THE ORGANIZATION OF AGRICULTURAL PRODUCTION ON THE SOUTHWEST PERIPHERY OF THE MAYA LOWLANDS: A SETTLEMENT PATTERNS STUDY IN THE UPPER GRIJALVA BASIN, CHIAPAS, MEXICO

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The Organization of Agricultural Production on the Southwest Periphery of the Maya Lowlands: A Settlement Patterns Study in the Upper Grijalva Basin, Chiapas, Mexico

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This study investigates the issue of elite management of intensive agricultural production on terraces during the Late-Terminal Classic period (A.D. 650-950) in the Upper Grijalva Basin of Chiapas, Mexico, on the southwest periphery of the Maya lowlands. The Late-Terminal Classic represents the height of social complexity in this zone with increased population marked by construction of many residential and civic structures.

A full coverage, systematic survey was conducted in two neighboring, contemporaneous polities each with differing needs for agricultural intensification due to differences in the distribution and extent of soils good for farming. In the San Lucas River Valley, characterized by the extensive distribution of relatively flat-lying soils good for agriculture, a 8.33 km^2 survey recorded settlement on the margins of the Clavo Verde polity where the flat valley bottom transitions to sloping hillsides representing the likeliest location of agricultural terraces. In the Morelos Piedmont, where sloping topography and the limited distribution of soils good for farming would have presented distinct challenges to farmers, a 18.61 km^2 survey recorded the extents of the core of the Morelos polity.

The Late-Terminal Classic population of the Clavo Verde polity was found to be under the carrying capacity of the best agricultural lands, and the absence of agricultural terraces indicates that this intensive farming technique was not adopted. For the Morelos polity, the Late-Terminal

Classic population was found to be over the carrying capacity of the best agricultural lands, and the presence agricultural terraces indicate that this subsistence technique was adopted. The small scale and simplistic forms of the agricultural terraces indicates that top-down, elite management would not have been necessary to coordinate the labor for terrace construction, maintenance and cultivation. Locally available commoner labor would have been sufficient for these activities. Furthermore, the irregular, discontinuous patterning of terraces throughout the zone suggests that their construction was not the result of elite, top-down planning. However, the strong association between elite dwellings and agricultural terraces suggests that elites may have monitored intensive agricultural production on terraces.

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1.0 ELITE MANAGEMENT OF INTENSIVE AGRICULTURAL PRODUCTION

This dissertation investigates the issue of elite management of intensive agricultural production on terraces during the Late-Terminal Classic period (A.D. 650-950) in the Upper Grijalva Basin (UGB), a Mayan setting in Chiapas, Mexico on the southwest periphery of the Maya lowlands. The Late-Terminal Classic represents the height of social complexity in the UGB with increased population marked by construction of many residential and civic structures. A full coverage, systematic survey was conducted in two neighboring, contemporaneous polities each with differing needs for agricultural intensification due to differences in the distribution and extent of soils good for farming. In the Morelos Piedmont, where sloping topography and the limited distribution of soils good for farming would have presented distinct challenges to farmers, a 18.61 km^2 survey recorded the extents of the core of the Morelos polity. In the San Lucas River Valley, characterized by the extensive distribution of relatively flat-lying soils good for farming, a 8.33 km^2 survey recorded settlement on the margins of the Clavo Verde polity where the flat valley bottom transitions to sloping hillsides representing the likeliest location of agricultural terraces.

Research on elite management of intensive agricultural production can be traced to the pioneering works of Steward (1949), Childe (1954) and Wittfogel (1957). These scholars hypothesized that early civilizations originated in river valleys of arid or semiarid regions where, because of growing population in naturally circumscribed regions, irrigation agriculture would have been required to sustain dense populations. Due to the high degree of organization and engineering know-how required to build and maintain large-scale irrigation systems, and to the mobilization of food surpluses intensification permitted, it was believed that elite management of these activities led to increasing social complexity and eventually the development of powerful state institutions (Trigger 2003: 24, 279). Later research in both the Old and New Worlds, however, has indicated that early state societies evolved in many different kinds of environments, and differed widely in fundamental structural aspects, such as demography, geographic extent, subsistence base, and degree of political centralization (Flannery 1972; Price 1971; Sanders and Price 1968; Sanders and Webster 1978; Trigger 2003; Wright and Johnson 1975). Taking these findings into consideration, recent approaches to the study of elite management of intensive agricultural production have sought to understand particular case studies in their own specific ecological and cultural contexts (Chase and Chase 1996; Erickson 1993; Harrison and Turner 1978; Kolata 1991; Rodriguez 2006; Liendo 2002). This trend has not been lost on researchers studying ancient Maya society. Instead of viewing the varying hydrological, topographic, and soil regimes found in the Maya lowlands as barriers to development, these natural characteristics have come to be viewed as presenting distinct challenges to farmers which were addressed in accordance with local and regional economies, political strategies, population levels, and the productivity of local cultivation systems (Fedick 1996a: 5). This perspective represents a departure from the traditional view of the Maya lowlands as a uniform and agriculturally limited landscape. As Fedick (1996a: 14) succinctly states,

> "the view depicts the Maya lowlands as a mosaic of landscapes which were perceived and managed in various ways in different places and times, often in response to changing political, as well as economic pressures."

Over the last three decades, many studies of ancient Maya society have related regional settlement patterns to environmental variability (Ashmore 1981: 59; Dunning 1992; Fedick 1989; Ford and Fedick 1992; Rice 1976; Rice and Rice 1990; Scarborough 1993; Turner 1974, 1983). More recently, the scale of analysis has shifted to the site level where attention to variations in soil, vegetation, water, and topographic conditions has permitted researchers to link status differences among households to resource management strategies such as elite control of agricultural fields (Dunning 2004; Liendo 2002; Lohse 2004) or water resources (Freidel et al. 1982; Scarborough 1993, 2003).

Although it has not been demonstrated that the economic foundation of all complex societies rested primarily upon management of intensive agricultural systems (e.g. Erickson 1988, 1993), relict intensive agricultural works such as irrigation systems, raised fields, and terraces have been recorded throughout the world, and have figured prominently in explanations of how many ancient societies functioned (Kolata 1986, 1991; Kunen 2004; Liendo 2002; Smith and Price 1994; Stanish 1994; Trigger 2003). Irrigation systems, raised fields, and terraces are intensive agricultural works because, through increased labor input in a given plot of land, they increase the productive output above what would otherwise be possible. Furthermore, like irrigation systems, raised fields and terraces have been categorized as hydraulic works (Price 1971; Wittfogel 1972). Raised fields permit a greater degree of control over water level and distribution, and insure that soils contain adequate amounts of moisture. Terraces capture soils eroded by rainfall, and aid in the moisture retention of soils contained behind their walls.

Important similarities and differences also exist in the managerial aspects of irrigation systems, raised fields, and terraces. It is generally assumed that irrigation systems, and to a lesser extent raised fields (see Kolata 1986, 1991), involve large-scale investments of organized labor for construction and maintenance tasks, whereas terracing requires less planning and coordination of labor (Smith and Price 1994; Steward 1949; Wittfogel 1957, 1971). Therefore, terrace systems must be of a very large scale in order to apply the argument that an administrative elite would have been necessary to mobilize and coordinate the labor for construction and maintenance. But a complicating factor in assessing the labor construction requirement is time. In the high Andes near Lake Titicaca, Erickson (1988, 1993) has found that large-scale intensive agricultural works such as raised fields could be built by small groups of local farmers in an accretionary fashion and do not necessarily represent a top-down administrative effort. Clearly the addition of terrace walls to an agricultural terrace system could follow a similar accretionary pattern. Therefore, this argument is difficult to apply to terraces unless it can be clearly demonstrated that the locally available labor for construction would not have been sufficient, and that the terraces were built over a relatively short period of time.

Another argument that has been applied to irrigation systems is that elite managers possess the engineering know-how, such as knowledge of gravity and hydraulics, required to plan and construct complex irrigation canals and therefore are necessary for their completion (Steward 1949; Trigger 2003: 290; Wittfogel 1971). Most agricultural terraces, especially the dryslope and check dam forms recorded during the survey, are technologically simplistic and involve little more than stacking stones along the natural contour of the hillside or along the bottom of a drainage channel. There is little reason to suggest that construction of these terrace forms would have required specialized knowledge on behalf of an administrative elite.

Uniformity or standardization in the layout or patterning of intensive agricultural works have led some researchers to suggest that the construction followed a pre-set design formulated by elite managers (Chase and Chase 1996; Kolata 1986, 1991). Standardization in the width and height of terrace walls has been cited as evidence for such a design template (Healy et al. 1983). But others are skeptical that an objective measurement for standardization can be attained. Erickson (1993: 389-390) asserts that all prehispanic agricultural systems in the Americas and elsewhere demonstrate formal structure, and since scholars disagree on their subjective evaluations of how to classify the continuous variation between unstructured and structured landscapes, this issue may never be resolved.

A final managerial aspect of irrigation and raised fields is dispute resolution which is linked to the degree of hyper-coherency inherent to the entire system. Disputes related to water scheduling or the expansion of the system which affects how water is distributed may require a managerial elite to resolve disputes (Steward 1949). Some complex terrace forms, such as bench terraces, have a small degree of hyper-coherency that may result in the need for elite managers to mediate disputes. Because of the relatively great height of bench terraces and the cutting away of some of the hillside to create flat planting surfaces, failure of a terrace wall upslope can release debris that damages walls downslope (Wilken 1987). The possibility for dispute arises if the terrace wall that failed, and the downslope terrace wall that was damaged, are cultivated by different families or corporate groups. Although a possibility, events such as this would seem to be exceedingly rare and no studies of ancient or contemporary terrace farming could be found that have applied the dispute resolution argument.

The issue of elite management of intensive agricultural production has been explored by anthropological archaeologists throughout the world (Blanton et al. 1993; Erickson 1988, 1993; Hassan 1997; Kolata 1986, 1991; Coe 1981; Hunt 1988; Sanders et al. 1979; Stanish 1994; Trigger 2003:279-314). These studies have resulted in differing interpretations and have demonstrated that civilizations differ widely in the degree to which elites managed intensive agricultural production. On one side, evidence is found for a high degree of elite management of intensive agricultural production (Blanton et al. 1993; Brumfiel 1983; Kolata 1986, 1991; Nichols and Frederick 1993; Parsons 1976, 1991; Sanders et al. 1979). On the other side, support is found for local household or community level management with little or no elite involvement (Erickson 1988, 1993; Hunt 1988; Smith and Price 1994).

Early reports of intensive agricultural features in the Maya region can be traced to the works of Siemmens and Puleston (1972), Harrison and Turner et al. (1978), Donkin (1979), and Turner (1974). These works documented the presence of intensive agricultural technologies such as raised fields in wetlands and terraces on hillsides which represented alternatives to the swidden agricultural strategy proposed in the "Milpa Model" (Hammond 1978). According to the Milpa Model, the Maya lowlands was characterized as a homogenous, undifferentiated environment capable of supporting relatively low populations through long-fallow, swidden agricultural strategies. The publication of "Prehispanic Maya Agriculture" (Harrison and Turner 1978) proposed a new interpretation of ancient Maya society, and presented alternatives to the "myth of the milpa" (Hammond 1978) portraying Maya society as having high regional population levels and intensive agricultural technologies. The Maya lowlands came to be characterized as a differentiated landscape with varied possibilities for agricultural intensification: uplands for mixed cropping, hillsides for terrace farming, and wetlands for raised field cultivation (Fedick 1996a: 2).

