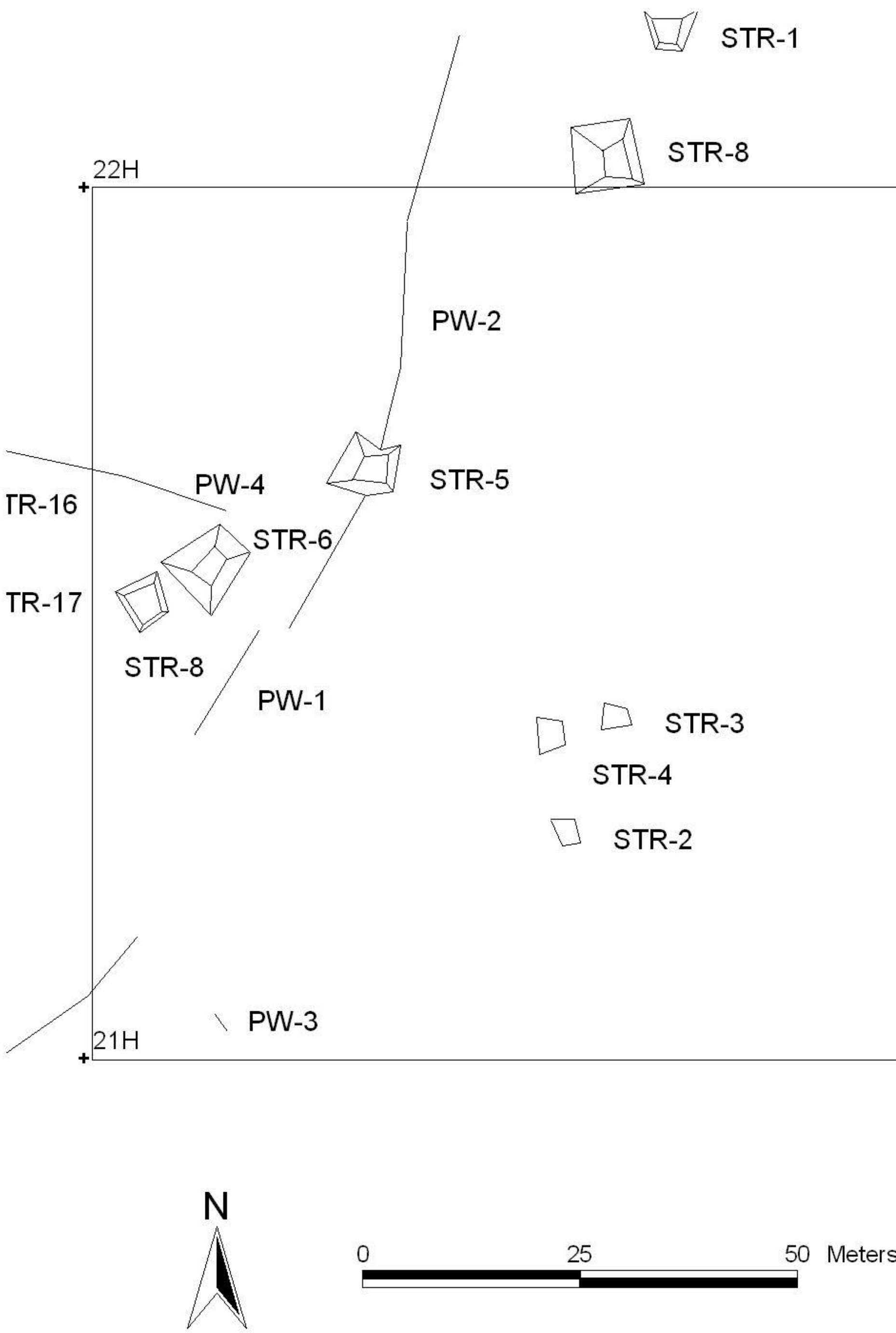


Figure B.219. Map of Section 21H.

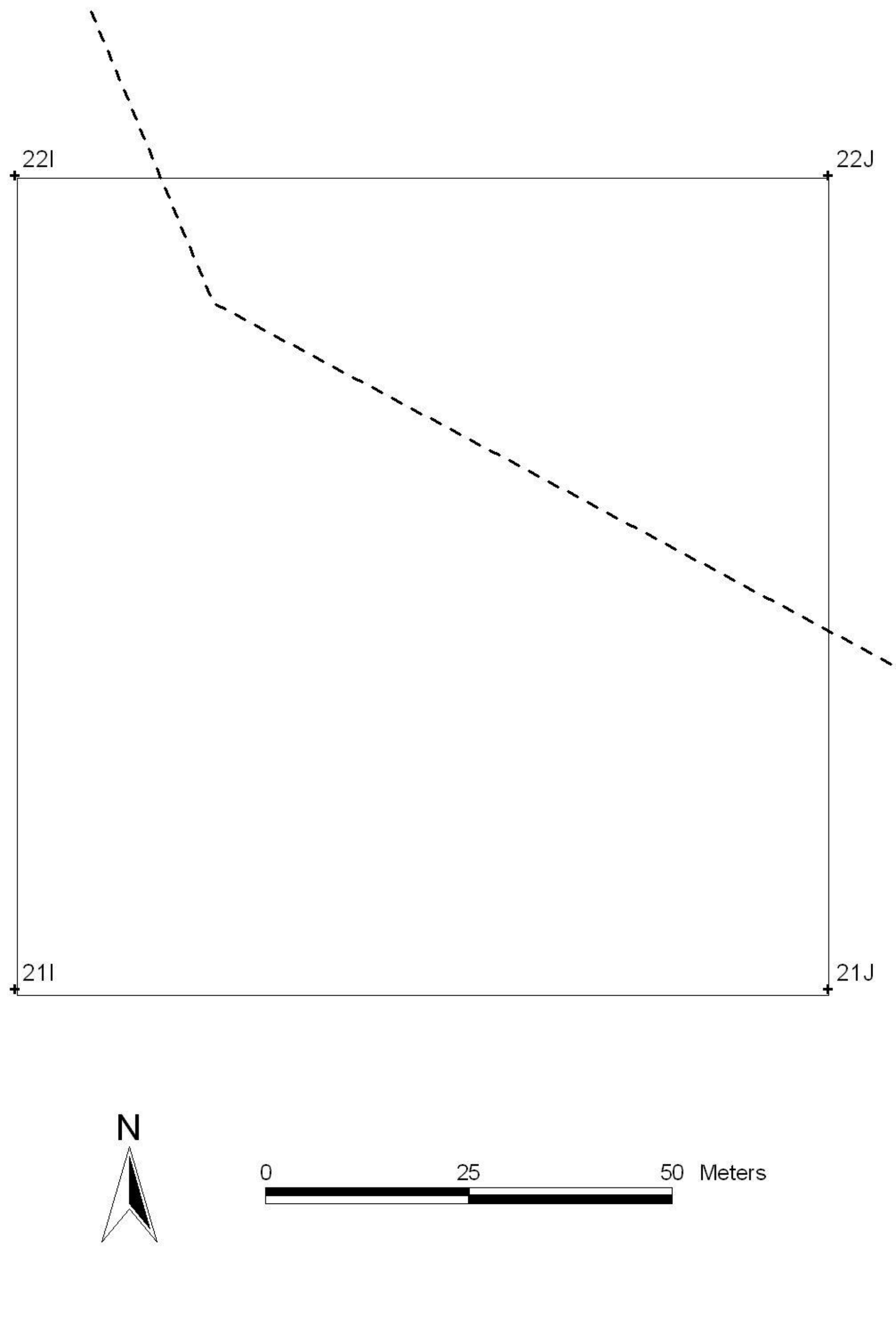


Figure B.220. Map of Section 21I.

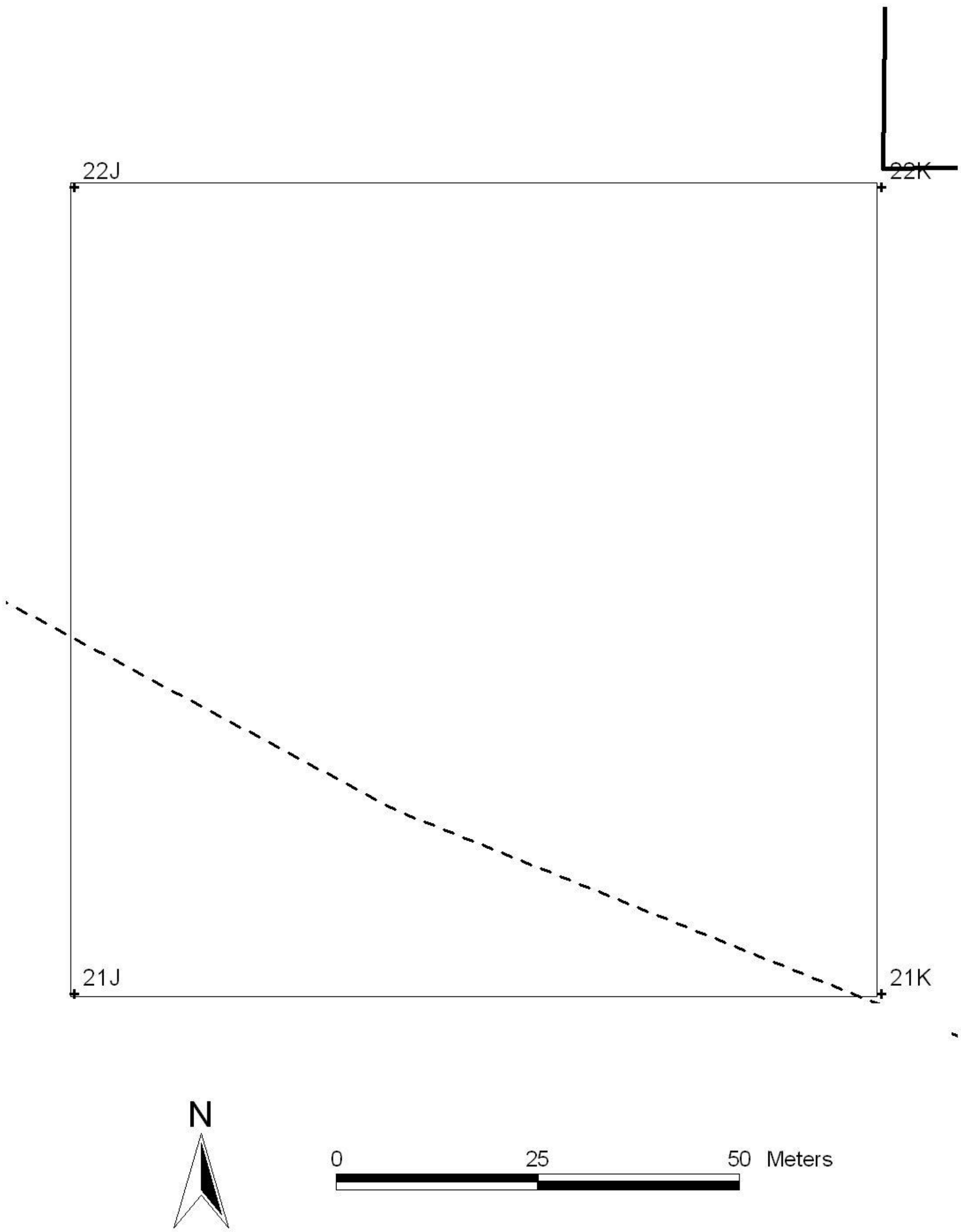


Figure B.221. Map of Section 21J.

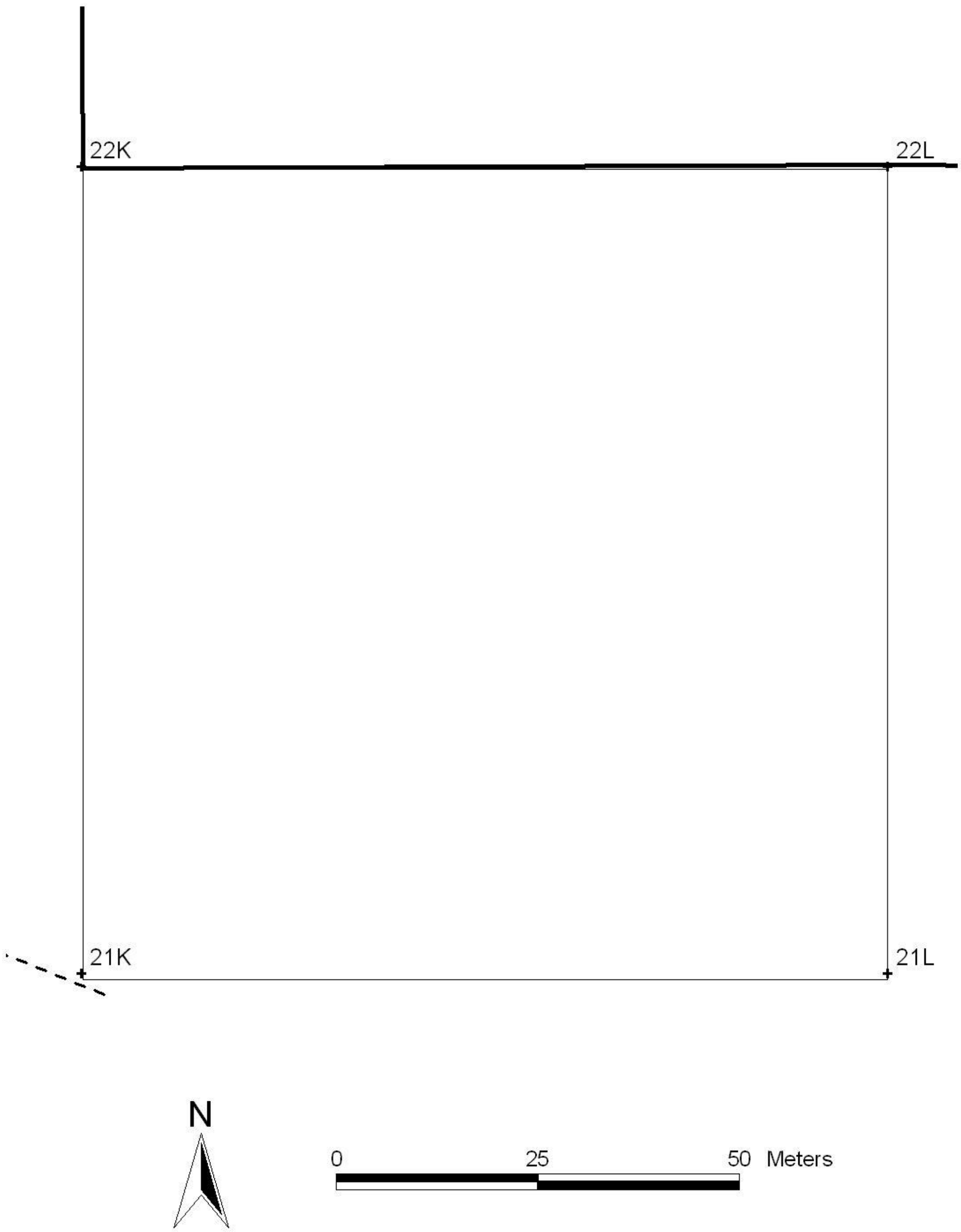


Figure B.222. Map of Section 21K.