Many scholars believe that Classic Maya elites likely had some control over agricultural production so as to extract support from farmers, but the nature of such control is debatable. During the Classic period (A.D. 250 – 950) at the site of Caracol, Chase and Chase (1996: 808) cite a huge contiguous population, regularity in the form and alignment of agricultural terraces, elite dwellings proximate to agricultural terraces, and a hierarchy of administrative plazas as direct evidence for elite management of agricultural production. Ford (1996: 301-302) argues that the concentrated distribution of critical resources in the interior Peten relates directly to the ability of elites at large centers (e.g. Tikal) to consolidate power. For a portion of the Late Classic period (A.D. 650 – 750) at Palenque, Liendo (2002) found high population nucleation with low sustaining rural populations, increased agricultural intensification in the immediate vicinity of the site, elite dwellings near intensive agricultural works (channelized fields and terraces), and high field construction labor requirements that could not have been satisfied by single households. His interpretation of this evidence is that agricultural production in the Palenque region during this time was centralized with elites in the main center directly controlling and managing agricultural labor and surplus production (ibid.: 189).

Nevertheless, doubts about the association of intensive agricultural production with direct elite management for prehispanic Maya society persist. The alternative view holds that agricultural production is managed at the household or community level with little or no elite input. Demarest (1992: 146) argues that the irregular distribution and alternation of swidden plots, raised fields and canal systems found throughout the southern Maya lowlands are illustrative of growth by accretion of many small, local efforts. In the Petexbatun region of Guatemala, Dunning et al. (1997: 263) cite the simplicity and small scale of agricultural terraces as an indication of household management of intensive agricultural production. Although a large reservoir dam was found at the site of Tamarindito, they suggest that its construction and maintenance costs could have been satisfied by local cooperating households without direct elite involvement (ibid.: 263). Fedick's (1996b: 130) study of the Upper Belize River Area found that residential settlement is associated with the best farm lands. But the location of civic-ceremonial centers displays a consistent pattern of spacing that probably had more to do with the political landscape than with the spatial distribution of land resources.

1.1 ARCHAEOLOGICAL BACKGROUND AND ANTECENDENTS

The present study contributes to the research concerned with elite involvement in intensive agricultural production by offering a comparison of how agricultural production was organized in two Late-Terminal Classic Maya polities each with differing needs for agricultural intensification. This approach is unique in that no existing studies of ancient Maya society have investigated the relationship between need for intensive agricultural production, and the degree of elite management of intensive agricultural works (e.g. terraces) using evidence from two contemporaneous polities with differing needs for agricultural intensification. Furthermore, this research constitutes a pioneering effort in the Upper Grijalva Basin (UGB) providing new insights into research conducted in other parts of the basin (Blake 1984; Bryant & Clark 1983; Clark & Lowe 1980; de Montmollin 1989a, 1995, 1997; Ekholm & Martinez 1983; Rivero 1987; Voorhies 1984), and contributing empirical data to previous accounts of agricultural terracing in the region (Lee 1974; Lowe 1959; Matheny & Gurr 1979, 1983).

In the UGB during the 1950s, numerous reconnaissance efforts throughout the region resulted in the identification of many sites worthy of future investigation (Lowe 1959a, 1959b; Lowe and Mason 1965; Shook 1956; Sorenson 1956). In the late 1960s and early 1970s, Mexico's National Institute of Anthropology and History (INAH) directed a salvage project aimed at recording ancient settlements along narrow portions of the Angostura canyon which would soon be flooded as construction of a hydroelectric dam neared completion. From 1973-

1983 the New World Archaeological Foundation's Upper Grijalva Basin Maya Project covered an area of approximately 2,600 km^2 (Lee 1981). The aim of the project was to locate sites, often with the help of local informants, make a sketch map of at least the sites' central parts, and surface collect ceramics for dating (de Montmollin 1995: 17). In 1979, Rivero selected a sample of the sites documented by the project to make small test excavations. Beginning in the early 1980s and continuing into the present, de Montmollin (1989a, 1995, 1997) has systematically surveyed large portions of the Upper Tributaries of the UGB resulting in a detailed picture of settlement and political structure in the region.

The Morelos area was briefly visited by Frans Blom in 1928 (Blom 1929). But the first archaeological reconnaissance of the zone was done by Lee in 1973, followed by Rivero's reconnaissance in 1979 which involved mapping and test excavations at select sites. Rivero (1987) also directed excavations in 1977 of domestic structures at the site of Los Cimientos (TR-29) which is located a little more than 5 km west of the core of the Morelos polity as documented in the present study. In 1980, Ronald Lowe conducted a cave survey in the region, and John Clark directed excavations at El Cerrito (Tr-42, which makes up a portion of house group cluster MR 28 in the present study). Intensive archaeological investigations of the San Lucas valley began in 1990 when de Montmollin surveyed the lower part of the valley in addition to parts of the Los Encuentros valley and the lower Rosario valley (de Montmollin 1997). De Montmollin would return to the San Lucas valley in 1995 to survey the core of what would become the Clavo Verde polity.

1.2 SUMMARY AND RESEARCH QUESTIONS

Systematic regional survey in the Morelos Piedmont and the San Lucas River Valley has yielded data necessary for the reconstruction of settlement patterns and agricultural terrace systems for two polities, the Morelos polity and Clavo Verde polity. The survey recorded architectural data, and surface collections of pottery and lithics were made, which permitted the identification and dating of elite and non-elite dwellings, civic structures, and terraces. Additionally, information about local environmental conditions, such as the locations of the best soils for agriculture, was recorded. These data are used to estimate the Late-Terminal Classic period populations, calculate a hypothetical maximum carrying capacity, and assess whether elites managed intensive agricultural production in the Morelos and Clavo Verde polities during the Late-Terminal Classic period. Specifically, this dissertation aims to answer the following research questions:

1) How are differences between the natural environments of the Morelos Piedmont and San Lucas River Valley linked to the need for intensive agricultural production in each polity? Did differences in the distribution of best agricultural lands between these two zones result in differences in the need for intensive farming?

Charting the distribution of soils good for farming in each of the zones allows for the calculation of estimates for the maximum maize production potential of long-fallow, swidden cultivation in the best farming zones. The greater amount of soils good for farming, and by extension the greater amount of maize that could potentially be produced, would result in a lesser need for intensive cultivation, and vice versa.

2) Was extensive farming of the best agricultural lands sufficient to support the Late-Terminal Classic period climax population indefinitely? Or, was it necessary to cultivate the less productive zones? Was intensive agricultural production adopted where the polity's population exceeded the carrying capacity of the best agricultural lands? Or, was carrying capacity not a factor in the decision to adopt intensive farming techniques?

Attempts to estimate population for ancient Maya society are nothing new (see for example Culbert and Rice 1990), but actual estimates of carrying capacity – of population limits related to specific land uses – for the ancient Maya are relatively rare (Turner et al. 2003: 368). Population is estimated by multiplying the number *five* (the presumed nuclear family size) by the total number of dwelling structures dated to the Late-Terminal Classic period in both polities. Based on ethnographic and nutritional studies, the maximum annual maize production potential using extensive farming techniques on the best agricultural lands in each polity is divided by the minimum annual per-person maize consumption requirement to estimate the hypothetical maximum carrying capacity for each zone. This figure is then compared to the population estimates to determine if the Late-Terminal Classic period populations of each polity would have been over, or under, the long-fallow, swidden carrying capacity of the best agricultural zones. This result is compared to the presence (or absence) of agricultural terraces to determine whether carrying capacity might have been a factor in the decision to adopt intensive farming techniques.

3) Was the organization of intensive agricultural production on terraces a "top-down" process managed by elites during the Late-Terminal Classic period? Or, was it a "bottom-up" process where the organizational initiatives were provided by commoners without elite input?

Elite management of agricultural production can be assessed by examining how elites are distributed in relation to the best agricultural lands and agricultural terraces. A strong association between the distribution of elites and the best agricultural lands or terraces might indicate that elites managed agricultural production in these zones (Chase and Chase 1996). Additionally, agricultural terrace size and field patterns can yield clues as to the nature of elite management of intensive production. Agricultural terrace systems of such a large scale that local households could not have satisfied the labor required to construct, maintain, and cultivate them can be interpreted as elite management of intensive production on terraces (Chase and Chase 1996). Standardization in agricultural terrace field patterning might suggest elite, top-down planning (Healy et al. 1983).

2.0 FIELD METHODS

The selection of a full-coverage, systematic survey methodology was based on its relevance for testing the research questions set forth in the introductory chapter. Settlement patterns studies have proven to be an effective, yet relatively low-cost way in terms of time and funding, to obtain data about broad, regional patterns. Furthermore, the survey results, especially in relation to population estimates, the human-environment relationship, and social organization in general are easily compared between case studies.

Documentation of regional settlement patterns in both the Morelos Piedmont and the San Lucas River Valley permits calculation of estimates for population size and density, and delineation of population composition and distribution. Population size and density estimates are compared to the swidden productive potential in both polities in order to assess the relative degree of population pressure on the best agricultural lands. Population distribution can be evaluated in relation to the natural and cultural characteristics of the region such as soils good for farming, water resources, and agricultural terraces in order to learn about the subsistence adaptations. In pre-industrial, agrarian societies like the prehispanic Maya, the majority of the population would have been involved in the food production process. Therefore, the distribution of settlements would be expected to concentrate near the most productive zones, leaving less productive areas uninhabited or settled later on because of population growth and/or the depletion of resources in the better zones. The study of regional settlement patterns can confirm this expected distribution of settlements, or reveal an alternative arrangement reflecting other aspects of social organization.

2.1 THE SURVEY

Between May 3 and August 29 of 2005, a total of 26.94 km^2 were systematically surveyed in the Upper Tributaries of the UGB (18.61 km^2 in the Morelos Piedmont, and 8.33 km^2 in the San Lucas River Valley) (Figure 2-1, Figure 2-2). The survey in the Morelos Piedmont represented the first full-coverage, systematic survey of this zone, whereas the survey of the San Lucas Valley expanded the 17.91 km^2 survey of the valley floor by Olivier de Montmollin in 1995 (de Montmollin 1997). The primary goal of the survey in both zones was to document settlement, agricultural terraces, and best extensive farming zones to permit reconstruction of the social and agricultural landscape during the Late-Terminal Classic period (A.D. 650 – 950). Expansion of the San Lucas survey zone was aimed at documenting settlement and agricultural facilities on the eastern and southern margins of the valley where the relatively flat valley floor transitions to sloping hillside representing the most likely locales for agricultural terracing. Survey methods were derived from Central Mexican and Oaxaca Valley techniques of systematic fieldwalking (Blanton et al. 1982; Parsons 1971; Sander et al. 1979), and from those used in other parts of the UGB (de Montmollin 1989b, 1995). A modification of the Central Mexican and Oaxaca Valley techniques involved using architecture rather than ceramic sherd scatters to define zones of settlement. This was done because even very modest architecture is sufficiently well preserved in the UGB to be detected.

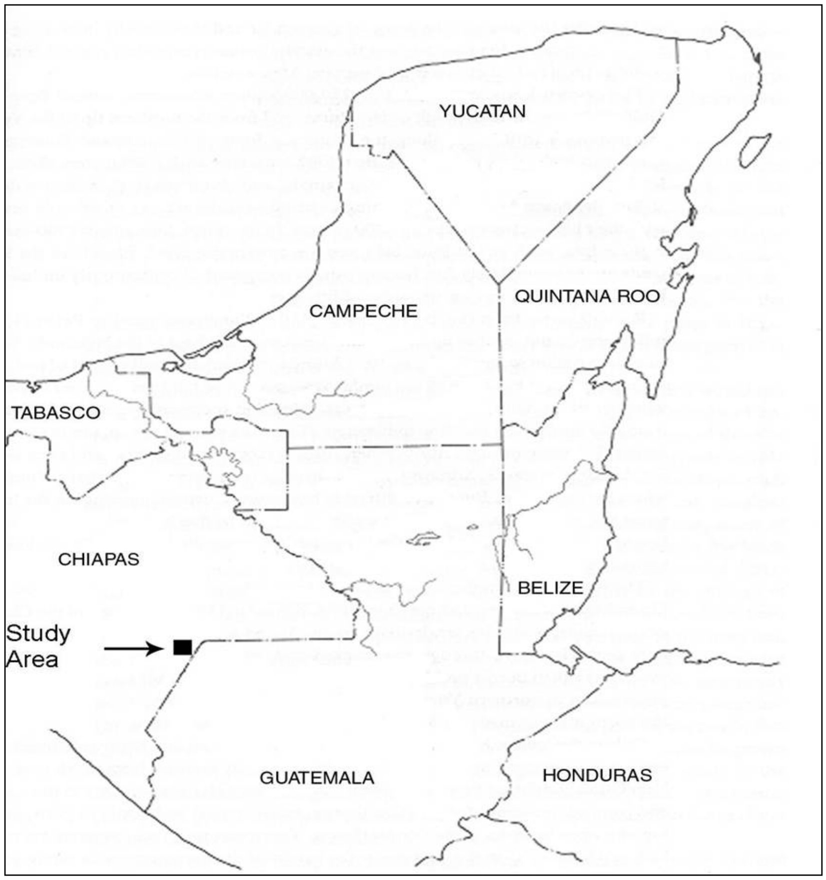

Figure 2-1 The Study Area

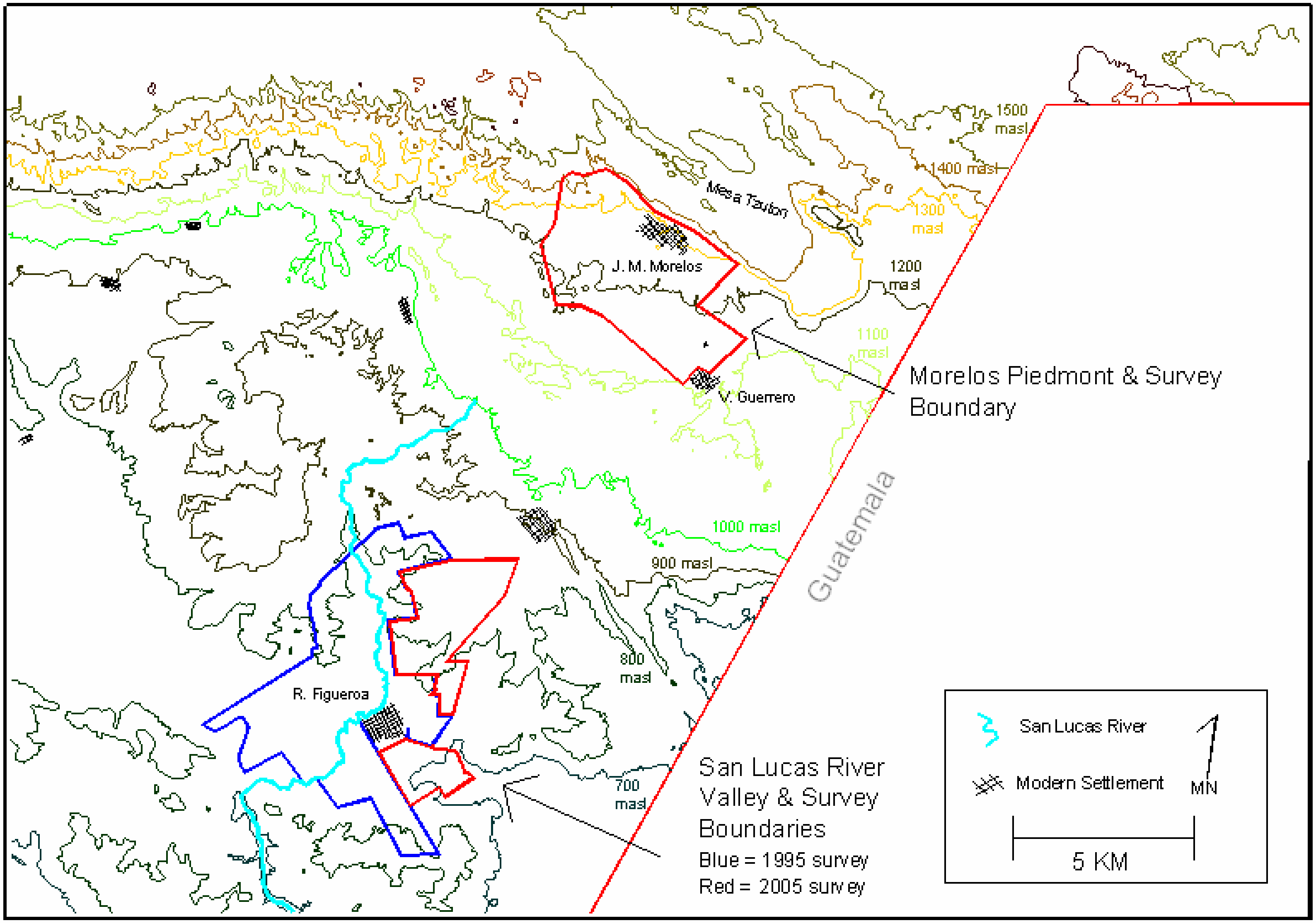

Figure 2-2 The Upper Tributaries of the Upper Grijalva Basin and the Survey Zones

A methodology considered for the present study was “siteless” survey (Dunnell and Dancey 1983; Dunnell 1992). Siteless survey has been presented as an alternative methodology to traditional, site-based survey techniques which, it is argued, are fundamentally flawed because of the *a priori* assumption that sites represent the most important archaeologically relevant units which leads to the exclusion of segments of the archaeological record that occur “off-site” (Dunnell 1992). Siteless survey is touted as a more inclusive and comprehensive methodology that focuses on the artifact as the basic unit of observation in the field. The archaeological record, then, is viewed as a more or less continuous distribution of artifacts on or near the surface of the earth, and not as a collection of sites waiting to be found (Dunnell and Dancey 1983: 272; Dunnell 1992: 34).

Although a purely siteless methodology was not adopted in the present study, the documentation of agrarian features away from “sites” was a fundamental component of the survey, as well as the documentation of topographical features and natural resources, such as best agricultural lands and water sources (Parsons 1972: 142, 143). Not only were terraces associated with residential and civic sites mapped, but agricultural terraces located away from settlement and civic centers were mapped as well. The evidence collected on settlement patterns, the distribution of agricultural terraces and best agricultural lands, and other natural features within the survey zones is used in the forthcoming analyses to explore the subsistence adaptation.

More recently, advancements have been made in using systematic survey to collect better data for the reconstruction of regional demography (e.g. Drennan et al. 2003). Based on the assumption that larger populations leave more *garbage* on the landscape than smaller populations do, Drennan et al. (2003) proposed that the number of artifact collections by time period per site is a better indication of population levels than is a simple tally of the number of sites by time period. In this way, larger sites will systematically be represented by larger numbers of collections and thus “count more” than smaller sites (ibid.: 156). For example, during regional survey of the Chifeng region of Inner Mongolia, where remains of ancient architecture are not such as to make it possible to inventory dwellings, but surface ceramics are ubiquitous and well-preserved, surface artifacts were systematically collected in order to facilitate quantification of surface ceramic densities by time period. To account for the differing lengths of time periods, the ceramic densities were divided by the number of centuries per time period, and the resulting quotient used to reconstruct the relative population levels over time (Drennan et al. 2003: 161, Figure 4.7).

In the present study, the scarcity of surface ceramics in the survey zones prevented the adoption of a similar methodology. Additionally, the good preservation of architectural remains permitted the use of dwelling structures to estimate population levels. A potential future use of Drennan’s methodology in the UGB would be to use ceramic densities per time period to estimate population levels prior to the Late-Terminal Classic population climax. As described below in Section 2.2, the percentage of all dwelling structures recorded during the survey that were occupied during earlier time periods is unknown. A systematic ceramic collection methodology, that would probably require the digging of test pits to acquire a large enough sample, could yield data for making comparisons of sherd density per time period in order to estimate the relative population levels over time.

Visibility was good throughout most of the survey zones where relatively shallow soils and thin or cleared vegetation made it unlikely that structures were hidden by natural deposition processes or thick plant life. The survey was conducted early in the planting season, therefore excessive growth of corn, beans, and other locally grown crops was not a factor. But conditions were not ideal in all parts of the survey zones. The hilly northwestern portion of the Morelos survey zone, which serves primarily as a hunting reserve for local inhabitants, was covered in many places by tropical deciduous vegetation, the climax formation common throughout the Upper Tributaries of the UGB. In this zone, the survey progressed more slowly as the interval between crew members was decreased in order to insure that cultural remains were not missed.

The preservation of architectural features in both survey zones was variable, but was generally good enough for the dimensions of structures and terraces to be accurately measured. In some cases preservation was good enough to make it possible to identify individual architectural attributes such as walkways, partitions, and in some cases, quality of construction (e.g. presence or absence of well-cut stones or stones of standardized sizes). The use of mechanized plowing has been minimal reducing the possibility of complete obliteration of structures, terraces, and other cultural remains.