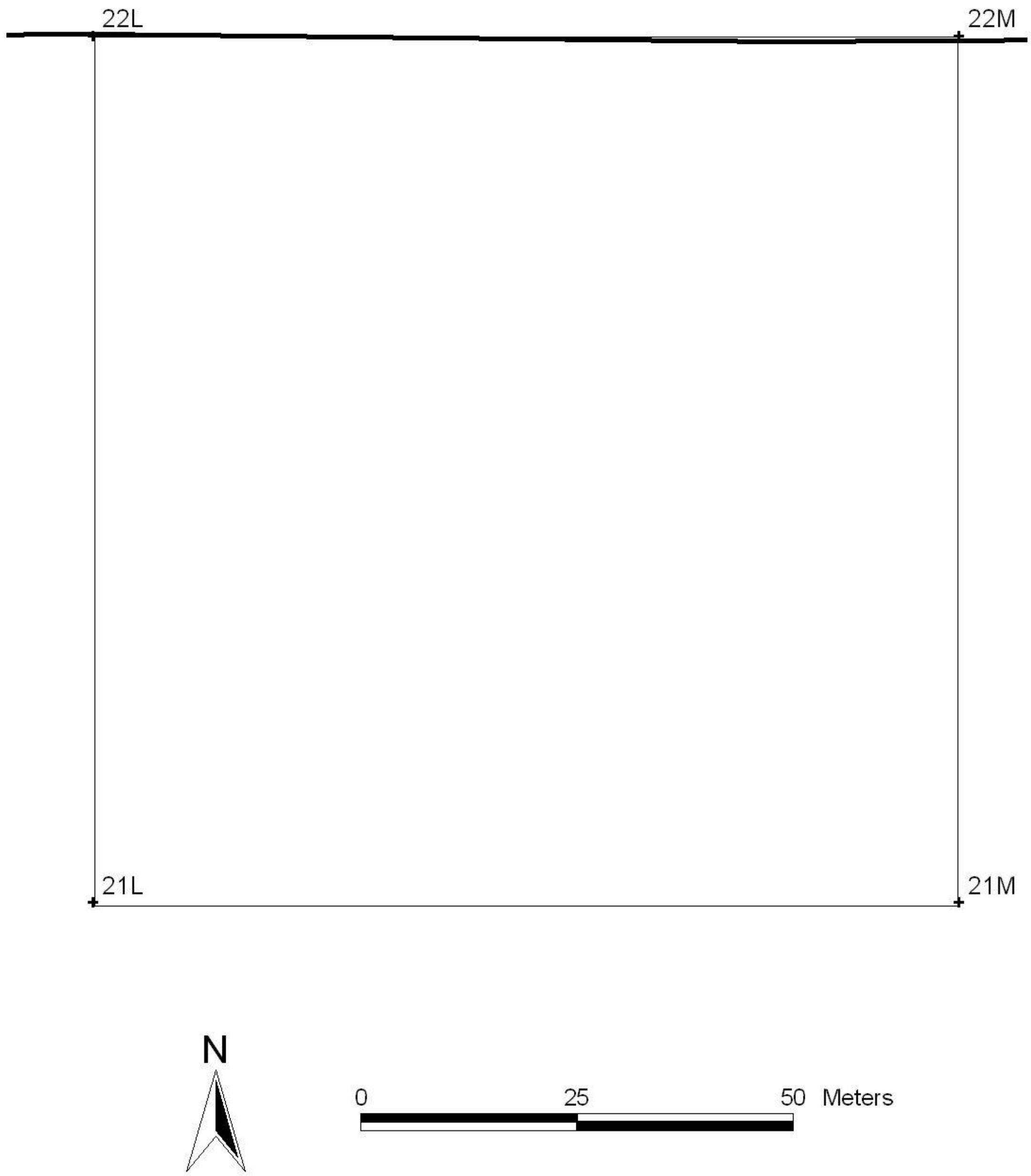


Figure B.223. Map of Section 21L.

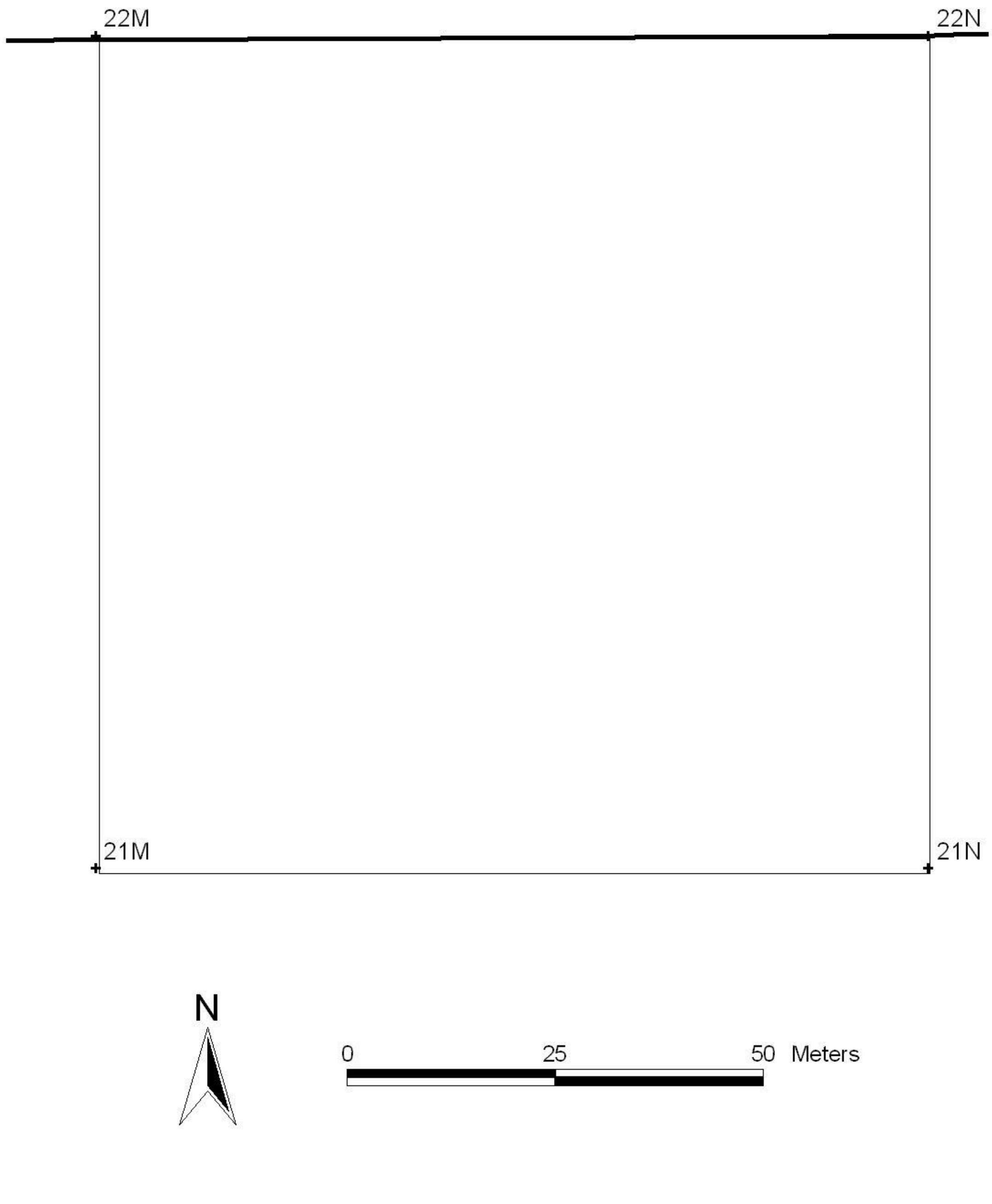


Figure B.224. Map of Section 21M.

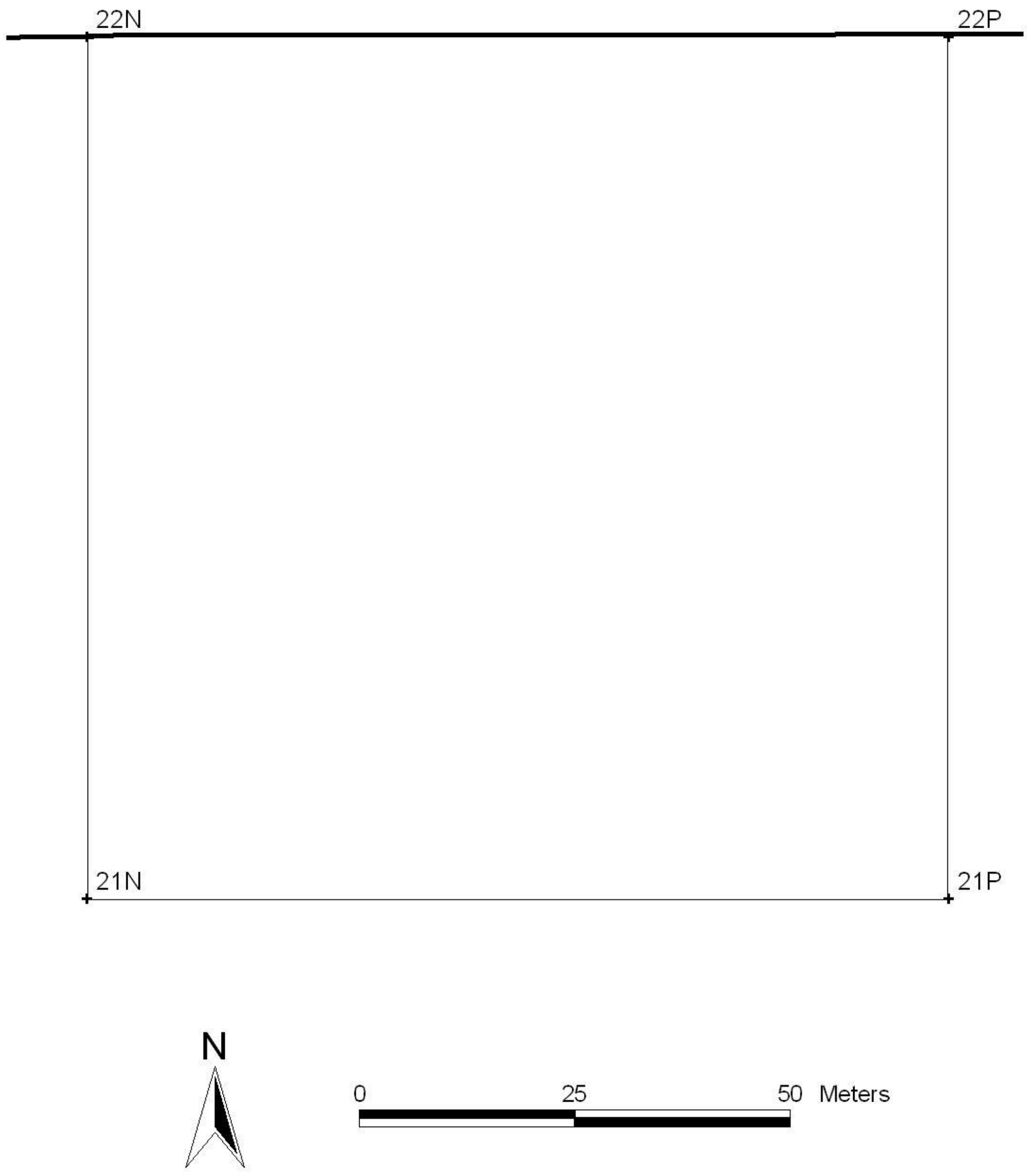


Figure B.225. Map of Section 21N.

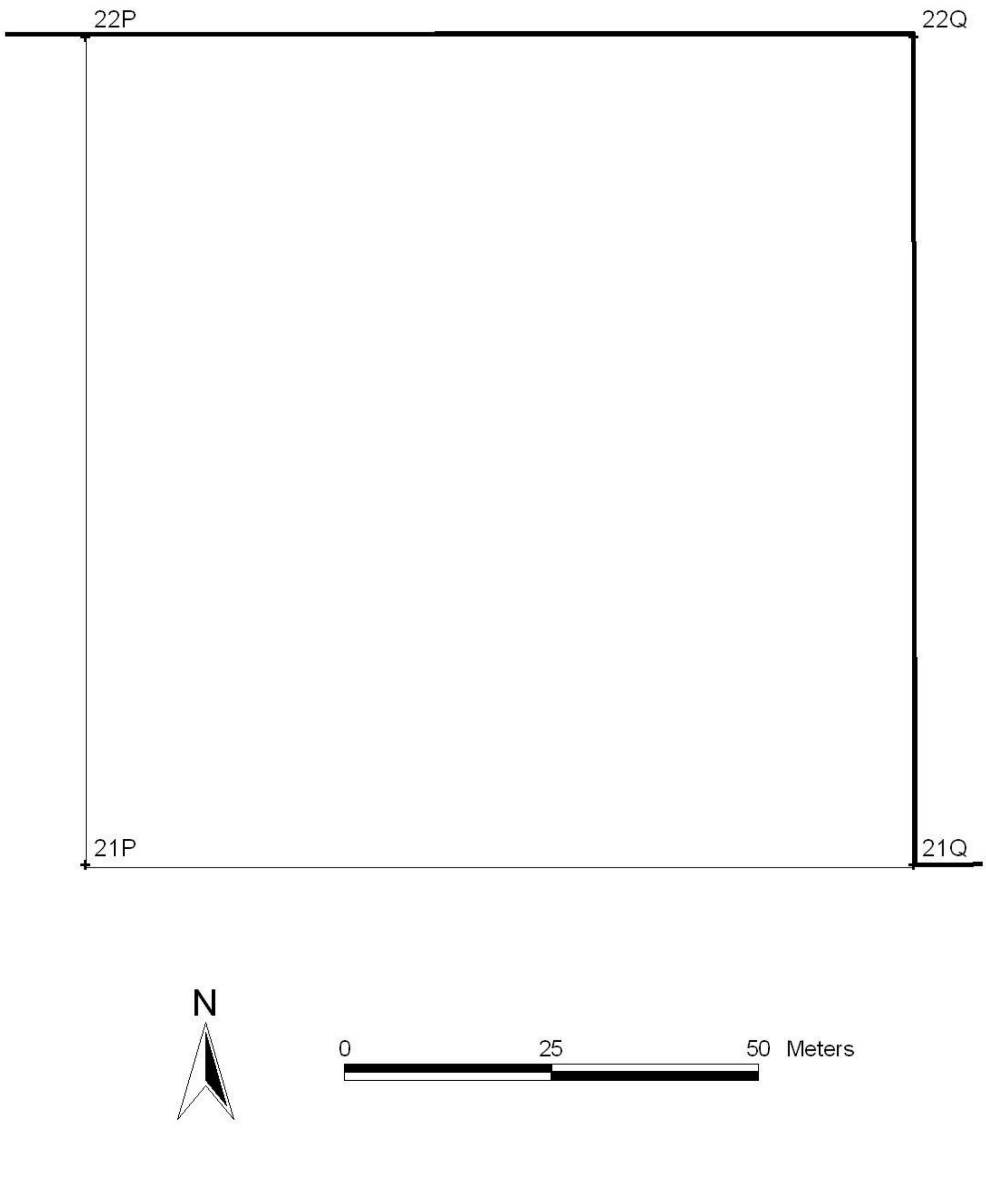


Figure B.226. Map of Section 21P.