Survey techniques included the following standardized set of procedures. A four to six person crew spaced at 15-40 m intervals (depending on local topographic and visibility conditions) walked in formation across the landscape to find architectural remains. Architectural features were divided into two general categories, terraces and structures. When one or more terraces or structures were found, the crew was called in to define the extent of all architectural remains and to map them using Brunton compass, tape, and GPS (see Appendix A). Each terrace and structure was assigned a unique numeric designation and specific attributes were recorded for each. Attributes recorded for terraces include terrace form (e.g. dryslope, footslope, check dam), slope of terrain, state of preservation, quality of construction, height, number of stone courses, average size of stones used, soil depth, and if under modern reuse (see sample Terrace Form in Appendix C). Attributes recorded for structures include height, state of preservation, quality of construction, whether or not associated with terraces, and other architectural details such as walkway, partition, stairway, and construction material (see sample Structure Form in Appendix C). Terrace mapping proved to be more time consuming than structure mapping. Terraces are typically irregular and difficult to follow because of variable topographic conditions such as differing degrees of erosion and sediment, and vegetative growth. Additionally, extreme care has to be taken to precisely record terrace wall angles as even one wrong measurement has the potential to misalign an entire system. In addition to mapping terrace systems and structures at a scale of 1:10, their location was also recorded at a broader scale on a regional map (1:50,000), and using GPS.

A diligent search was made for ceramic and lithic artifacts which were surface collected during mapping. Collection units were assigned a unique numeric designation in the field and correspond to structures and/or terraces occupying a contiguous space on the landscape with less than 100 m between a particular structure or terrace and its nearest neighbor. Based on structure densities found in other parts of the Upper Tributaries of the UGB (de Montmollin 1989b, 1995), a distance of 100 m is a reasonable estimate to distinguish between collection units that potentially corresponds to settlement patterns at the community level (de Montmollin 1997: 8). Although surface material was sometimes found on top of and directly adjacent to structures and terraces, this occurrence was too infrequent to warrant proveniencing material to each individual architectural feature. Terraces occupying a contiguous space with less than 100 m between a particular terrace wall and its nearest neighbor are classified as *terrace systems* and have been assigned a unique numeric designation. In the forthcoming analyses, many of the structures recorded during the survey are interpreted as dwellings, and are classified into house groups. A house group is defined as one or more dwellings occupying a contiguous space on the landscape grouped closer together than to any other dwelling structures. One or more house groups occupying a contiguous space with less than 100 m between a particular house group and its nearest neighbor are henceforth referred to as *house group clusters*. A detailed description of how dwellings and house groups are defined is provided in Chapter 3.

In addition to mapping structures, for each collection unit soil conditions, local topography, vegetation, proximity to water sources, and modern land use were also recorded (see sample Natural Environment Description Form in Appendix C). Also, local inhabitants were informally interviewed to gain insight into the variations in farming potential across the landscape, types of crops cultivated, water sources, fertilization, labor inputs and yields harvested. This information was used to assist in the identification of the best agricultural lands and to generate reasonable estimates for maize production in both zones.

The decision to record individual structures and terraces during the survey is not only related to the favorable logistical conditions described above, but also due to the flexibility it provides during analysis. This methodology insures the thorough and complete documentation of individual architectural features which can later be grouped into potentially meaningful units. The ability to examine individual structures, or to group individual structures into larger units such as house groups and house group clusters, allows for the exploration of potentially meaningful cultural patterns corresponding to particular aspects of society. Individual dwellings and house groups, for example, may furnish information about family organization and economic specialization. The distribution of dwellings and house groups throughout the region, especially in relation to the best agricultural lands and agricultural terraces, can provide information about the subsistence adaptation.

2.2 CHRONOLOGICAL CONSIDERATIONS

House group clusters and terrace systems recorded during the survey were dated according to the presence of pottery types whose chronology had been previously established for the UGB (Ball 1980; Bryant et al. 2005). For the purposes of this study, a system of classification was utilized that allowed easy and quick analysis of the ceramic sherds collected in order to identify which clusters of structures and terraces dated to the Late-Terminal Classic period and other time periods (see sample Ceramic Classification Form in Appendix C). The majority of ceramic material recovered during the survey was dated to three time periods, Late-Terminal Classic (A.D. 650-950), Proto-Classic (A.D. 100-250), and Formative (600 B.C. – A.D. 100) [breakdown of the number of structures and terraces by time period are provided later in the dissertation as required for estimating population (Chapter 3) and calculating agricultural productive potential (Chapter 4)] (Table 2-1). The vast majority of ceramic materials dated to the Late-Terminal Classic which is not surprising given that this time period represents the apex of social and political development throughout the UGB (de Montmollin 1995). Two ceramic groups in particular, Chachalaca and Tasajo, were used for dating ceramic sherds to the Late-Terminal Classic period. Ceramics of the Chachalaca group commonly occur in tecomate, jar, basin, bowl, and dish forms and are principally identified by a thick, heavily crackled/crazed dull red slip; and coarse, irregular unslipped exterior surfaces (Bryant et al. 2005: 448). Forms of the Tasajo ceramic group include plates, dishes, bowls, tecomates, and jars and are principally identified by a thick, well-polished reddish-orange slip over dish interiors and jar exteriors; unslipped, irregular dish exteriors; and medium-hard paste liberally tempered with coarsely-ground volcanic ash and quartz sand (ibid.: 463).

The Late-Terminal Classic period is, of course, the time period of particular interest in the present study. But Proto-Classic ceramics were found in association with some architectural features, both structures and terraces, in the Morelos Piedmont (Figure 2-3). This is consistent with previous reports of Proto-Classic settlement in this zone, potentially by intrusive Maya speaking groups which may have entered the region prior to 250 B.C. (Bryant and Clark 1983: 224). Formative period ceramics were collected in association with one small cluster of structures in the Morelos Piedmont, but none were recovered in the San Lucas Valley. Due to the general scarcity of ceramic materials directly associated with individual structures and terraces, for house group clusters and terrace systems containing Late-Terminal Classic ceramic materials and ceramics dated to earlier time periods, it is presently impossible to determine how many of the architectural features date to the earlier time period. In other words, for a house group cluster or terrace system that contains both Late-Terminal Classic and Proto-Classic ceramic material, it is not possible to say how many of the individual dwellings, civic structures, agricultural terraces, etc. were utilized during the Proto-Classic period. All that can be said is that it is probable that some of them existed during this time period. Due to the overwhelming predominance of settlement during the Late-Terminal Classic period climax in the Morelos Piedmont, San Lucas Valley, and throughout the UGB (de Montmollin 1989a, 1995, 1997), it is assumed that all structures and terrace systems that are part of a settlement containing ceramic material dated to the Late-Terminal Classic period were utilized during this particular time period (Figure 2-4, Figure 2-5). This assumption is in accordance with the initial research objective to compare settlement and agricultural facilities for two, Late-Terminal Classic period polities with differing needs for agricultural intensification due to differences in environmental setting.

Table 2-1 Chronology

Time Span (A.D.)	Period	Upper Grijalva Tributaries Phases
1450 – 1550	Proto-Historic	US
1200 – 1450	Late Post-Classic	TAN
950 – 1200	Early Post-Classic	ON
850 – 950	Terminal Classic	NICHIM
650 – 850	Late Classic	MIX
450 – 650	Middle Classic	LEK
250 – 450	Early Classic	KAU
100 – 250	Proto-Classic	IX
600 (B.C.) – 100	Formative	ENUB - JUN

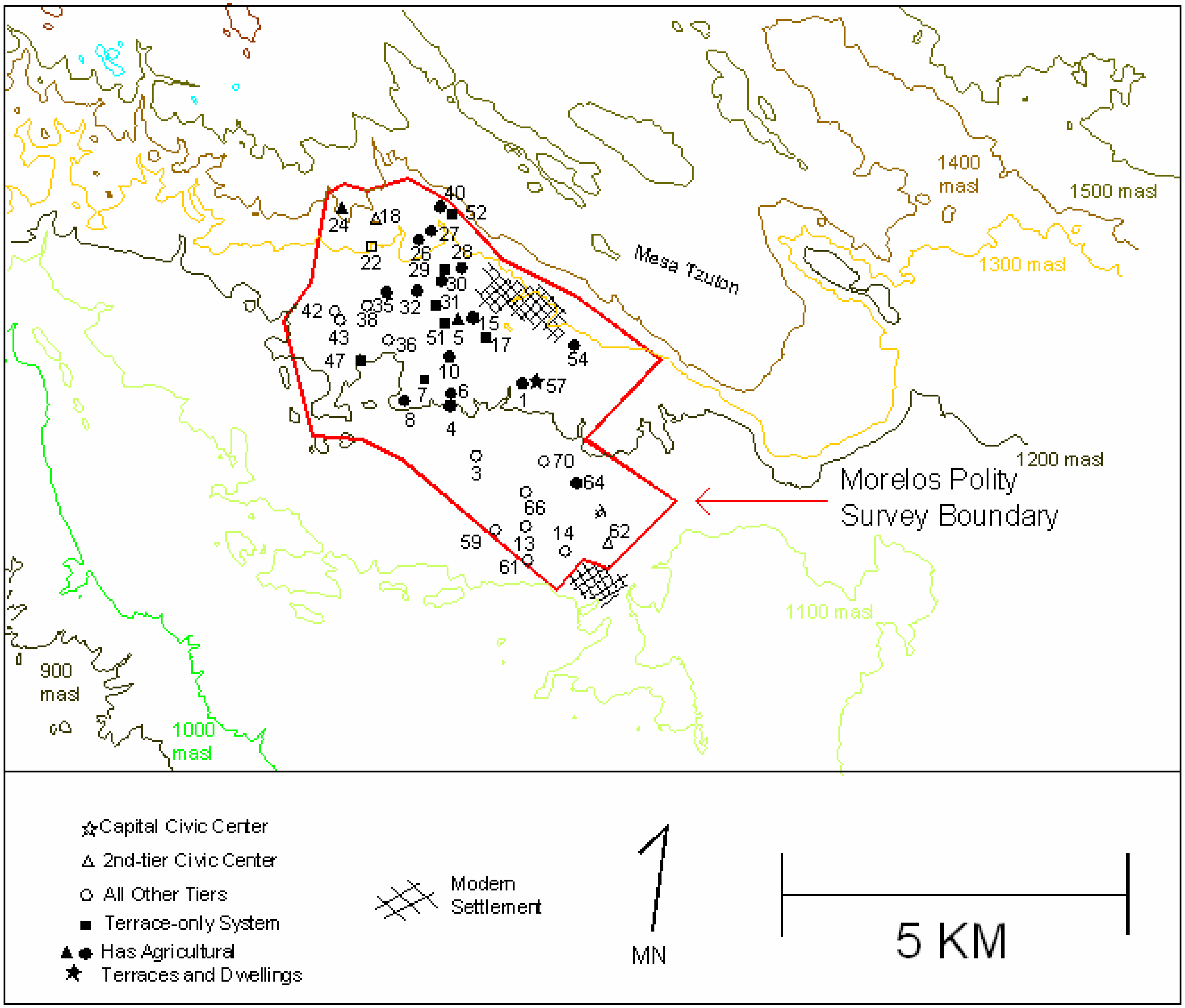

Figure 2-3 Morelos Polity House Group Clusters and Terrace Systems with Proto-Classic Period Ceramics