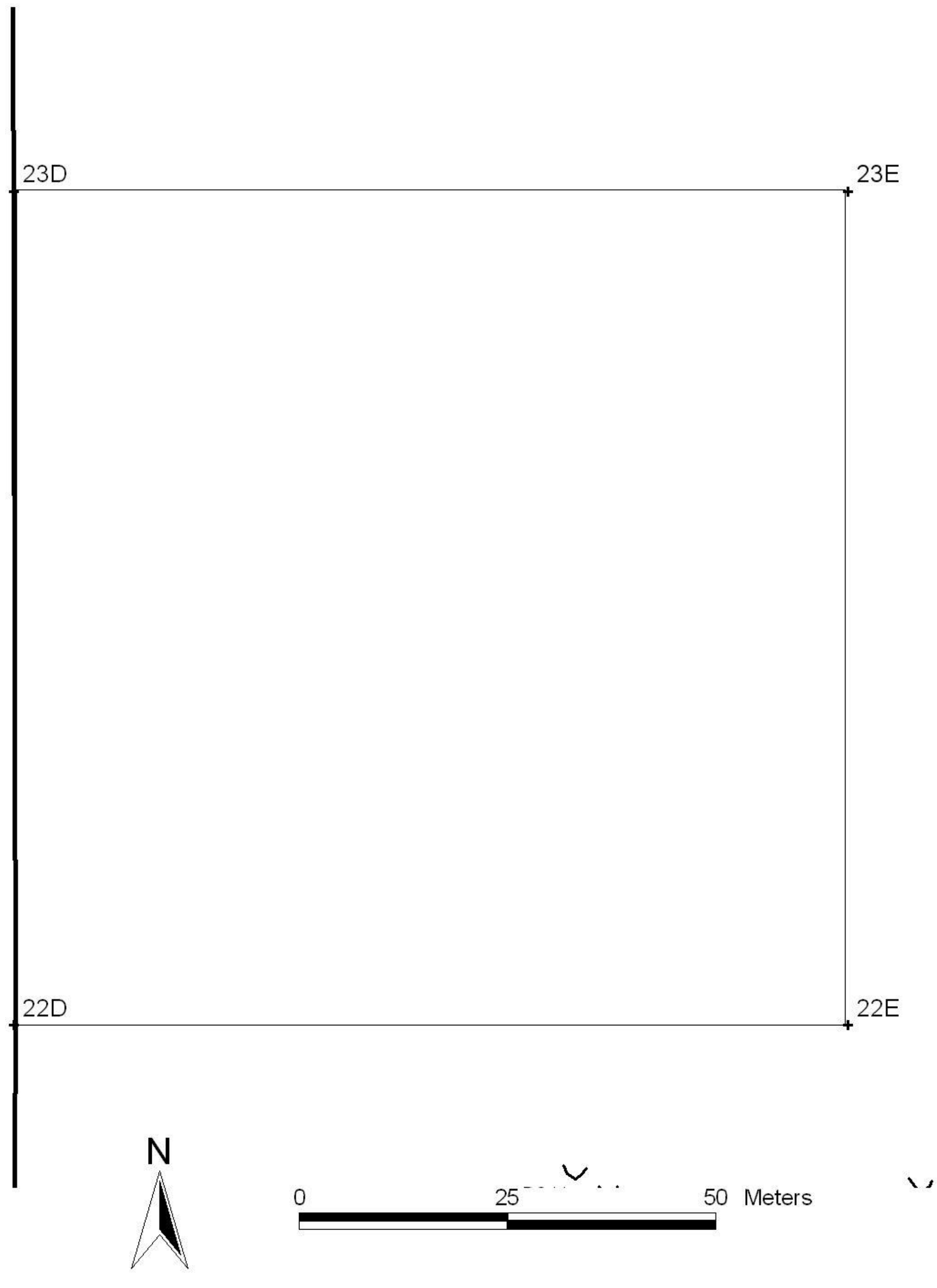


Figure B.227. Map of Section 22D.

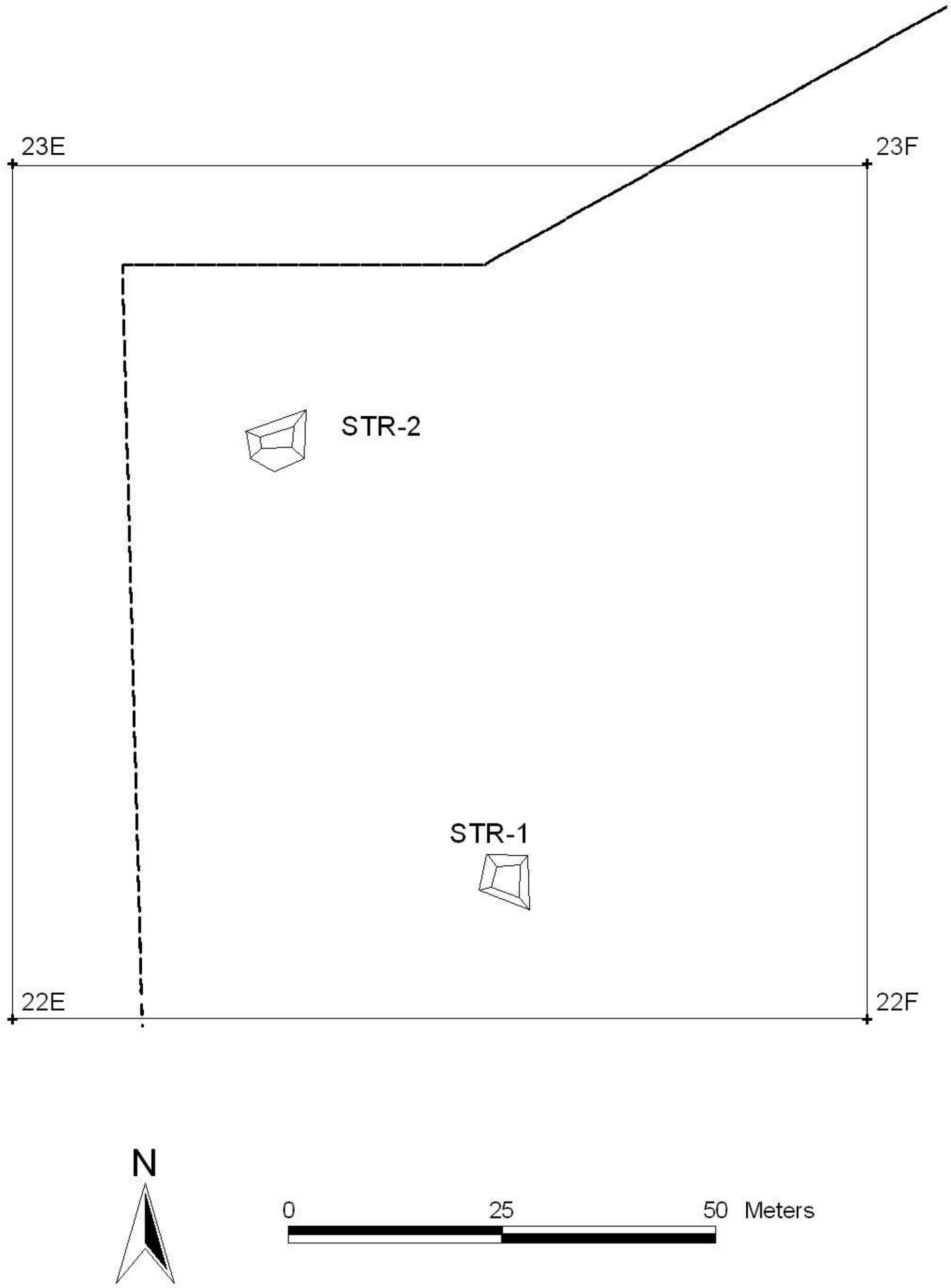


Figure B.228. Map of Section 22E.

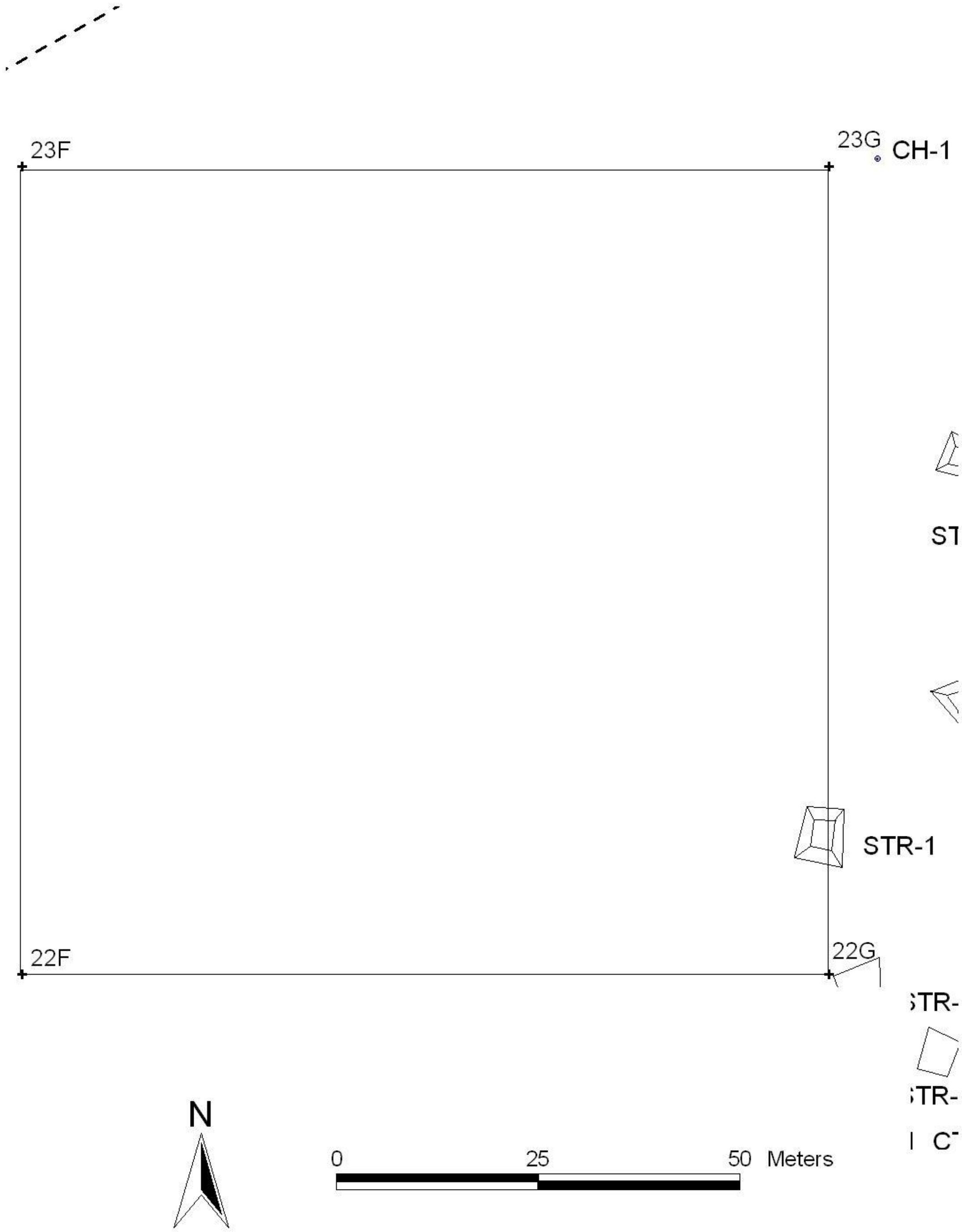


Figure B.229. Map of Section 22F.

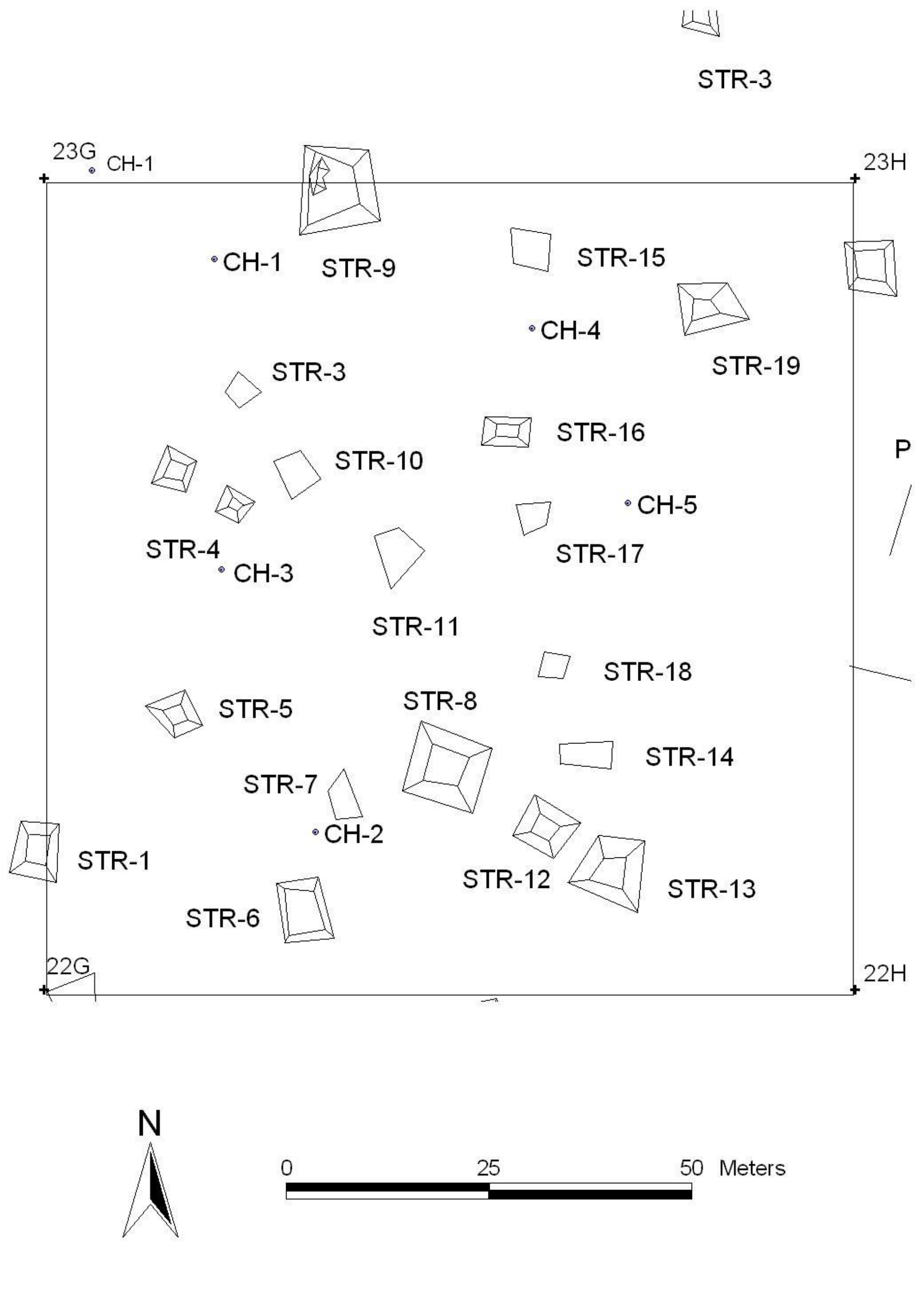


Figure B.230. Map of Section 22G.