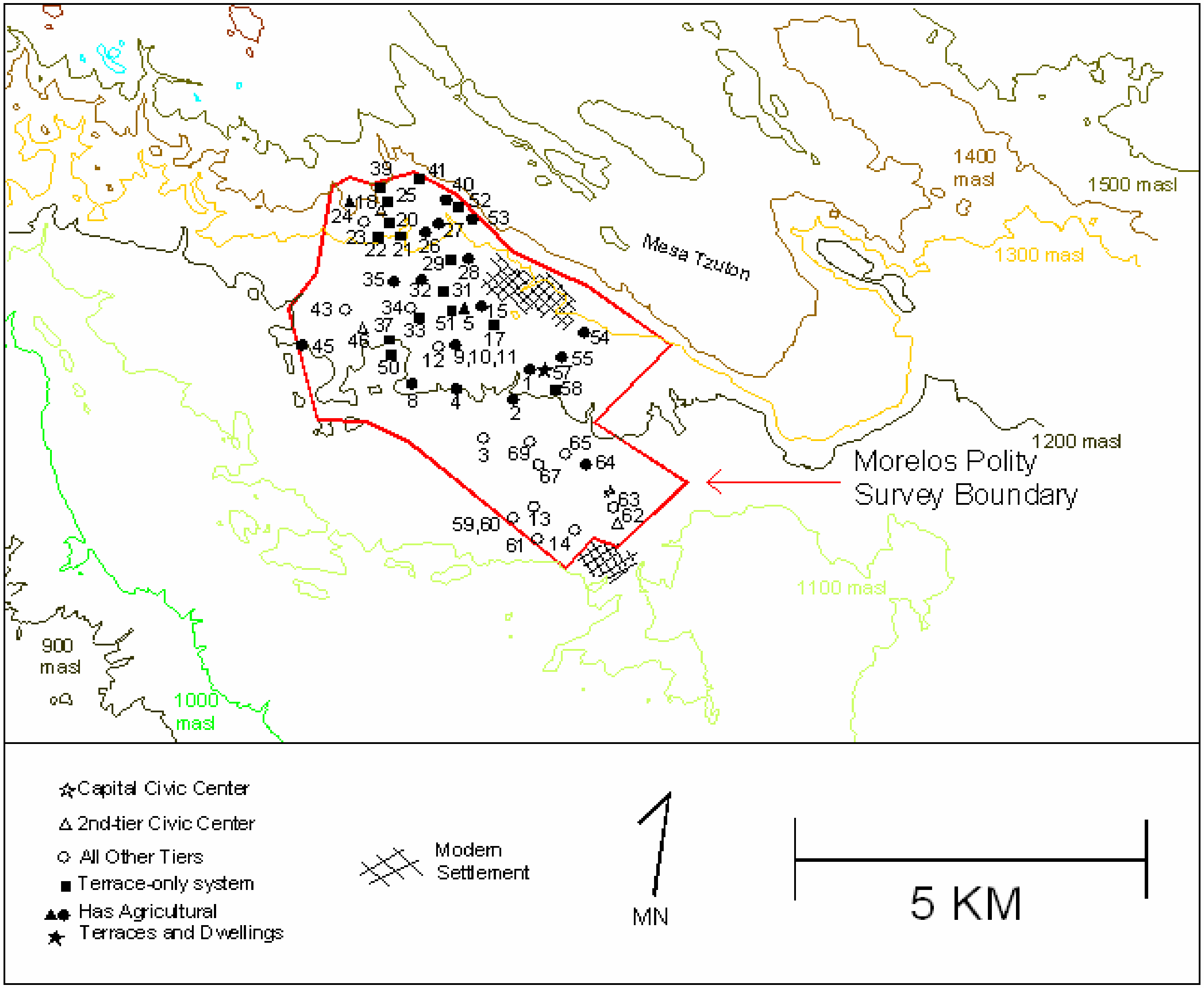

Figure 2-4 Morelos Polity Late-Terminal Classic Period: All House Group Clusters and Terrace Systems

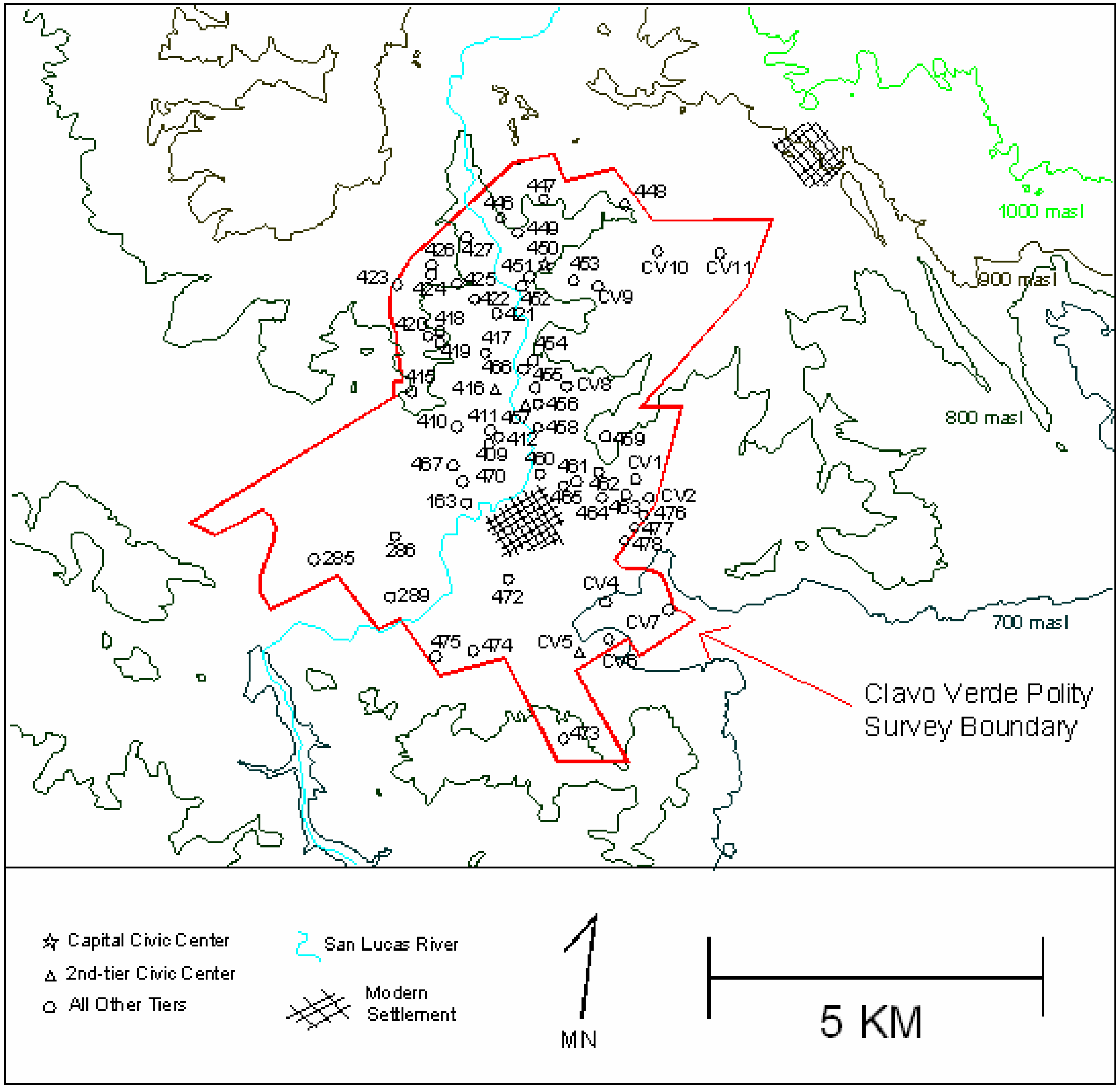

Figure 2-5 Clavo Verde Polity Late-Terminal Classic Period: All House Group Clusters ("CV" denotes 2005 survey)

3.0 POPULATION COMPOSITION, POPULATION SIZE AND DENSITY, AND CIVIC STRUCTURES AND CIVIC HIERARCHY

3.1 POPULATION COMPOSITION

3.1.1 Elite and Commoner House Groups and Dwellings

One of the basic units of analysis used in this study is the house group. House groups are interpreted as having been occupied by one or more nuclear families, and represent the household level of social organization. The house group most likely represents the scale at which individual household members integrated production and consumption activities (Wilk and Ashmore 1988; Manzanilla 1986; Marcus 2004; Martinez 1986, Vogt 1968, 2004). In the present study, the house group is defined as one or more dwellings occupying a contiguous space on the landscape grouped closer together than to any other dwelling structures. This definition insures the inclusion of all dwellings in the analyses be they isolated single dwellings, or part of a multiple dwelling group.

Due to the scarcity of surface ceramics associated with house groups, a distance of 100 m separating one house group from its nearest neighbor was used to delineate boundaries between collection units. House groups occupying a contiguous space with less than 100 m between a particular house group and its nearest neighbor were assigned a unique numeric designation during the survey and are henceforth referred to as *house group clusters*. The number of house groups per house group cluster was found to range from 1 to 88, and include both formal patio groups and informal groups. Patio house groups are defined as several structures sharing a central ambient space (or patio). Informal house groups consist of several dwellings grouped closer to each other than to other structures and with no apparent central ambient space (Ashmore 1981: 48-50).

All house groups are divided into three groups based on dwelling length: 1) range structure elites (house group has at least one dwelling 11 m or greater in length), 2) non-range structure elites (house group has at least one dwelling between 9 and 11 m in length and/or is oriented onto a civic plaza), and 3) commoners (house group consists of dwellings between 3 and 9 m in length and is not oriented onto a civic plaza) (Table 3-1). These distinctions are based on the presumed association of higher status individuals with more elaborate architecture in their domiciles as evidenced, in this case, by greater length (Ashmore et al. 2004: 311; Chase and Chase 1992; Haviland and Moholy-Nagy 1992: 51). Division of the house group data-set into these three types allows for a more nuanced examination of the distribution of elites and commoners in relation to agricultural facilities relevant to the issue of elite management of intensive agricultural production (see Table 3-2 and Table 3-3). (See Appendix D for complete list of house groups sorted by type)

Table 3-1 Description of House Group Types

House Group Type	Defining Characteristics
Range Structure Elites	At least one dwelling 11 m in length or greater
Non-Range Structure Elites	At least one dwelling between 9 and 11 m in length and/or is oriented onto a civic plaza
Commoners	All dwellings between 3 and 9 m in length and not oriented onto a civic plaza

Table 3-2 Morelos Polity Late-Terminal Classic Period: Number of House Groups by Type

House Group Type	Number of House Groups	Number of Dwellings	Average Number of Dwellings per House Group
Range Structure Elite	41	109	2.7
Other Elite	52	124	2.4
Commoners	319	571	1.8
Total	412	804	-

Table 3-3 Clavo Verde Polity Late-Terminal Classic Period: Number of House Groups by Type

House Group Type	Number of House Groups	Number of Dwellings	Average Number of Dwellings per House Group
Range Structure Elite	12	37	3.1
Other Elite	51	112	2.2
Commoners	437	775	1.8
Total	500	924	-

The habitational dwelling structures that make up house groups are divisible into three general types based on length: 1) commoner dwellings, 2) elite dwellings, and 3) range structures. A stem-and-leaf plot showing the distribution of dwelling lengths in the Morelos polity during the Late-Terminal Classic period indicates two distinct and separate bunches, one between 3 and 9 m and another between 9 and 11 m, and a less distinct straggling of dwellings between 11 and 21.9 m (Figure 3-1). Such a pattern of multiple bunches is an indication of distinct kinds of cases – in this instance three distinct kinds of dwellings, small dwellings between 3 and 9 m in length (interpreted as commoner dwellings), medium dwellings between 9 and 11 m in length (interpreted as elite dwellings), and large dwellings 11 m or greater in length (interpreted as range structures).

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 8   555555788889
 9   0000011223
 9   566667899
10   0001223344
10   556666779
11   0014
11   5555777889
12   01112
12   55
13   011
13   6689
14   00003
14   7
15   6
16   55
17   08
18   0
19   00
20   0
21   9
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Figure 3-1 Morelos Polity Late-Terminal Classic Period: Stem-and-Leaf Plot Showing Distribution of Dwelling Lengths (in meters, n = 804, range = 3.0 to 21.9 m, median (M) = 5.5 m, mean = 6.1 m)

A stem-and-leaf plot showing the distribution of dwelling lengths in the Clavo Verde polity during the Late-Terminal Classic period indicates a pattern similar to that of the Morelos polity (Figure 3-2). The majority of dwellings are bunched between 3 and 9 m. At about the 9 m threshold, the quantity of dwellings begins to decrease sharply but a smaller number are bunched between 9 and 11 m, albeit less distinctively. Beyond 11 m, the number of dwellings straggles upwards peaking at 15.8 m. This pattern of multiple bunches is interpreted in the same way as in the Morelos polity. Commoner dwellings between 3 and 9 m in length, elite dwellings between 9 and 11 m in length, and range structures 11 m or greater in length.

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 7   55555555555555555666666777777788888899999999999
 8   00000001122222233333333444444
 8   555556666788888899999
 9   00000122233333444
 9   5677778889
10   0000011333444
10   7788899
11   234
11   59
12   24
13   04
14   0
14   8
15   3
15   8
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Figure 3-2 Clavo Verde Polity Late-Terminal Classic Period: Stem-and-Leaf Plot Showing Distribution of Dwelling Lengths (in meters, n = 924, range = 3.0 to 15.8 m, median (M) = 5.4 m, mean = 5.7 m)

1) Commoner dwellings are habitational structures with a minimum length of at least 3 m and a maximum length less than 9 m, and are not part of a house group with at least one elite dwelling (9 m in length or greater) or that is oriented onto a civic plaza (Table 3-4). The rationale of using 3 m as the minimum length requirement for a dwelling is based upon the minimum amount of floor space necessary for dwelling purposes (de Montmollin 1989b: 45). Structures less than 3 m in length are interpreted as too small a space for sleeping quarters and therefore having served other functions such as altars for ritual displays.

2) Non-range structure elites are defined as residents of dwellings from house groups with at least one dwelling between 9 and 11 m in length. Dwellings 9 m in length or greater (including range structures described below) represent about 10 percent of all dwellings in the Morelos polity for the Late-Terminal Classic period which is consistent with other studies of the

ancient Maya which indicate that the largest component of society consisted of basic producers who were primarily farmers, and that the relative proportion of commoner producers to elite consumers would have been between 80-90 percent and 10-20 percent respectively (Lohse and Valdez 2004: 2; Webster 1985: 384-385). Another reason for emphasizing dwelling length is that range structures (discussed below), the clearest examples of elite residences which likely doubled as civic buildings, are notable for their length, which makes it logical to equate greater dwelling length with higher sociopolitical status (de Montmollin 1995: 171).

3) Junior relatives / retainers are dwellings between 3 and 9 m in length that are part of house group with at least one dwelling 9 m in length or greater and/or oriented onto a civic plaza. These dwellings might represent the residences of extended family members of the higher-ranked families in the larger dwellings (de Montmollin 1995: 171; Haviland and Moholy-Nagy 1992: 52) or commoner assistants or servants (Marcus 2004). The logic of classifying dwellings oriented onto civic plazas as part of the elite stratum is that the occupants would have had privileged access to the elite-related functional and ritual activities presumed to have taken place on the plazas (Chase and Chase 1992: 9; de Montmollin 1995: 171; Pendergast 1992: 64).

4) Range structures probably functioned as civic buildings as well as special elite residences and therefore are interpreted as having served a habitational function (de Montmollin 1989b: 51). For this reason, range structures are included in the total count of dwellings for each polity (Table 3-4). Range structures are the longest structures in the region not including pyramids and ballcourts, and are defined as dwellings 11 m in length or greater.

The identification of range structures is particularly pertinent in the present study because of their presumed dual-functionality as elite residences and civic buildings. Range structures might represent the residences of the highest ranking elites, and therefore the distribution of range structures in relation to agricultural facilities will yield clues as to the degree of elite management of agricultural production. The average length of range structures in the Morelos polity and Clavo Verde polity was found to be 13.9 m and 14.8 m respectively. But, many more range structures were recorded in the Morelos polity (44) than in the Clavo Verde polity (13) (Table 3-4), and house groups containing range structures constitute a greater percentage of all house groups in Morelos (9.7%) than in Clavo Verde (1.4%) (Table 3-5). Furthermore, compared to other polities in the UGB, range structures in the Morelos polity constitute a relatively large percentage of all dwellings (Table 3-6). The civic and residential function of range structures is supported by analogy with the long council houses oriented onto civic plazas at Post-classic Quiche Maya sites (Carmack 1981). Range structures oriented onto civic plazas might represent palaces as it is assumed that those who inhabited these large structures enjoyed privileged access to the elite-related activities presumed to have taken place on civic plazas, and would have been of considerably higher standing than those who lived in dwellings away from civic plazas (Christie 2003; Kowalski 2003). But what function was served by range structures away from civic plazas? It is possible that the greater number of range structures in the Morelos polity, especially those located away from civic plazas and near agricultural terraces, is an indication of elite management of intensive agricultural production in this more marginal zone.

In the Morelos polity, 22 of the 44 range structures are on civic plazas, and the remaining 22 are away from civic plazas. In the Clavo Verde polity, 6 of the 13 range structures are on civic plazas, and 7 are away from civic plazas. So, in both polities the location of range structures is nearly half on civic plazas, and half away from civic plazas, indicating no great disparity in where range structures are located.

Table 3-4 Morelos Polity and Clavo Verde Polity Late-Terminal Classic Period Total Number of Dwelling Structures by Type

Dwelling Type	Morelos Polity (n = 804)	Clavo Verde Polity (n = 924)
Range Structure Elite (11 m or greater in length)	44	13
Non-Range Structure Elite (between 9 to 11 m in length)	38	47
Junior Relative / Retainer (between 3 to 9 m in length but part of house group with at least one dwelling 9 m in length or greater and/or oriented onto civic plaza)	151	89
Commoner (between 3 to 9 m in length and *not* part of house group with at least one dwelling 9 m in length or greater and/or oriented onto civic plaza)	571	775
Total Number of Dwellings	804	924
Survey Area in km^2	18.61	26.24

Table 3-5 Percentage of House Group Types in the Morelos and Clavo Verde Polities for the Late-Terminal Classic Period

House Group Type	Morelos Polity	Clavo Verde Polity
Range Structure Elite	9.7	1.4
Non-Range Structure Elite	11.9	12.1
Commoners	78.4	86.5

Table 3-6 Number and Percentage of Range Structures in UGB Polities

Polity	Number of Range Structures	Percent of Total Dwellings	Survey Area (km^2)
Morelos	44	5.4	18.61
Ojo de Agua*	123	3.1	55.45
Los Encuentros*	24	1.8	25.99
Clavo Verde	13	1.4	26.24
Rosario*	43	1.0	52.40
*From de Montmollin 1995:167, Table 32; includes range dwellings and other civic residences 10 m in length or greater.			

The definition of elites can be made more expansive when it includes even modest dwellings (less than 9 m in length) that are part of a house group containing at least one dwelling 9 m or greater in length and/or oriented onto a civic plaza. Because of this, estimates for the elite percentage of the total population are skewed upwards. Dwellings 9 m in length or greater (including range structures) constitute 10.1 percent of all dwellings for the Late-Terminal Classic period in the Morelos polity (82 dwellings out of 804 total dwellings) (Figure 3-1, Table 3-4). But, when the modest junior relative / retainer dwellings that are part of house groups containing dwellings 9 m or greater in length and/or oriented onto civic plazas are counted, the number of elite dwellings (including range structures) rises to 249 which represents 30.9 percent of all dwellings (Table 3-4).

In the Clavo Verde polity during the Late-Terminal Classic period, dwellings 9 m in length or greater (including range structures) constitute 6.5 percent of all dwellings (60 dwellings out of 924 total dwellings) (Figure 3-2, Table 3-4). But, when the modest dwellings that are part of house groups containing dwellings 9 m or greater in length and/or oriented onto civic plazas are counted, the number of elite dwellings (including range structures) rises to 143 which represents 15.5 percent of all dwellings (Table 3-4).

Previous research concerning ancient Maya social organization has made explicit the subtle divisions along status lines that are not easily identified in the archaeological record (Hendon 1996; Lohse and Valdez 2004; Marcus 1995; McAnany 1993). Modest dwellings that are part of elite house groups were presumably for junior relatives and/or retainers of the highest ranking families in the larger dwellings. It appears likely that many of the dwellings classified as elite in the Morelos and Clavo Verde polities were not only for the highest ranking individuals in society, but also for lesser nobles, administrators, retainers and their families and domestics. The task of assigning a particular societal role to each dwelling and house group in these two polities would be an extraordinarily challenging one and, given the lack of nuanced data that excavation could provide, would seem to be, at present, an impossibility. Therefore, length has been taken as a reasonable approximation of social status and is used here to make analytical distinctions within the dwelling data-set. Although the criteria used to define range structure elites, non-range structure elites, junior relatives / retainers, and commoners are quite crude, they result in a systematic and relatively complete summary of the patterns observed across each survey zone facilitating settlement comparisons within and between the Morelos and Clavo Verde polities.

3.1.2 Domestic Altars

Domestic altars are small, square-shaped structures less than 3 m in length and frequently associated with house groups. Altars are most likely platforms upon which ceremonial activities were performed and offerings made. Thus, altars are interpreted as having served a ritual function. Domestic altars were rare in both survey zones. A total of 19 domestic altars were recorded during the survey of the Morelos Piedmont and all were part of house group clusters with ceramic materials dated to the Late-Terminal Classic period. For the San Lucas Valley, 1 domestic altar was recorded during the 2005 survey and 9 were recorded during the 1995 survey (de Montmollin 1997: 18, Cuadro 2). All were dated to the Late-Terminal Classic period using surface collected ceramics. Due to the small percentage of domestic altars recorded, and because of the possibility that many may have been missed during the survey due to their small size, low height, and generally poor state of preservation, they have not been incorporated into the classification scheme for house groups described above.