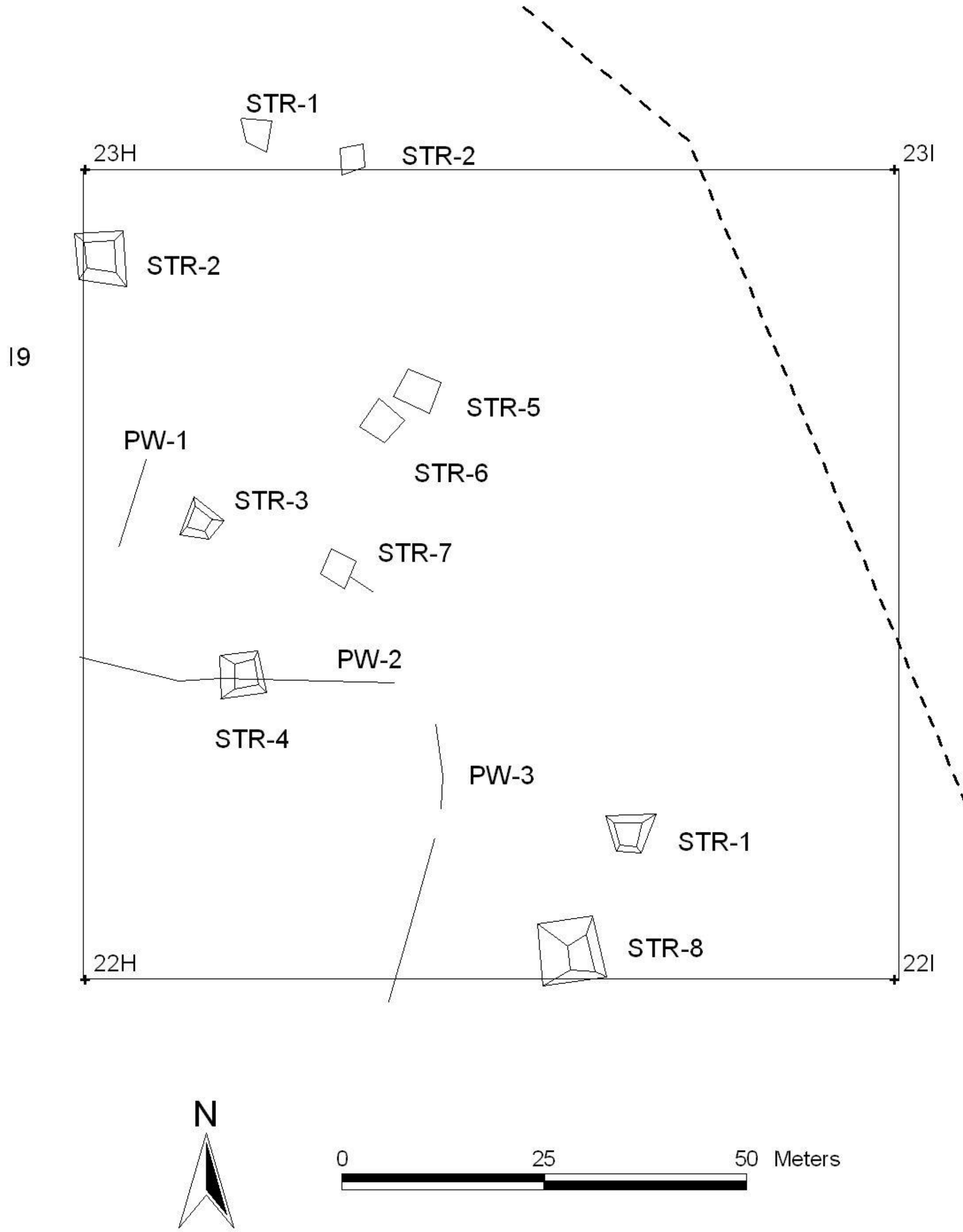


Figure B.231. Map of Section 22H.

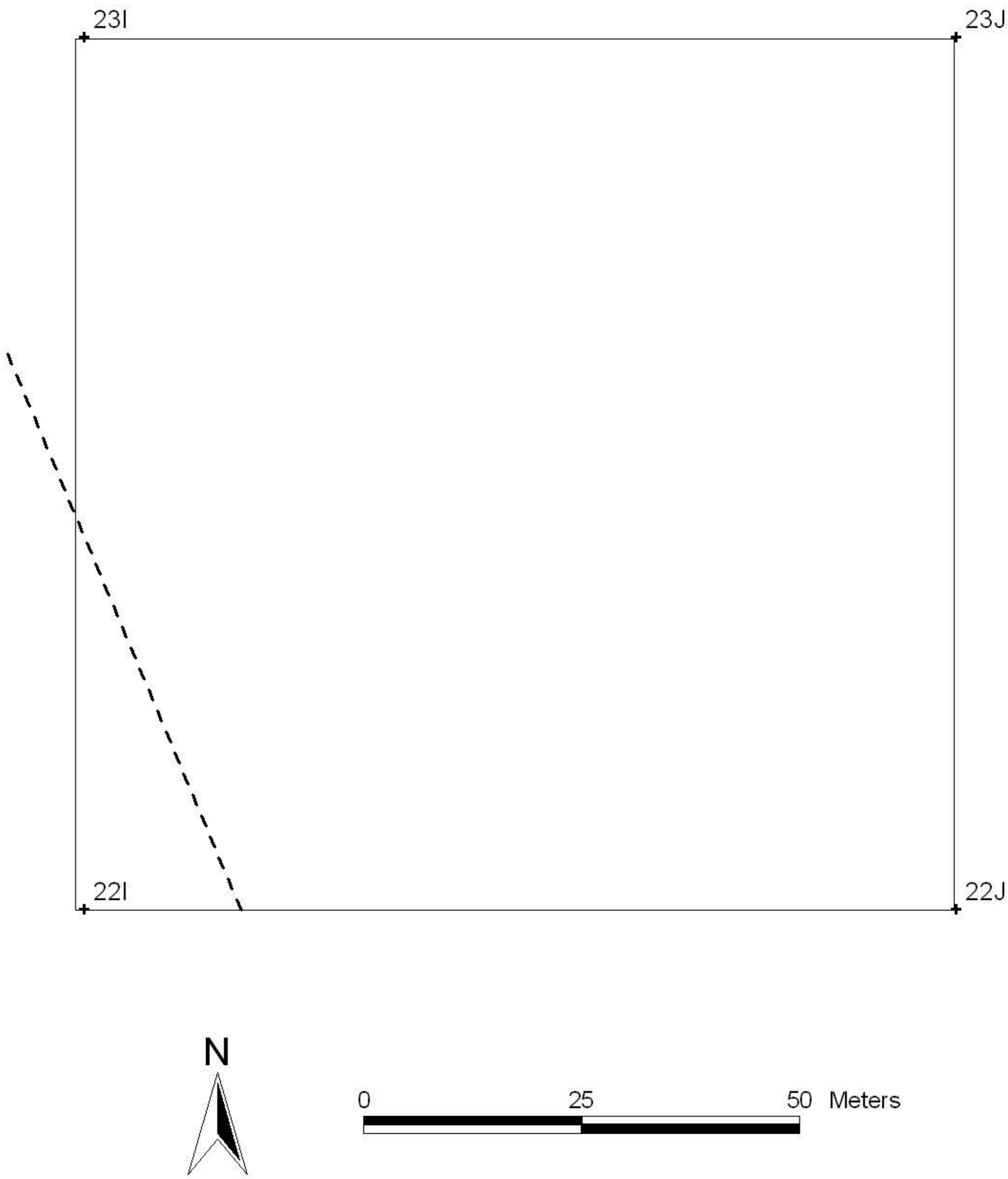


Figure B.232. Map of Section 22I.

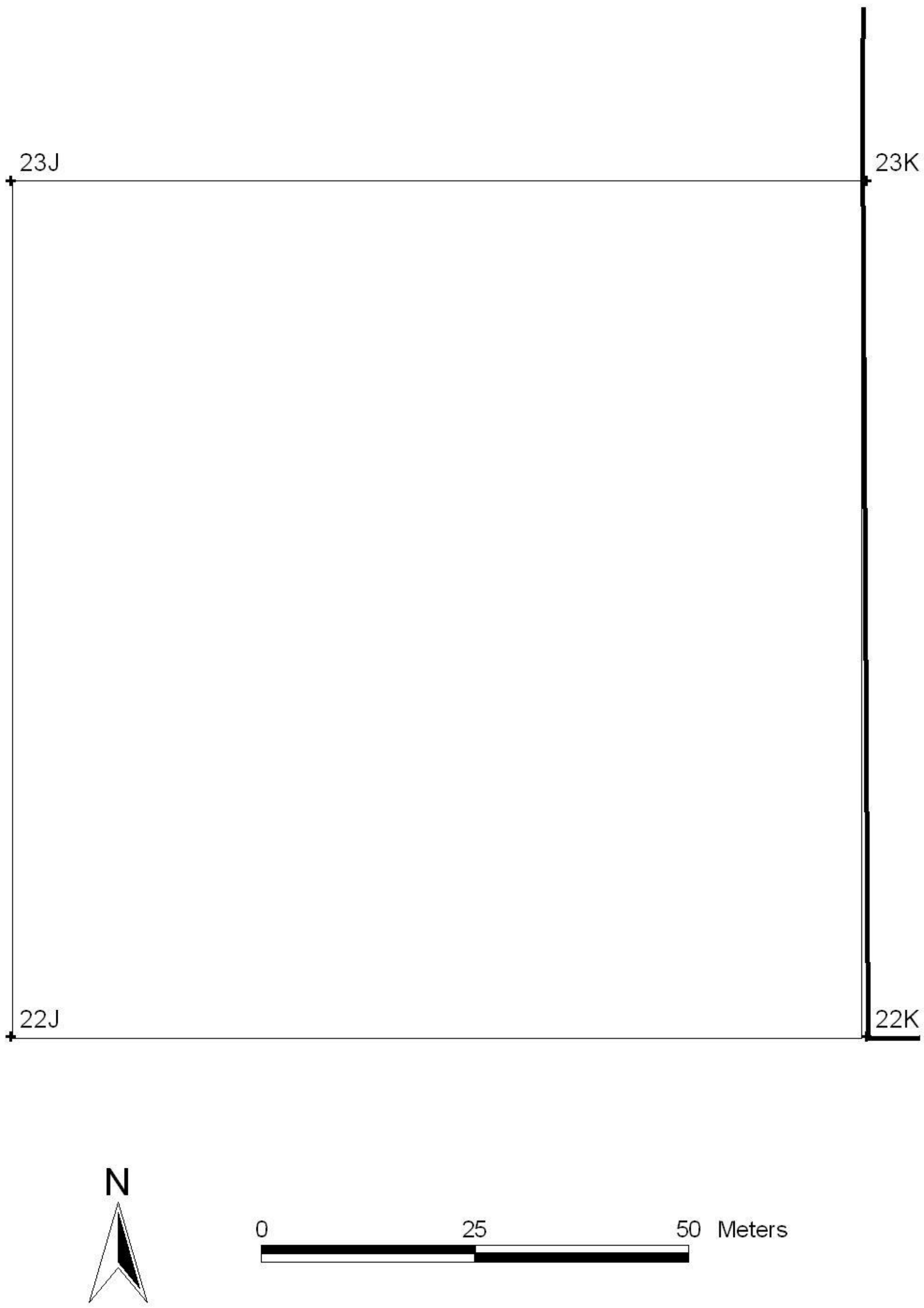


Figure B.233. Map of Section 22J.

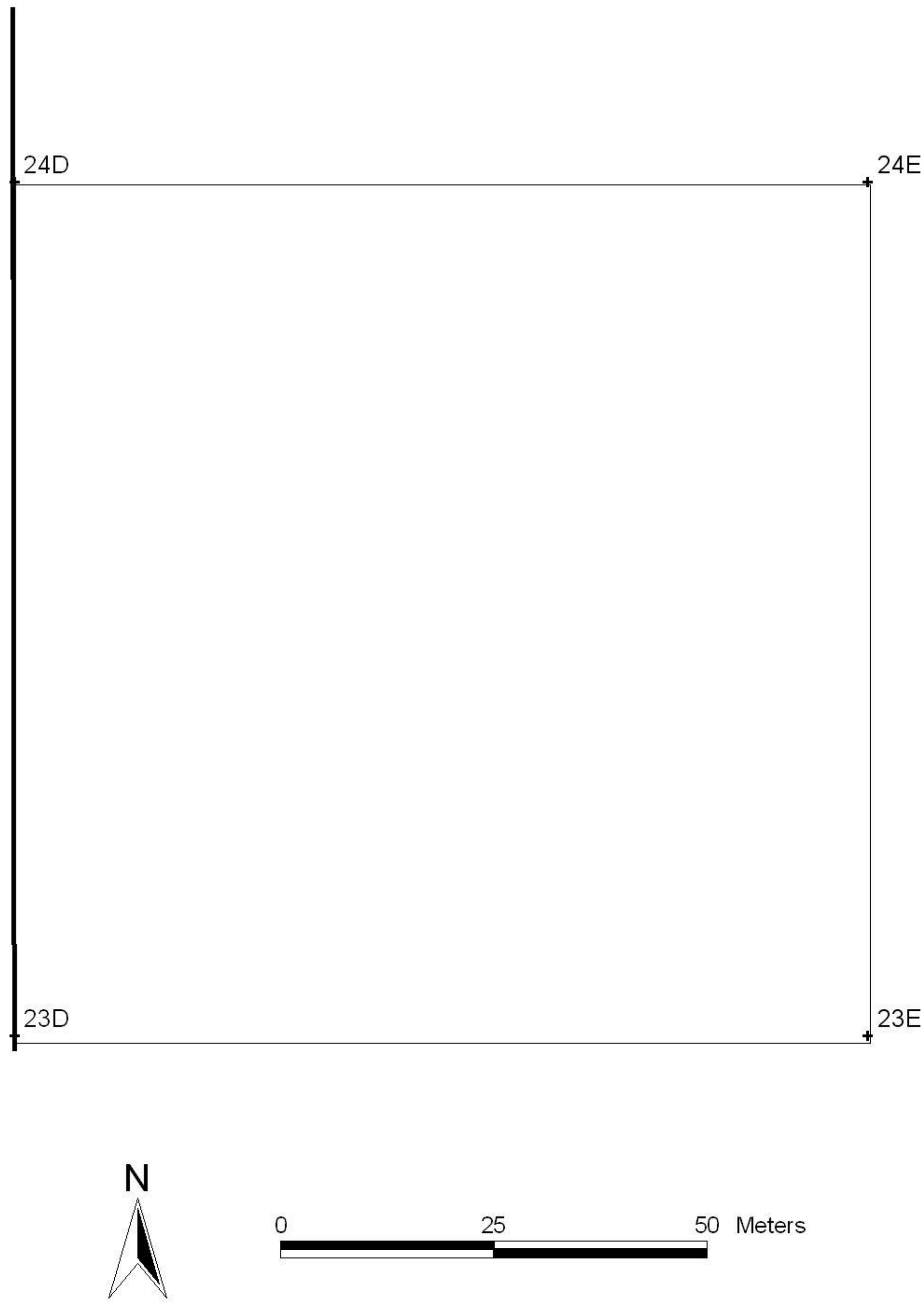


Figure B.234. Map of Section 23D.

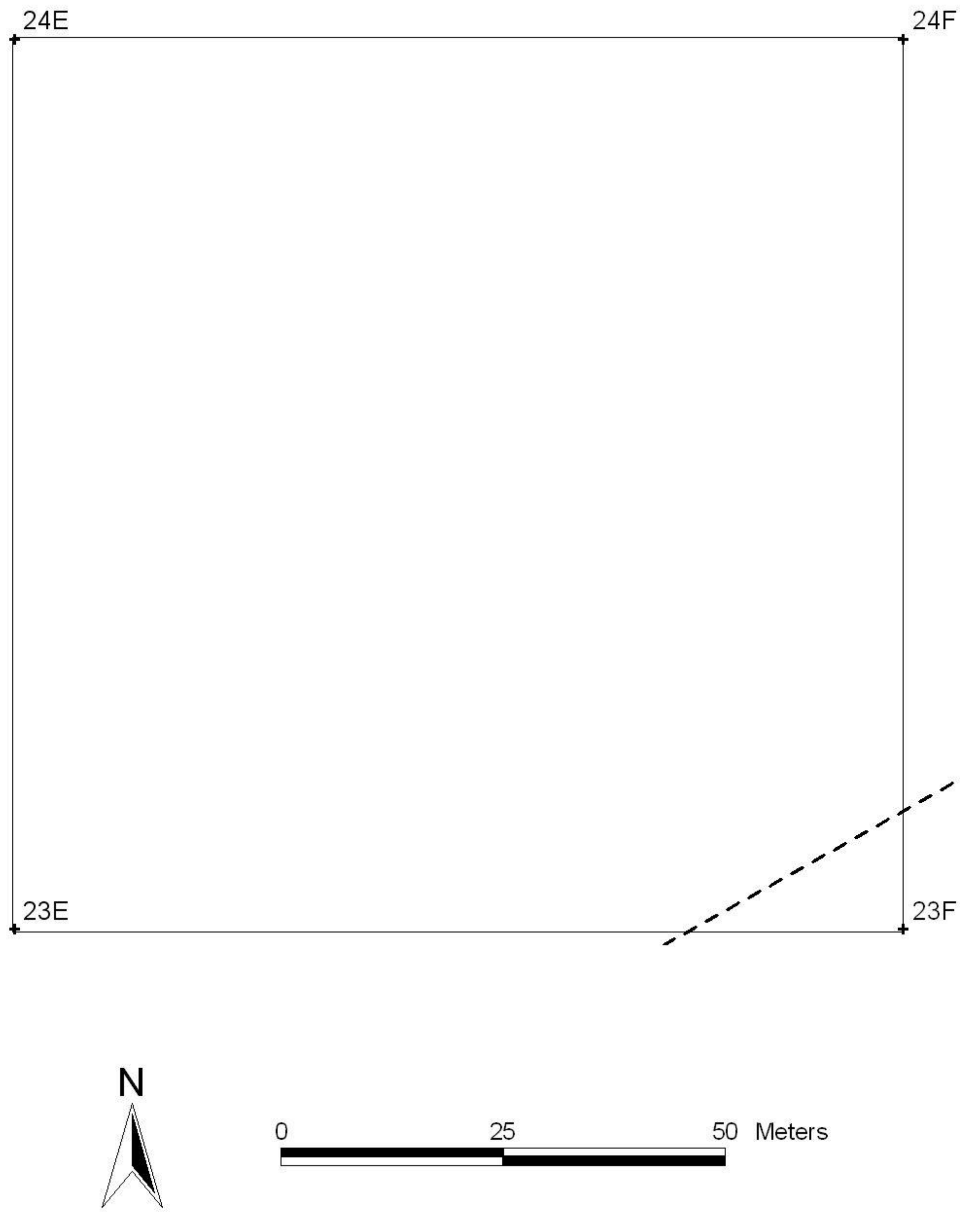


Figure B.235. Map of Section 23E.

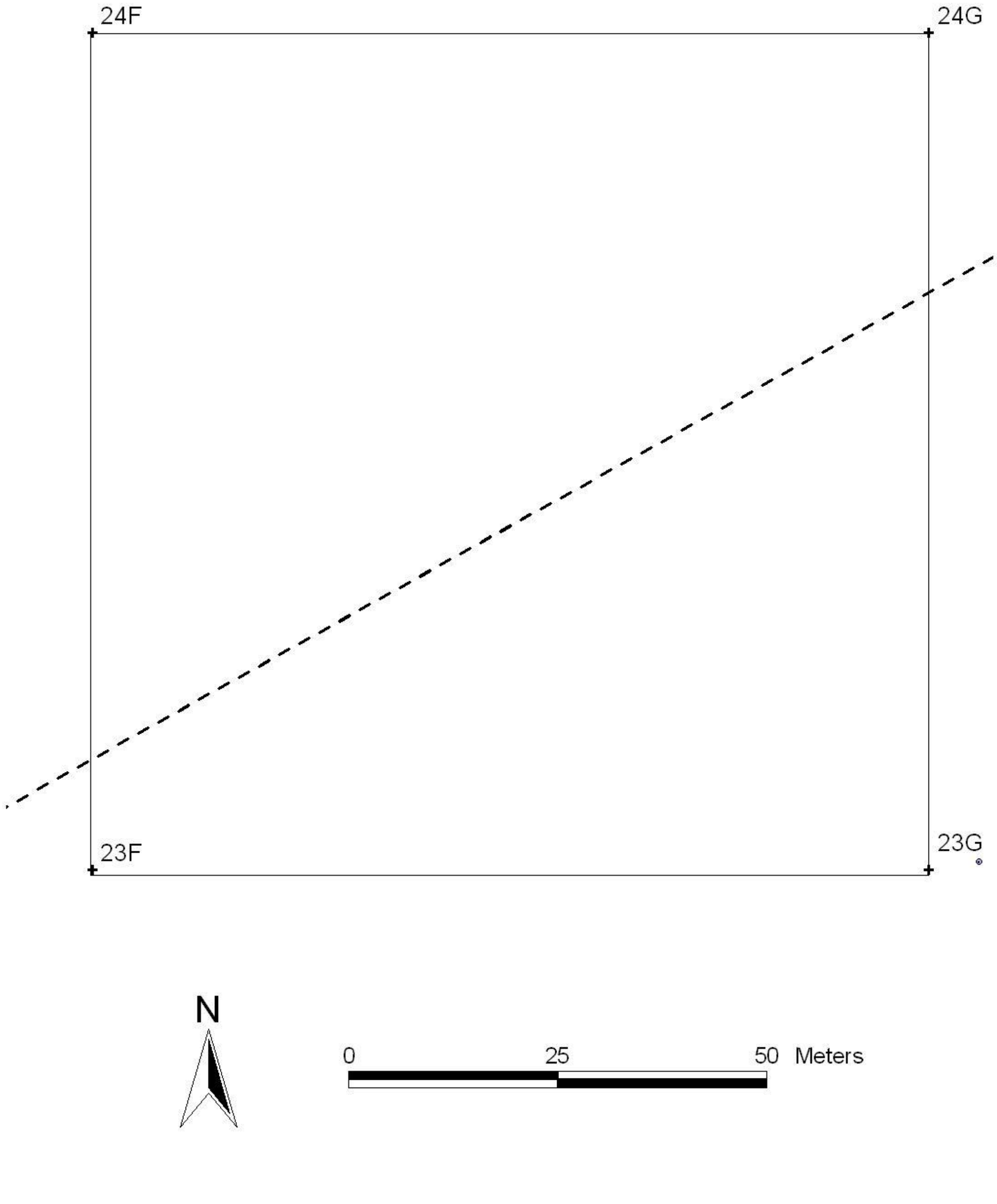


Figure B.236. Map of Section 23F.

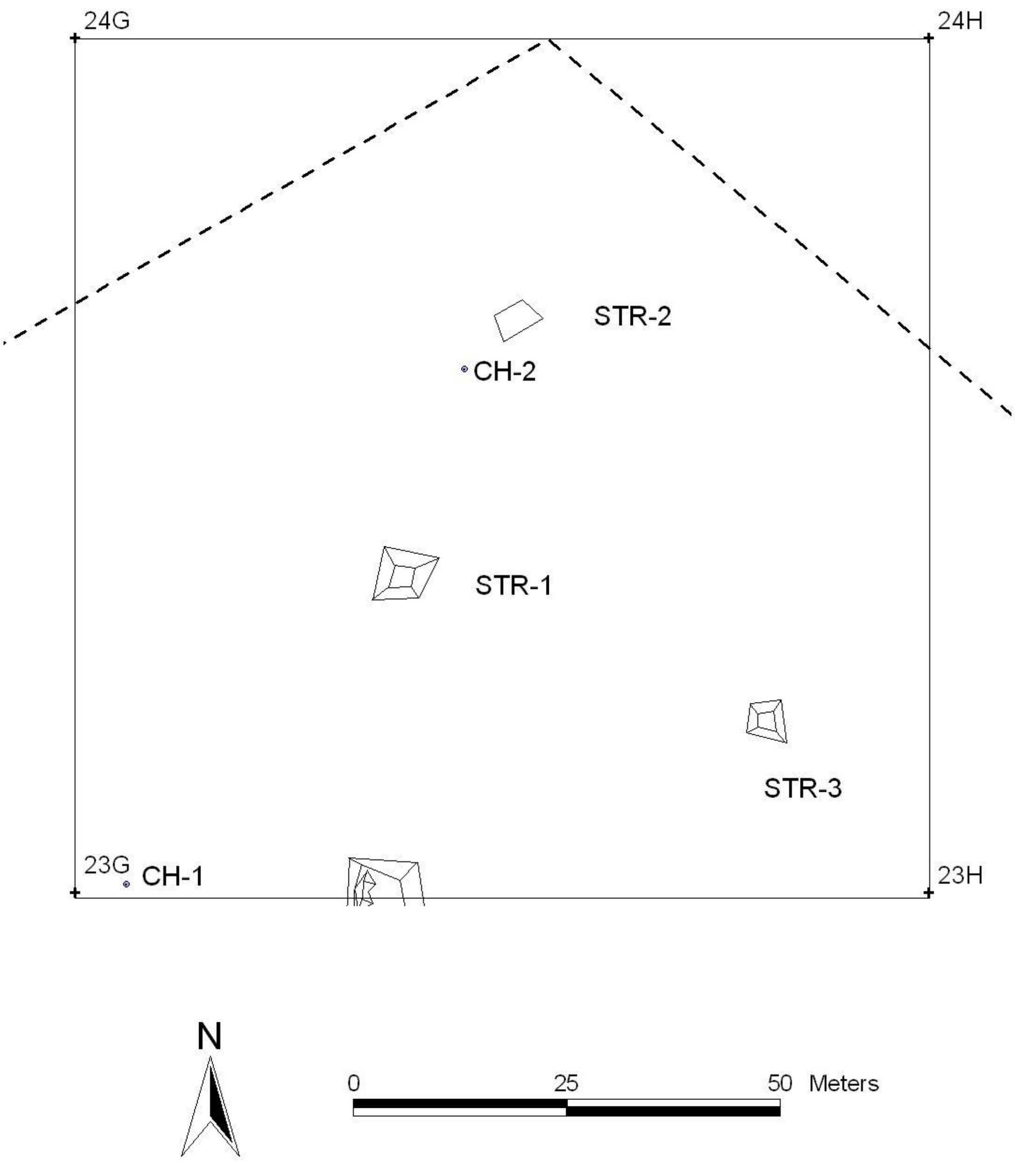


Figure B.237. Map of Section 23G.

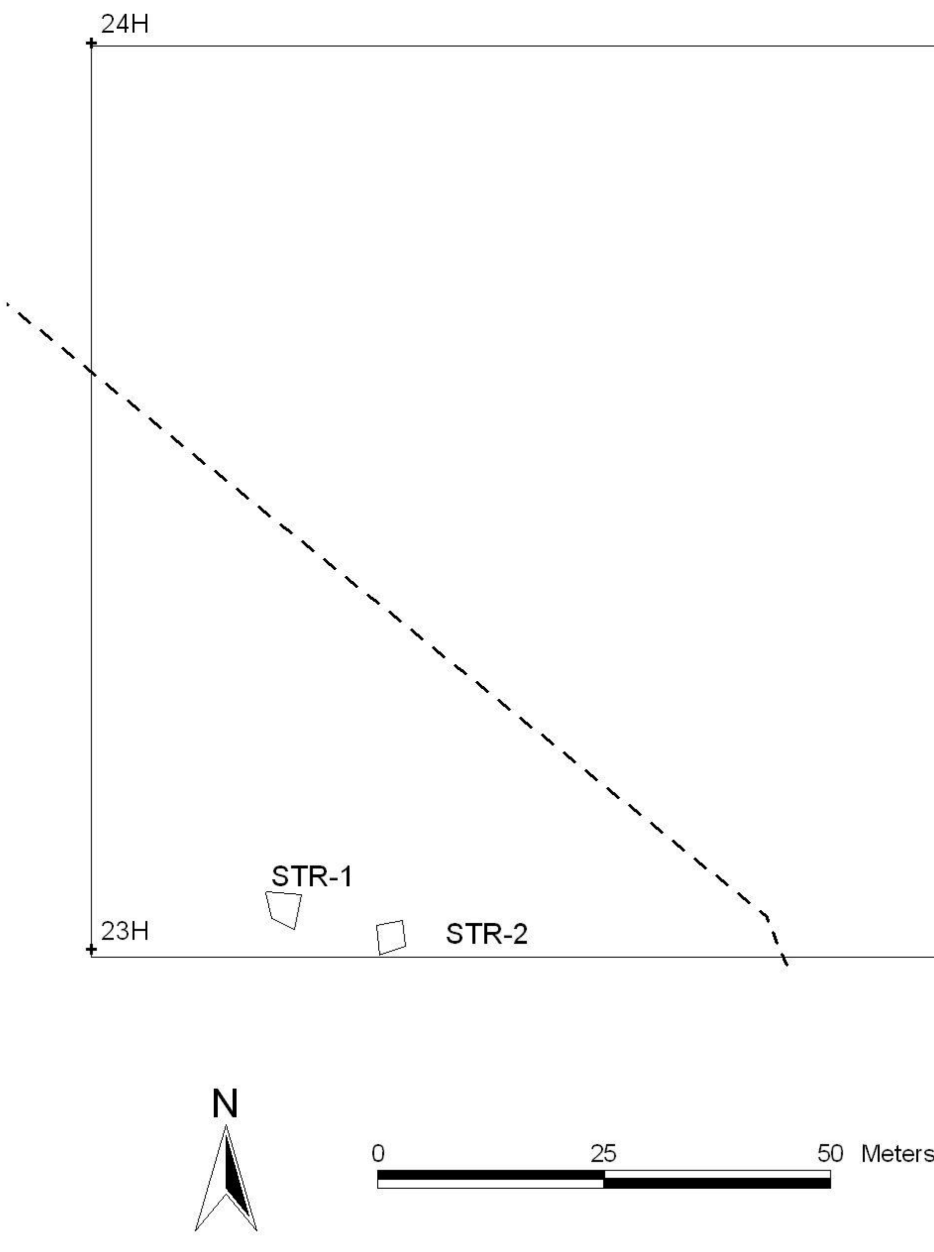


Figure B.238. Map of Section 23H.