3.2 POPULATION SIZE AND DENSITY

Estimating population figures for the ancient Maya is a notoriously difficult undertaking and an inexact science at best, but many attempts have previously been made to produce more accurate estimates (see for example Culbert and Rice 1990). Population estimates for the Morelos and Clavo Verde polities not only provide a datum for comparison to other polities within the Upper Grijalva Basin (UGB), but also for comparisons to population studies throughout the Maya zone and Mesoamerica. In the present study, population estimates are derived by multiplying the total number of dwelling structures of all kinds per time period by 5 individuals (Table 3-7 and Table 3-8). Use of the value of 5 assumes one nuclear family per dwelling, and is roughly consistent with other archaeological and ethnographic studies of Maya house groups (Ashmore 1990; Dahlin et al. 2005; Haviland 1982; Redfield and Villa Rojas 1934; Liendo 2002; Tourtellot 1983). Although some previous studies of Maya house groups have resulted in a greater number of individuals per dwelling ranging from about 6 to as many as 25 (Hellmuth 1977; Puleston 1974; Rice and Rice 1984), here the relatively small size of dwelling structures in both polities indicates that the more conservative value of 5 people per dwelling is a reasonable estimate. During the Late-Terminal Classic period in the Morelos polity, the average dwelling length is 6.1 m. In the Clavo Verde polity during the same time period the average dwelling length is 5.7 m. In both polities the average dwelling area is just over 30 m^2. This figure is comparable to Webster and Gonlin's (1988) study of rural dwellings in the Copan Valley. They found that the average size of the stone platform that supported a perishable house to be nearly 30 m^2 (Webster and Gonlin 1988: Table 1). Naroll's (1962) study of floor area and settlement population has been applied to Maya archaeological data (Rice and Culbert 1990: 18). Naroll found that an individual has, on average, 10 m^2 of space. Accepting this figure as an accurate estimate, 5 people per dwelling represents a generous estimate for the Morelos and Clavo Verde polities even though it is on the lower end of previous studies of Maya house groups. Furthermore, use of the conservative value of 5 is desirable because it will provide an estimate on the lower end of the population range and guard against over estimating population pressure on the subsistence base.

3.2.1 Morelos Polity

The vast majority of dwellings in the Morelos Polity (804) were part of house group clusters where ceramic surface collections indicate occupation during the time period of particular interest to this dissertation, the Late-Terminal Classic (A.D. 650-950). But many dwellings (548) were part of house group clusters which had Proto-Classic period (A.D. 100-250) surface ceramics (Table 3-7). One house group cluster with 13 dwellings had ceramic materials dating to the Late-Terminal Classic, Proto-Classic, and Formative periods (600 B.C. – A.D. 100). The population estimates in Table 3-7 and Table 3-8 were calculated using the following procedure. Each house group cluster was dated to the Late-Terminal Classic period, the Proto-Classic period, and/or the Formative period based on the surface collected ceramics. Next, the total number of dwellings per house group cluster was tabulated. Finally, the total number of dwellings per time period was multiplied by 5, the presumed average nuclear family size, to arrive at the total population per time period. Because the scarcity of surface ceramics during the survey prevented proveniencing materials to individual dwellings and house groups, the population figures for the Proto-Classic period are probably inflated because it is unlikely that all of the dwellings in each house group cluster containing Proto-Classic ceramic materials were in use during this time period. Alternatively, it is assumed that all dwellings were utilized that are part of house group clusters with ceramic material dating to the Late-Terminal Classic period due to the overwhelming predominance of Late-Terminal Classic settlements in the region (de Montmollin 1995). The Late-Terminal Classic represents the height of social complexity throughout the UGB with increased population marked by construction of many residential and civic-ceremonial structures. Because of the small number of dwellings associated with Formative period ceramics, no regional population density estimate was made. No evidence for Early to Middle Classic (A.D. 250-650) occupation was recovered during the survey. This is consistent with findings in other parts of the Upper Tributaries of the UGB which seem to indicate a hiatus in settlement during this time period (de Montmollin 1995: 41). Early Classic Maya occupation of the site of Ojo de Agua (Figure 2.1) is one exception, indicated most notably by a ballcourt which conforms to the Petén style. But numerous excavations throughout the UGB have failed to turn up much evidence for Early to Middle Classic dwellings or civic structures (de Montmollin 1995: 49). This lacuna in settlement is consistent with much of southeastern Mesoamerica during the period of time from about A.D. 100-500. Ecological explanations proposed for the hiatus include volcanic eruptions and drier climatic conditions (Dahlin et al. 1987) and earthquakes (Lowe 1977; 1982). A political explanation attributes the hiatus to a breakdown of elite interaction spheres (Demarest 1988). A more local explanation attributes the hiatus to the collapse of Terminal Formative Mizoque chiefdom centers in the region (de Montmollin 1995: 36-37, 49).

Table 3-7 Morelos Polity Population Estimates

	Late-Terminal Classic	Proto-Classic	Formative
Total Number of Dwellings	804	548	13
Number of People	4,020	2,740	65
Dwellings per km^2	43.3	29.4	N/A
Number of People per km^2	216	147	N/A
Total Area (km^2)	18.61	18.61	N/A

3.2.2 Clavo Verde Polity

For the 2005 survey of the Clavo Verde Polity, all dwellings (78) were part of house group clusters with ceramic materials dating to the Late-Terminal Classic period, and only 11 dwellings were part of house group clusters with evidence for Proto-Classic period occupation (Table 3-8). For the 1995 survey, all dwellings (846) were part of house group clusters with ceramic materials dating to the Late-Terminal Classic period with the exception of a few small settlements for which no ceramic material was recovered (a total of 81 dwelling structures) (Table 3-8). These structures were included in the Late-Terminal Classic period dwelling count and population estimate due to the overwhelming predominance of Late-Terminal Classic period settlements in the region, and due to the fact that such a small number of structures does not have a large impact on the overall results (de Montmollin 1997: 7). During the 1995 survey, evidence for Proto-classic period occupation was found in association with four dwelling structures adjacent to a civic-ceremonial complex (RV 466) (de Montmollin 1997: 7, 40). Population density is not estimated for the Proto-Classic because of the scarcity and isolation of settlement during this time period. No ceramic material dating to the Formative period was collected within the Clavo Verde survey boundary.

Table 3-8 Clavo Verde Polity Population Estimates

	Late-Terminal Classic	Proto-Classic	Formative
Total Number of Dwellings	924	15	N/A
Number of People	4,620	75	N/A
Dwellings per km^2	35.2	N/A	N/A
Number of People per km^2	176	N/A	N/A
Total Area (km^2)	26.24	N/A	N/A

3.2.3 Population Densities in Other Maya Zones

Population density figures for the Morelos and Clavo Verde polities were found to be comparable to estimates for other ancient Maya rural zones (Table 3-9), and are used in Chapter 4 to arrive at a reasonable estimate for the carrying capacity of both polities. But population density figures alone do not reveal much about the population pressure exerted on each polity's natural productive resources, and how many people could have been supported before the local carrying capacity was exceeded. The specific agrarian strategies applied to the natural environment must also be considered in conjunction with population figures in order to ascertain the relative need for intensive farming. In other words, regardless of the population density, the natural characteristics specific to each polity must be evaluated in order to determine how much food could have been produced, and if it would have been enough to feed the entire population during the Late-Terminal Classic climax. I have found that using long-fallow, swidden cultivation, the Late-Terminal Classic population in the Clavo Verde polity was below carrying capacity (maximum carrying capacity estimate is 8,384 people, population estimate is 4,620) (see Table 4-4). In the Morelos polity, applying the same agrarian strategy would have resulted in the Late-Terminal Classic population being over carrying capacity (maximum carrying capacity estimate is 3,200 people, population estimate is 4,020) (see Table 4-4). Given this, the need for intensive agricultural production would have been greater in the Morelos polity than in the Clavo Verde polity. In the Morelos polity intensive farming on terraces was used to bring more marginal zones into production. In the Clavo Verde polity, no agricultural terraces or other intensive farming features were found. This is not surprising given that enough food could have been grown to feed the entire population using extensive farming techniques alone. Explanation of how the agricultural productive potential and carrying capacity is calculated for each polity is provided in Chapter 4.

The following population density estimates for other Maya zones serve as benchmarks for comparison to the Morelos and Clavo Verde polities, and with the exception of the three examples from the Upper Tributaries of the UGB, all have been the subject of research aimed at explicating the relationship between population pressure and agricultural production (Table 3-9). Because of the enormous variation from case to case in areal coverage, only population density figures are provided.

Settlement surveys in the Maya lowlands have indicated that populations on arable land during the Late Classic period were remarkably dense (see Culbert and Rice 1990). Although urban population densities were very high, ranging from 500 to 1,000 people per km^2, rural populations were also large and exhibit a wide range of densities from as low as 6, to as high as 506 people per km^2 (Rice and Culbert 1990). Because of the relatively small scale of the settlements within the Morelos and Clavo Verde polities, especially when compared to the geographically vast and architecturally complex lowland "cities" like Tikal, Calakmul, Caracol, Copan, and Palenque, only rural population densities are provided here.

The approximately 314 km^2 rural periphery of Tikal, not including the urban core, had a Late Classic population density of about 153 people per km^2 (Culbert et al. 1990: 116-117). For the same time period, the population density of the 15.94 km^2 surveyed portion of Seibal's rural periphery is comparable at 144 people per km^2 (Tourtellot 1990: 84, 101-102, 30-31). In the Petexbatun region, Late Classic population densities of intersite zones surrounding Dos Pilas were 486 people per km^2 (O'Mansky and Dunning 2004: 96). On the southeast periphery of the Maya lowlands, Late Classic population densities in the Copan Valley outside of the Copan pocket were quite low ranging from 6 to 7.5 people per km^2 (Wingard 1996). Population densities inside of the Copan pocket are much higher. For the same time period, the rural population of the Copan pocket, that is to say, population within the pocket excluding the urban core, ranged from 407 to 506 people per km^2 (Webster and Freter 1990). For the central Peten lakes region Rice and Rice (1990: 143) estimate Late Classic rural population densities averaged 191 people per km^2.

Closer to the Morelos and Clavo Verde polities, population density estimates are now provided for three polities in the Upper Tributaries of the UGB systematically surveyed by de

Montmollin (1989b, 1995). The three polities, Rosario, Ojo de Agua, and Los Encuentros, are all within 20 km of the Morelos and Clavo Verde polities, and the population figures that follow are for the Late-Terminal Classic period. The Rosario polity covered an area of 52.4 km^2 and had an estimated population density of 397 persons per km^2. The Ojo de Agua polity covered 55.45 km^2 and had an estimated population density of 362 persons per km^2. Finally, the Los Encuentros polity had an areal extent of 25.99 km^2 and an estimated population density of 253 persons per km^2 (de Montmollin 1995: 55-56). The surveys of these polities did not yield much evidence for agricultural terracing, but settlement for all three is spread predominantly along the bottoms of valley floors where terracing is not likely to be found. Although de Montmollin (1989a, 1989b, 1995) focuses primarily on the political structure of these polities and not on agricultural production, the distribution of settlement appears to relate more to political dynamics and not to the distribution of the best soils for farming.