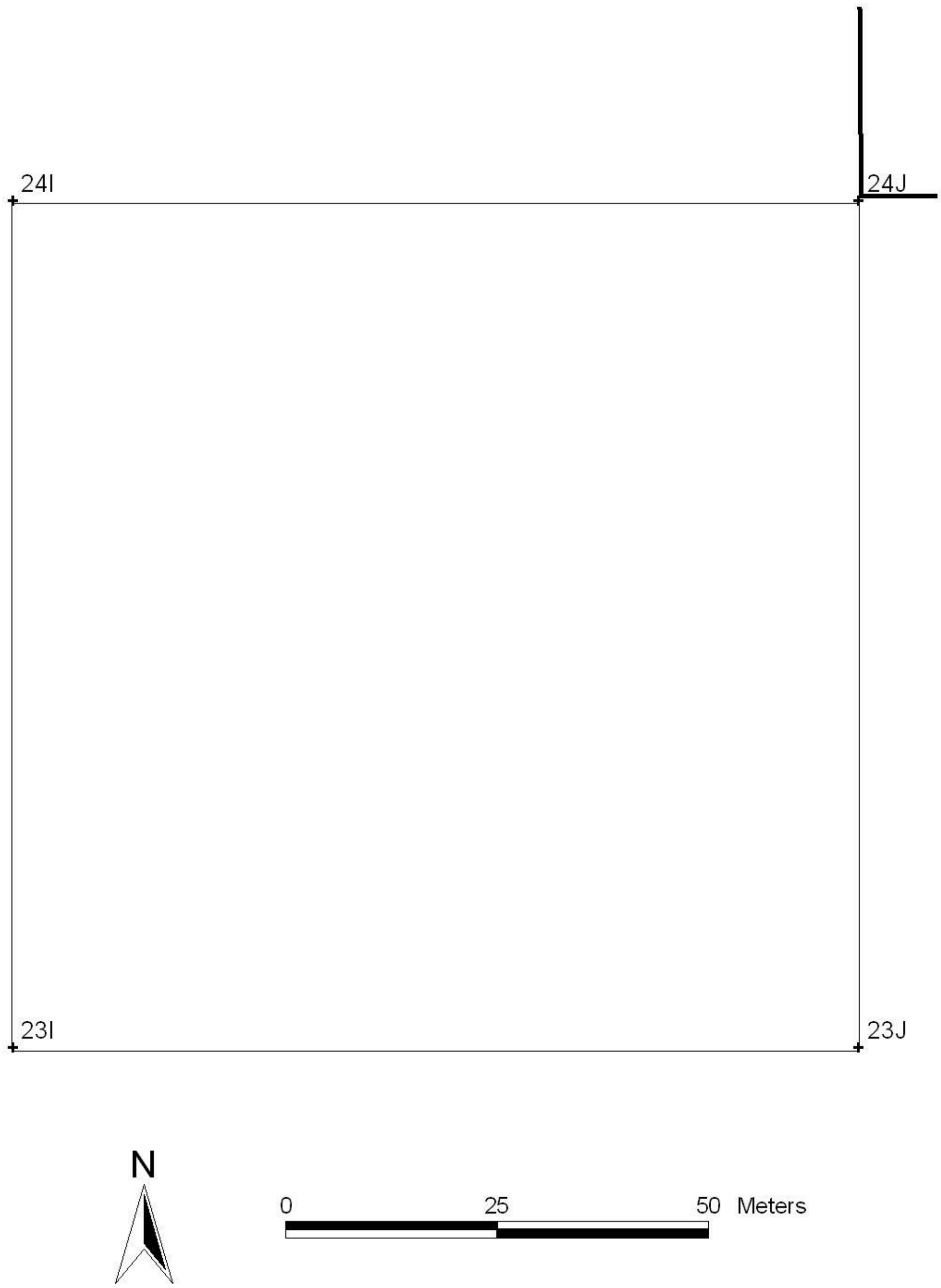


Figure B.239. Map of Section 23I.

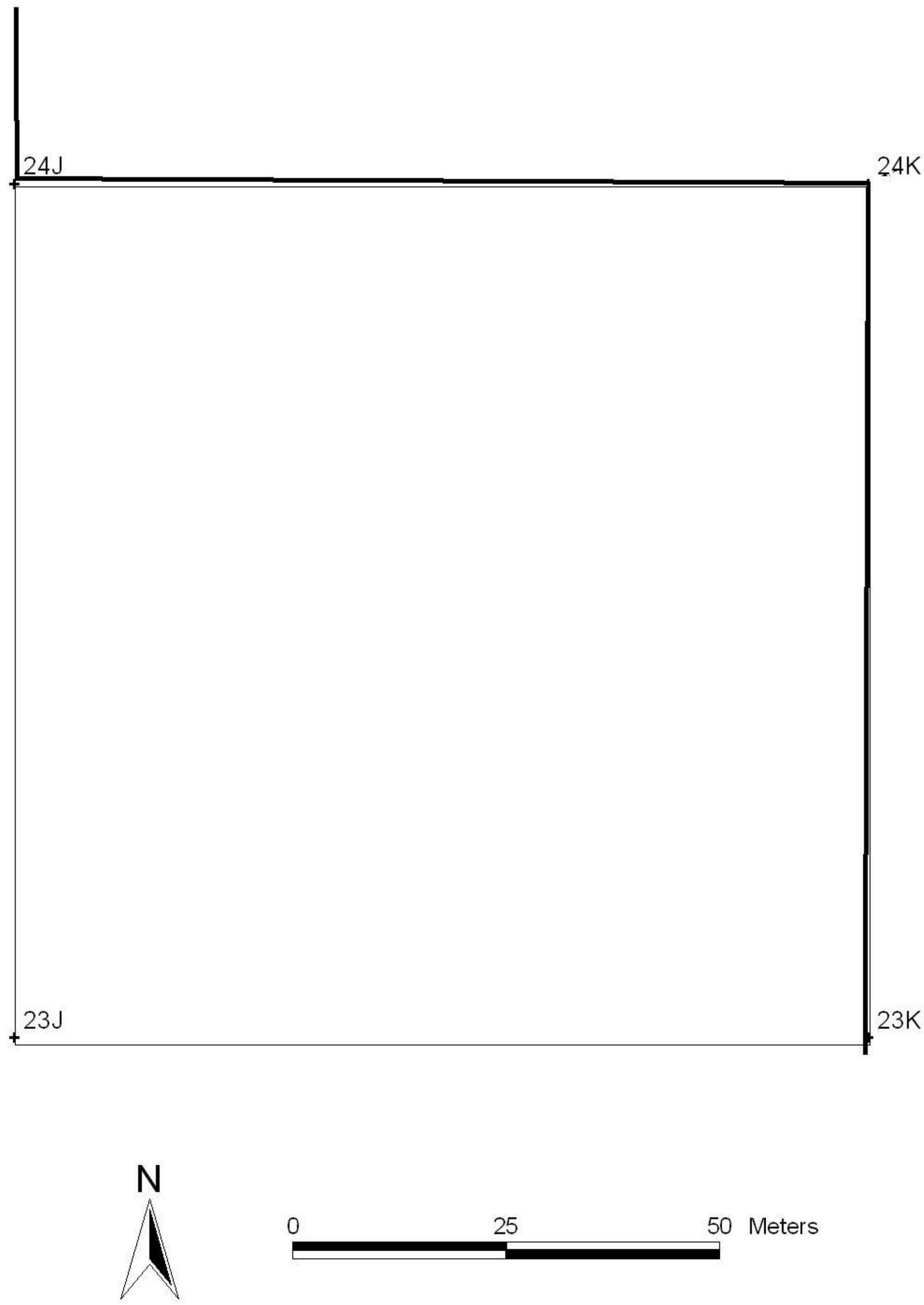


Figure B.240. Map of Section 23J.

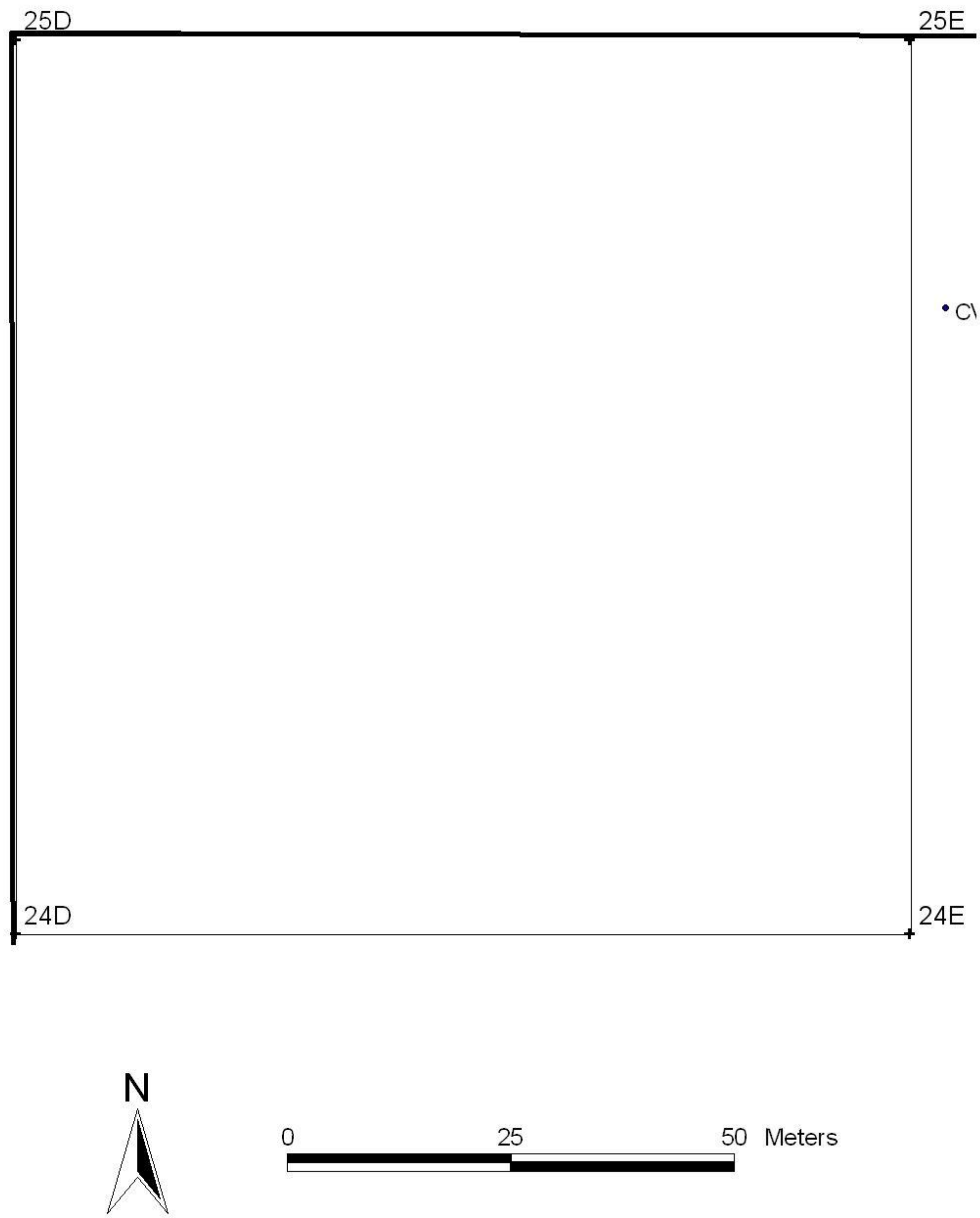


Figure B.241. Map of Section 24D.

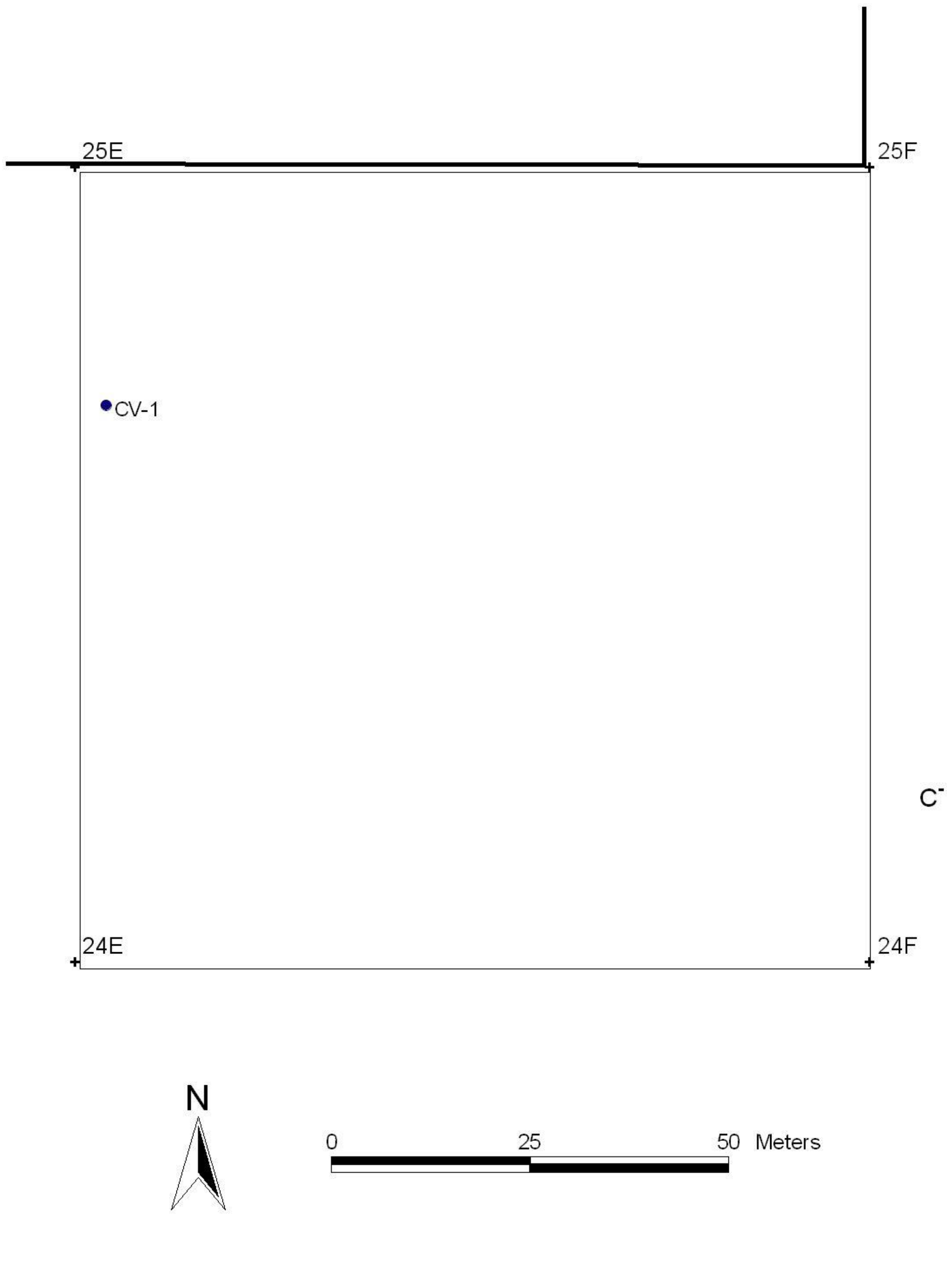


Figure B.242. Map of Section 24E.

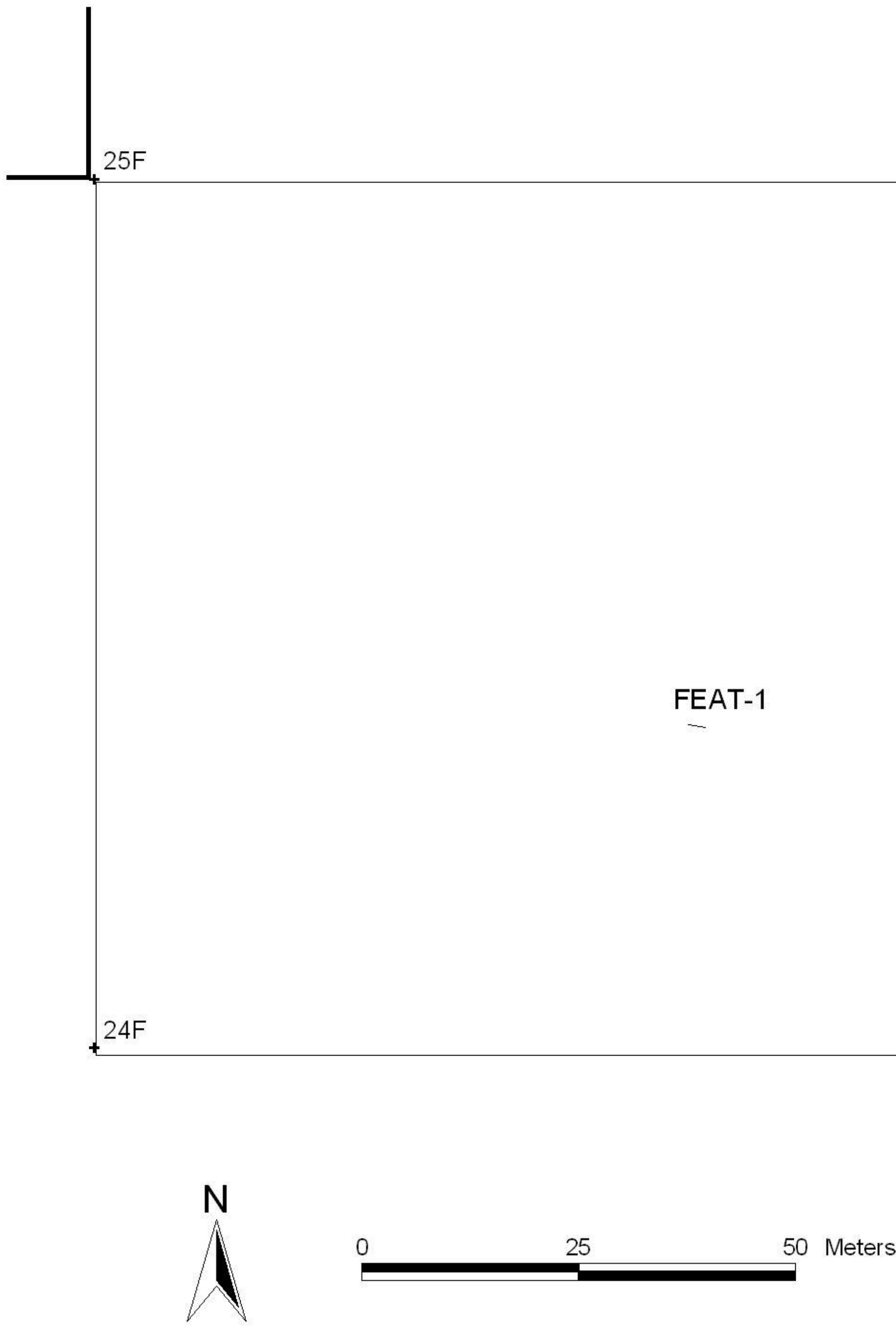


Figure B.243. Map of Section 24F.

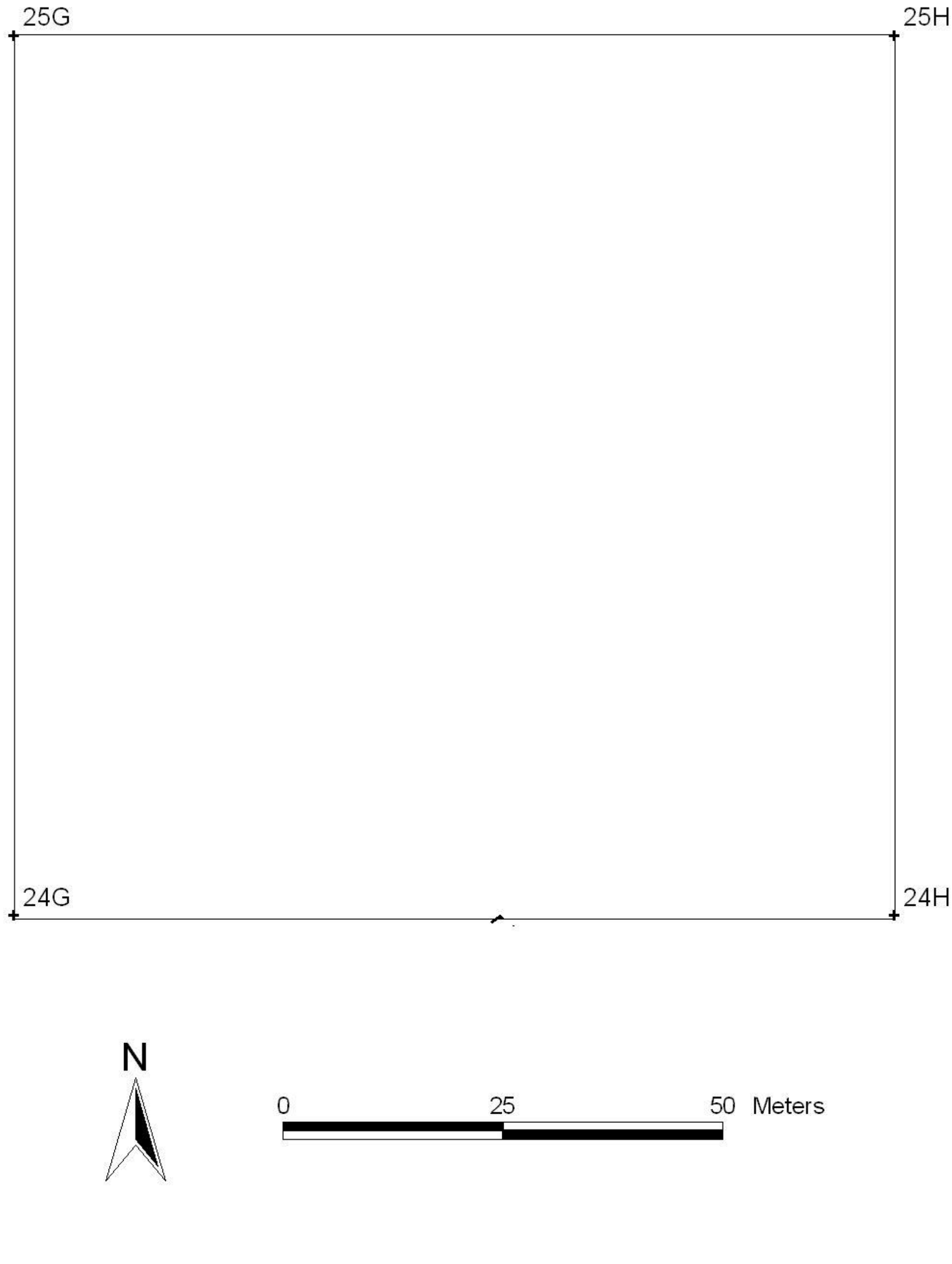


Figure B.244. Map of Section 24G.

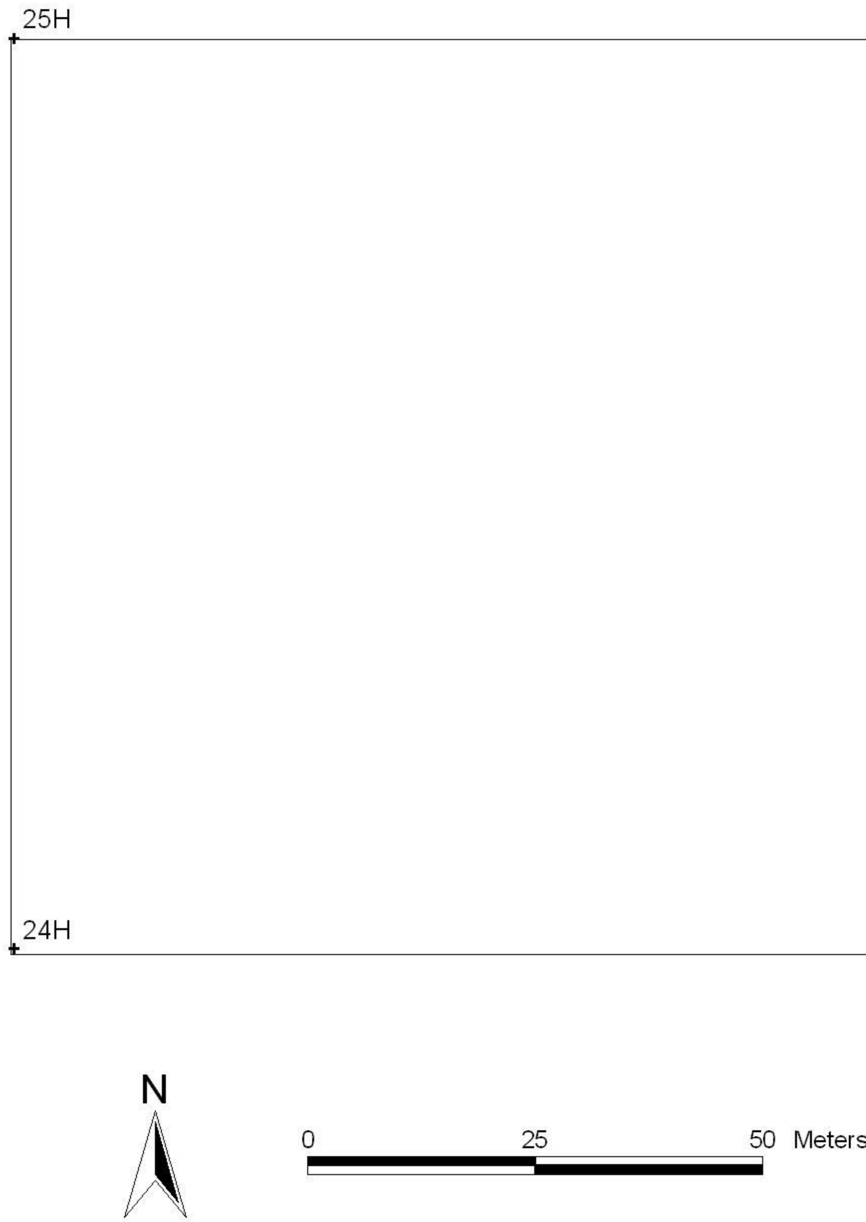


Figure B.245. Map of Section 24H.

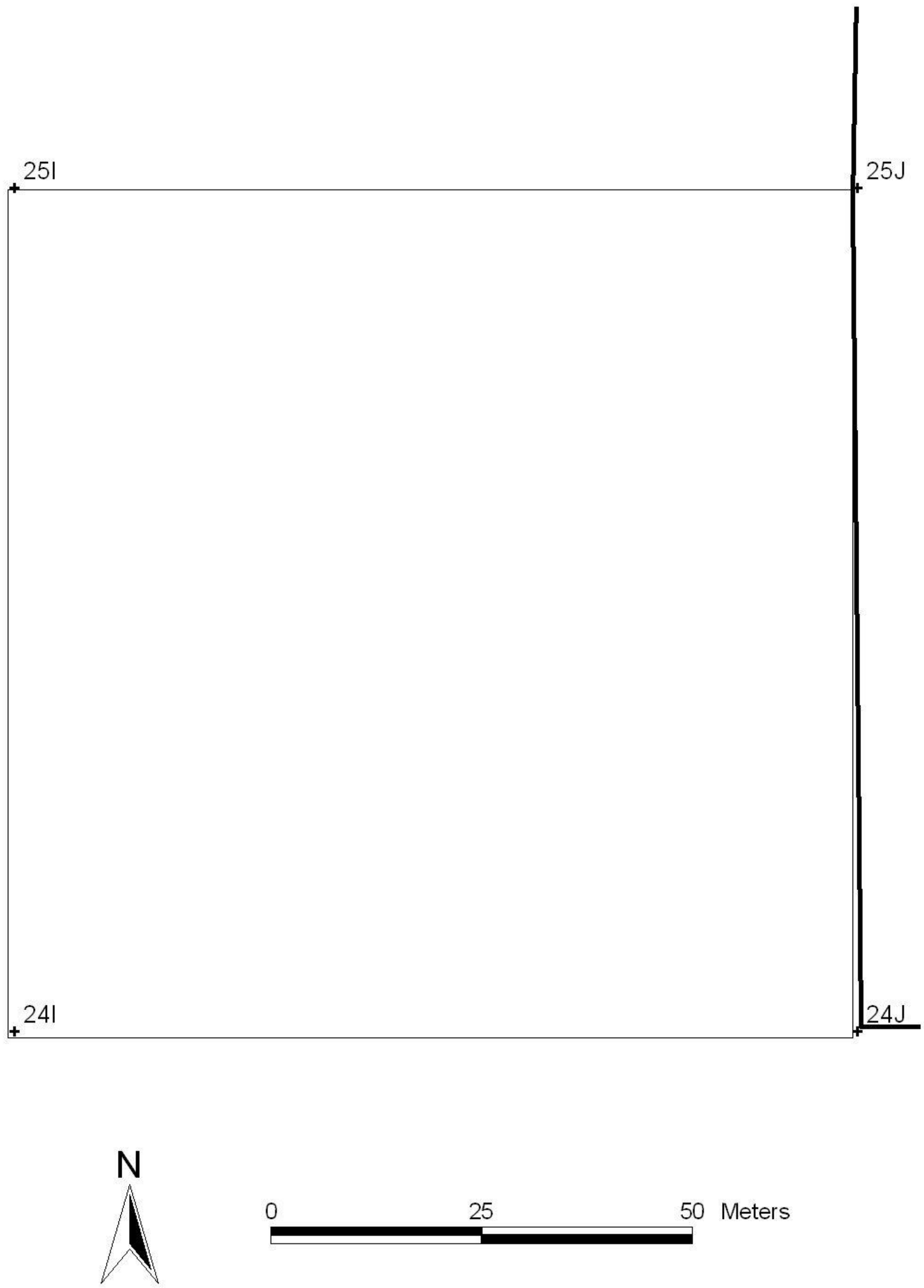


Figure B.246. Map of Section 24I.

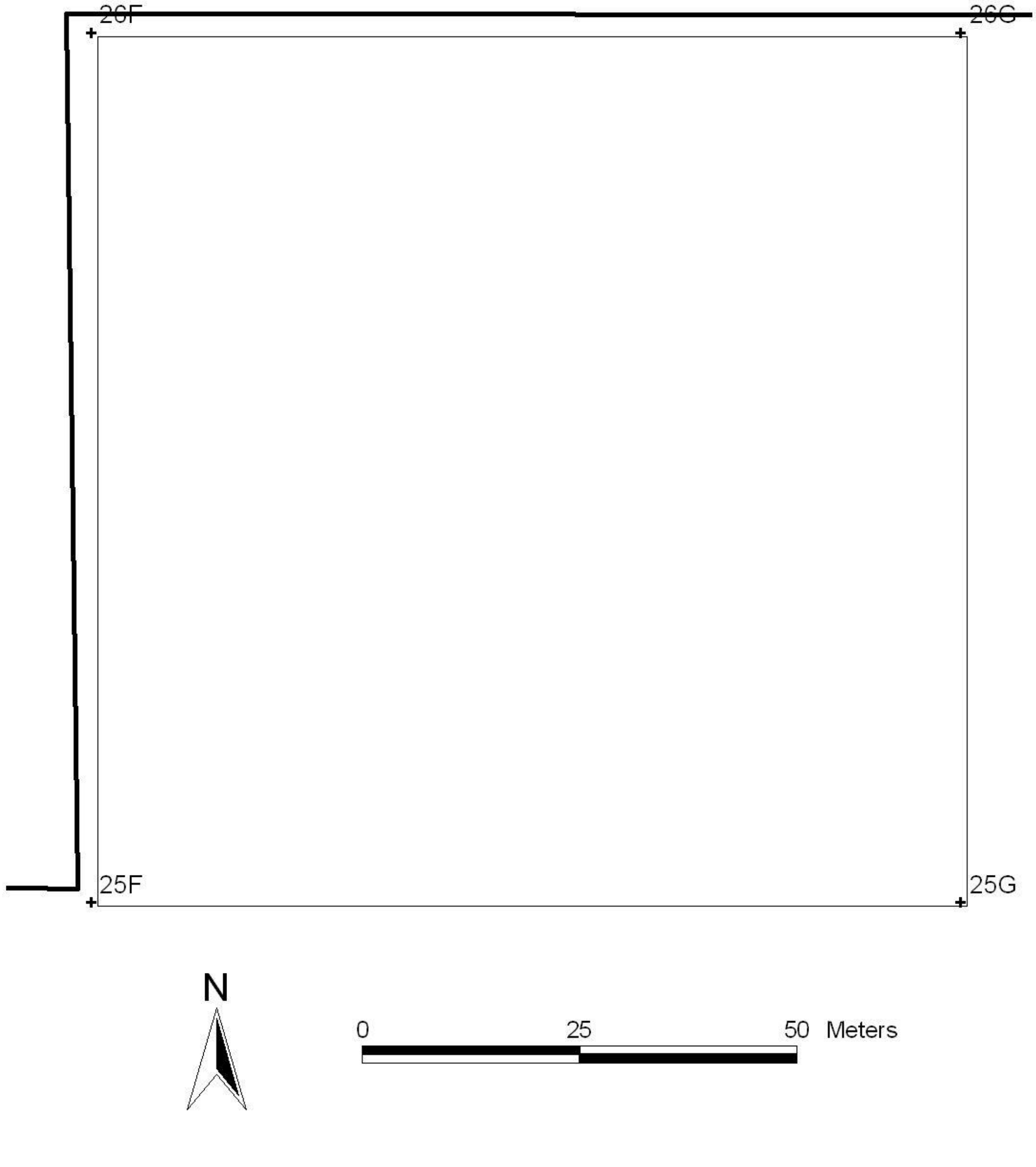


Figure B.247. Map of Section 25F.

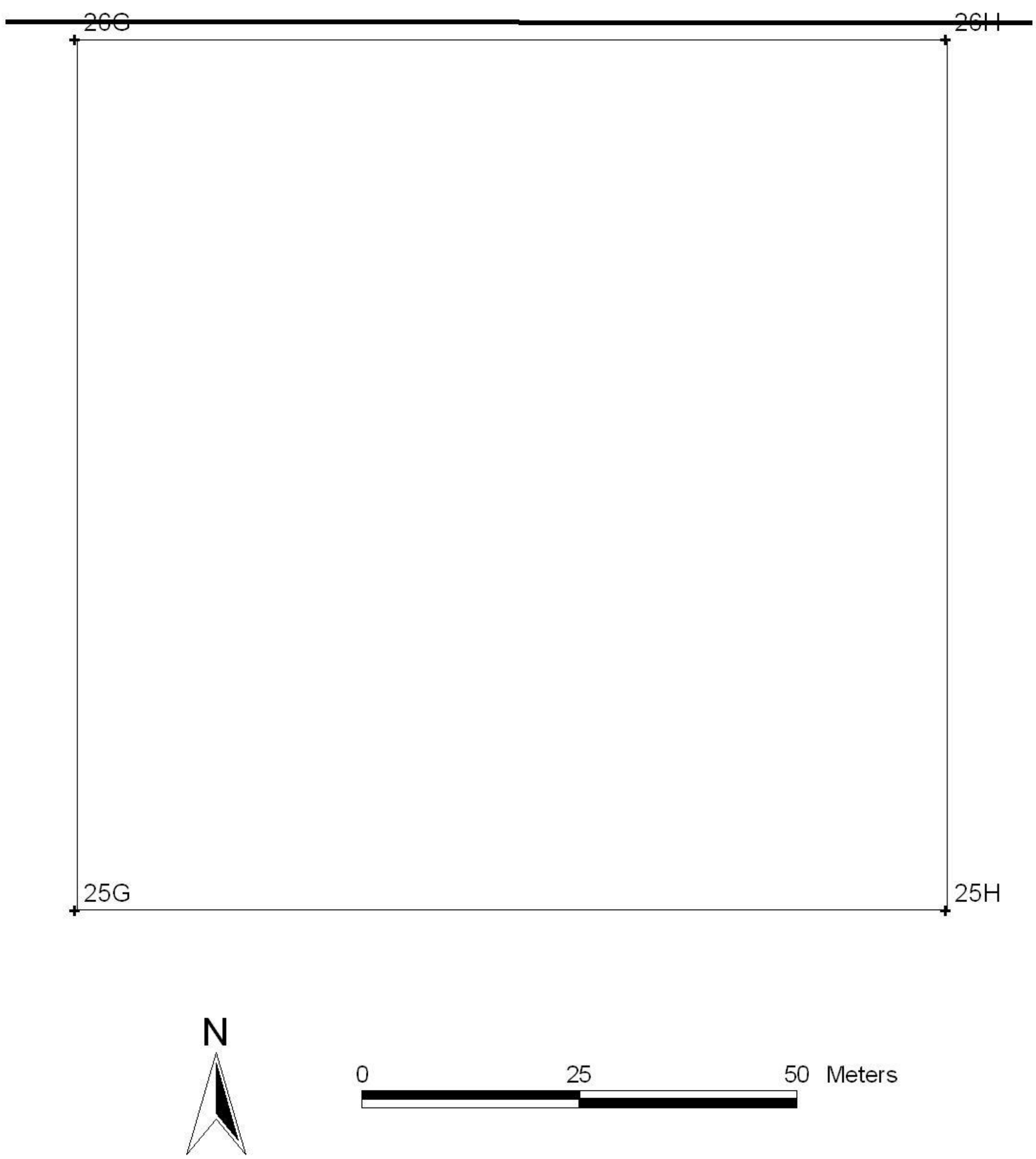


Figure B.248. Map of Section 25G.

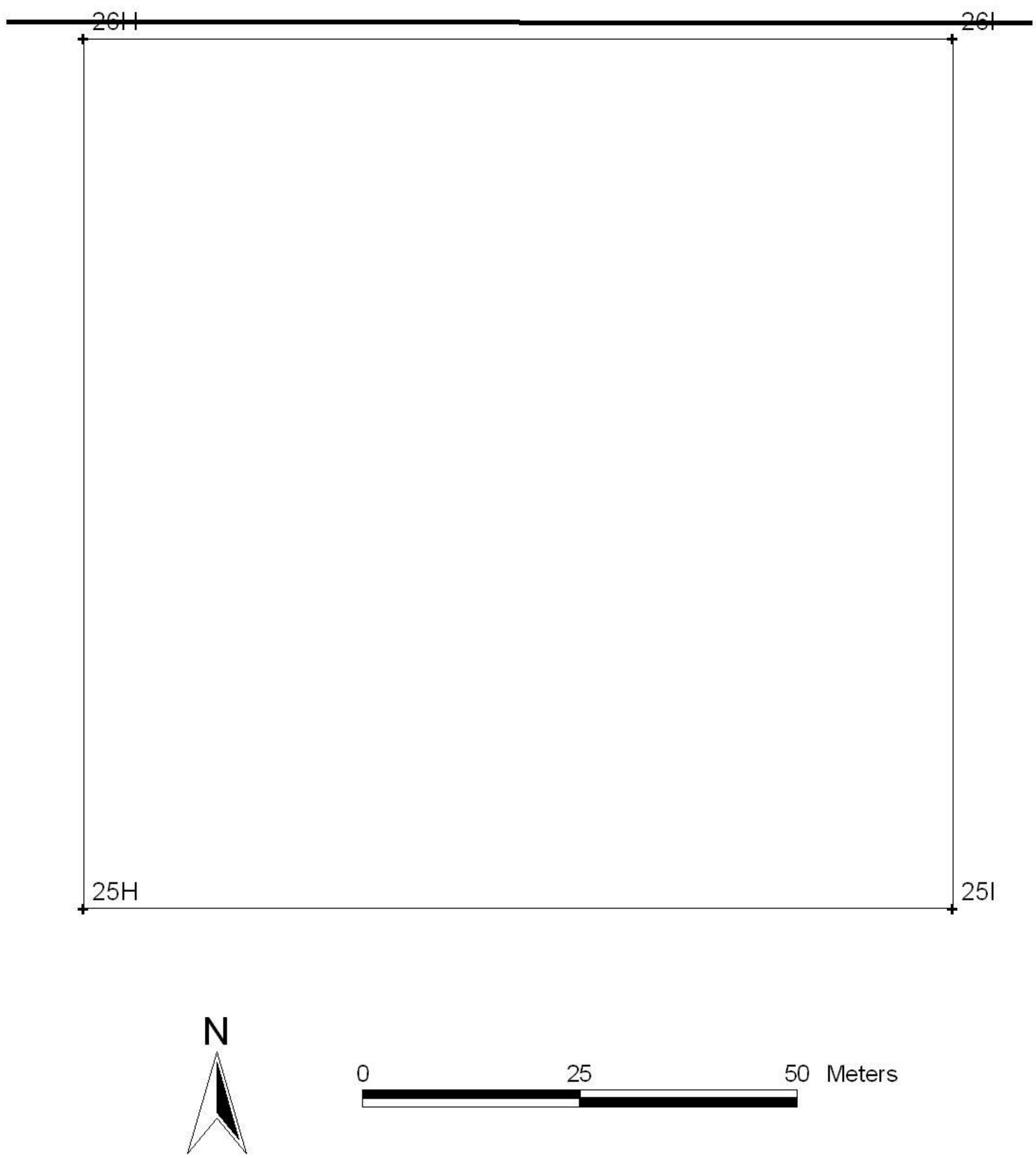


Figure B.249. Map of Section 25H.

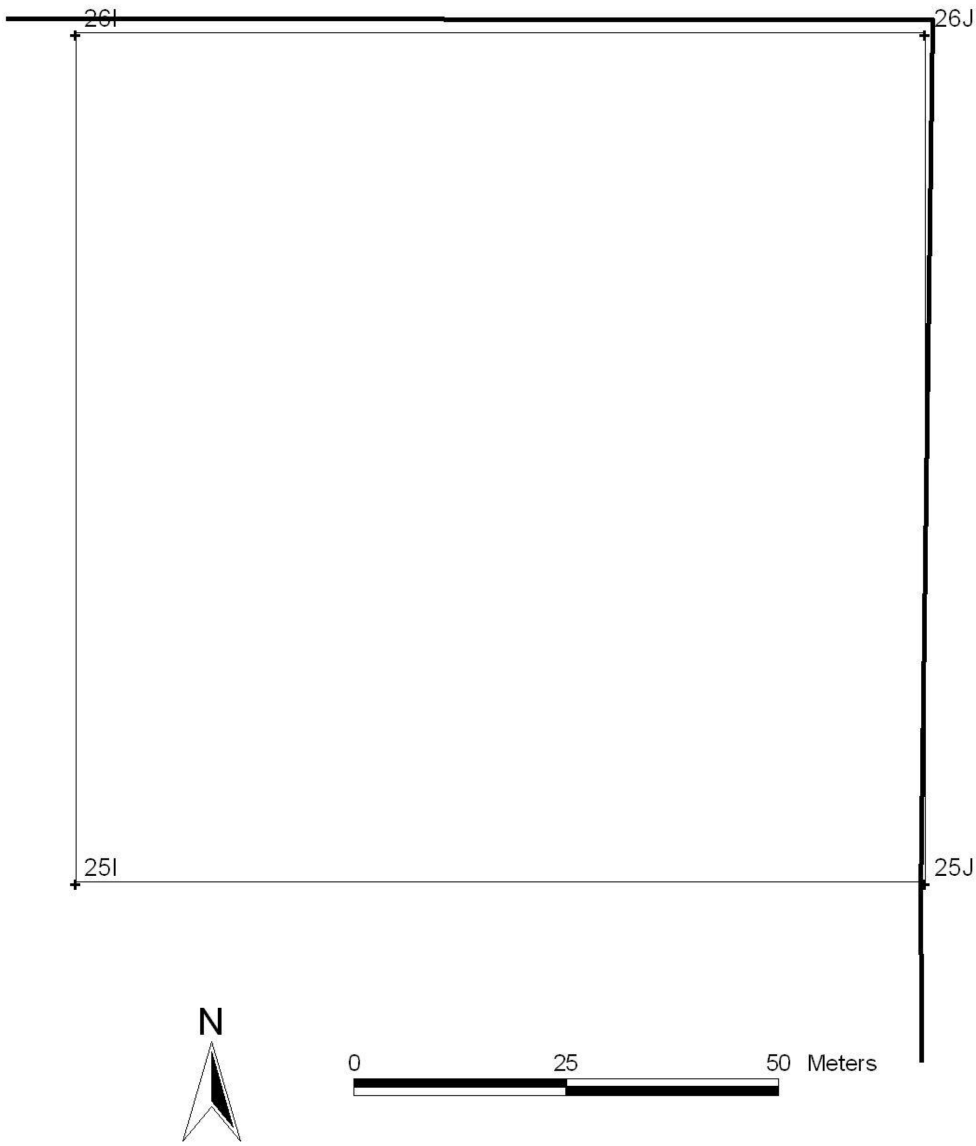


Figure B.250. Map of Section 25I.