Table 3-9 Population Density Estimates for Selected Maya Rural Zones

Name	Time Period	Surveyed Area (km^2)	People per km^2	Source
Copan Pocket Rural	Late Classic	24	407-506	Webster and Freter (1990)
Dos Pilas Intersite Zones	Late Classic	20	486	O'Mansky and Dunning (2004: 96)
Xunantunich Rural and Urban	Late Classic	14	452	Ashmore et al. (2004: 307)
Rosario	Late-Terminal Classic	52.4	397 (373)*	de Montmollin (1995: 55-56)
Ojo de Agua	Late-Terminal Classic	55.45	362	de Montmollin (1995: 55-56)
Los Encuentros	Late-Terminal Classic	25.99	253	de Montmollin (1995: 55-56)
Morelos	Late-Terminal Classic	18.61	216	Present study
Central Peten Lakes Region	Late Classic	32.5	191	Rice and Rice (1990: 143)
Clavo Verde	Late-Terminal Classic	26.24	176	de Montmollin (1997); present study
Tikal Rural Periphery	Late Classic	11.5	153	Culbert et al. (1990)
Seibal Rural Periphery	Late Classic	15.94	144	Tourtellot (1990)
Copan Valley outside Copan Pocket	Late Classic	38	6-7.5	Webster and Freter (1990: 43, 52)

*Excludes population at Tenam Rosario, the capital civic-ceremonial center

As Maya lowland population grew throughout the Classic period, progressively greater demands would have been placed on the agricultural base that long-fallow, swidden cultivation alone could not have satisfied. Previous research has shown that as population density increased, the Maya responded by intensifying production (Chase and Chase 1998; Dunning and Beach 1994; Healy et al. 1983; Pope and Dahlin 1989). This intensification is evidenced by relict agricultural features such as terraces and raised- and drained-fields, but other, less archaeologically visible forms of intensification were most likely applied as well such as multi-cropping, fallow shortening, and infield cultivation (Killion 1992; Nations and Nigh 1980; Rice 1978, 1993; Sanders 1973; Tourtellot 1983, 1993). Whether these intensive forms of production in conjunction with long-fallow swidden cultivation could have produced enough food to provision the Late Classic populations during the period of their greatest density has been a topic of much debate (Culbert 1988: 95; Scarborough 1993: 25; Webster 2002). This issue is examined in greater detail in Chapter 4 where maize production derived from long-fallow swidden cultivation and intensive production within settlements and on terraces is compared to the nutritional requirements of the Late-Terminal Classic population peaks in both the Morelos and Clavo Verde polities.

3.3 CIVIC STRUCTURES AND CIVIC HIERARCHY

3.3.1 Civic Structures

In addition to the dwelling structures described above in Section 3.1, a variety of civic structures were also recorded during the survey. The civic structures recorded during the survey are divisible into four basic types: 1) civic altars, 2) ballcourts, 3) pyramids, and 4) range structures (as described in Section 3.1, range structures are interpreted as having civic and residential functions). The identification of ballcourts, pyramids, and range structures is of particular interest because they serve as the basis for the development of the civic hierarchy presented below in Section 3.3.2.

1) Civic altars are small, square-shaped structures less than 3 m in length located adjacent to pyramids or ballcourts. Civic altars are most likely small platforms upon which ceremonial activities were performed and offerings made. Thus, altars are interpreted as having served a ritual function. Although the possibility exists that some structures identified as altars may have served other functions, domestic or otherwise, a more nuanced interpretation requires additional research and is beyond the scope of this study.

2) Ballcourts were perhaps the most easily identifiable structure type during the survey. Characterized by two parallel ranges, ballcourts were found to be minimally 16.5 m in length and maximally 23 m in length (Figure 3-3). Ballcourts were probably arenas for playing a ceremonial rubber ballgame and are interpreted as having ritual significance (Freidel 1992: 107-111; Miller and Houston 1987; Schele and Mathews 1998: 210-213).

Figure 3-3 Ballcourt at Morelos Polity Capital (MR 57) Facing East

3) Pyramids are identified as large, squarish basal platforms with inward sloping walls and relatively great height (Figure 3-4). The long axis of pyramids recorded in the survey range from 8.5 m to 27 m, and from 2 m to 9 m in height. Pyramids were likely the focal points of political and ritual activities.

Figure 3-4 Pyramid at Morelos Polity Capital (MR 57)

4) Range structures are the longest structures in the region not including pyramids and ballcourts, and are defined as dwellings 11 m in length or greater (see Section 3.2 for discussion of dwelling lengths). Range structures have been interpreted as special elite residences which also doubled as administrative buildings, perhaps as council houses (Carmack 1981; Christie 2003: 5; de Montmollin 1989b: 51; 1995: 66). Range structures oriented onto civic plazas are used here in the development of the civic hierarchy. Range structures oriented onto civic plazas might represent palaces as it is assumed that those who inhabited these large structures enjoyed access to the elite-related activities presumed to have taken place on civic plazas, and would have been of considerably higher standing than those who lived in smaller dwellings away from

civic plazas. Although there is considerable disagreement over the morphological definition of palaces (see for example Christie 2003), in Maya studies palaces have typically been defined as large, range-type, vaulted masonry multi-room structures (Kowalski 2003: 204). Here, length is used as the distinguishing characteristic as preservation of structures was generally not good enough to permit recording other detailed architectural features.

The civic structure counts (Table 3-10) result from the efforts of two independent regional survey projects: the 1995 survey of the San Lucas River Valley by de Montmollin (1997: Cuadro 7 and Cuadro 12), and the 2005 survey of the Morelos Piedmont and the eastern and southern margins of the San Lucas Valley conducted by the author. The 1995 survey covered 27.5 km^2 and resulted in the delineation of two Late-Terminal Classic period polities named Concepción and Clavo Verde. The Clavo Verde polity, which is of particular interest in this study, covers an area of 17.91 km^2 (de Montmollin 1997). The 2005 survey extended the area covered by the 1995 survey by 8.33 km^2 encompassing the eastern and southern margins of the Clavo Verde polity. Additionally, the 2005 survey documented the core of the Morelos polity in the Morelos piedmont zone covering 18.61 km^2.

Table 3-10 Polity and Clavo Verde Polity Late-Terminal Classic Period Civic Structures

Civic Structure Type	Morelos Polity Total	Clavo Verde Polity 1995 Survey	Clavo Verde Polity 2005 Survey	Clavo Verde Polity Total
Pyramids	25	19	1	20
Ballcourts	6	3	1	4
Range Structures	44	12	1	13
Altars	10	2	0	2
Total	41	24	2	26
Survey Area in km^2	18.61	17.91	8.33	26.24

3.3.2 Civic Hierarchy

A civic hierarchy has been defined for each polity to permit comparison of the distribution of elites at civic centers, to those away from civic centers. In Chapter 5, these distributions are examined, and compared to the distribution of elites in relation to agricultural terraces, in order to assess the relationship of elites to the organization of intensive agricultural production on terraces.

The criteria used to develop the civic hierarchy for the Morelos polity (Table 3-12) and the Clavo Verde polity (Table 3-13) are listed in Table 3-11. They are based on the number of different civic structures (ballcourts, pyramids and range structures) that form civic plazas. This approach was taken because it permits a reasonable delineation of the civic hierarchy based on the nature of the data collected. During the survey civic structures were well-enough preserved to permit their identification as either ballcourts, pyramids or range structures. A greater variety of building types at a plaza indicates a greater diversity of political activities (de Montmollin 1995: 77; Schortman 1986: 124-125). Therefore, ranking civic centers according to the number of different civic structure types at civic plazas represents a reasonable starting point for delineating each polity’s civic hierarchy. A distinguishing characteristic of the capital civic center and all five of the second-tier civic centers is that each contains at least one civic plaza bordered by a minimum of one ballcourt, one pyramid, and one range structure. No other centers in the civic hierarchy possess a ballcourt. Despite this similarity shared by all five of the second-tier civic centers and the capital civic center, MR 57 has been classified as the capital because, using a locational criterion, it is situated near the center of the Morelos polity.

Table 3-11 Criteria for Development of Civic Hierarchy

Tier	Attributes
Capital	One civic plaza* with at least one ballcourt, pyramid and range structure. Central location.
2	One civic plaza with at least one ballcourt, pyramid and range structure.
3	One civic plaza with two or more pyramids or range structures. No ballcourt.
4	One pyramid or range structure. No civic plaza. No ballcourt.
5	No civic structures.
*Civic plaza is defined as an open, central space surrounded by two or more ballcourts, pyramids or range structures.	

Table 3-12 Morelos Polity Late-Terminal Classic Period Civic Hierarchy

Tier	Count	Designation
Capital	1	MR57
2	5	MR5, MR18, MR24, MR46, MR62
3	7	MR4, MR8, MR28, MR55, MR59, MR61, MR64
4	5	MR3, MR14, MR43, MR54, MR63
5	19	MR1, MR2, MR9, MR10, MR12, MR13, MR15, MR23, MR26, MR27, MR32, MR34, MR35, MR40, MR45, MR53, MR65, MR67, MR69

Table 3-13 Clavo Verde Polity Late-Terminal Classic Period Civic Hierarchy

Tier	Count	Designation
Capital	1	RV450
2	3	CV5, RV416, RV457
3	6	RV447, RV449, RV454, RV477, RV289, RV 466
4	6	CV2, RV418, RV448, RV285, RV286, TR163
5	41	CV1, CV4, CV6, CV7, CV8, CV9, CV10, CV11, RV409, RV410, RV411, RV412, RV415, RV417, RV419, RV420, RV421, RV422, RV424, RV425, RV426, RV427, RV446, RV451, RV452, RV453, RV455, RV456, RV458, RV459, RV460, RV461, RV462, RV463, RV464, RV465, RV470, RV472, RV474, RV475, RV478
RV and TR designation indicates recorded during the 1995 survey; CV indicates recorded during the 2005 survey.		

The survey data collected represents civic structures in their final forms and does not yield information about construction phases. Basing the civic hierarchy on the number of ballcourts, pyramids and range structures that form civic plazas avoids problems associated with a volumetric approach in which the size of a civic building is taken as a reflection of the labor needed for construction and, by extension, a ruler's ability to mobilize the needed labor. In this approach the problem of equifinality looms large. Different civic buildings of about the same size may have been built in different numbers of stages. However, the problem of equifinality can be bypassed if the labor required for upkeep of the building's final size is used rather than that required for construction. Given two differently sized civic buildings, the larger building would require more labor for its upkeep than the smaller building, and the number of construction phases is irrelevant. In this way, building size can be interpreted as an indicator of a particular ruler's ability to project propaganda about his own power and authority (de Montmollin 1995: 75). Conceptualizing civic volumes in this way represents a potentially fruitful approach that may be useful in future studies of the region aimed at further refining the civic hierarchy.

The political territories of the Morelos and Clavo Verde polities are defined by the distribution of civic structures and plazas in relation to natural topographic features. The Morelos polity is bordered on the north, west, and northeast by high ledges and hills which can be equated with the polity's boundaries (Figure 2-4, Figure 3-5). The polity's capital civic center (MR 57) is situated upon a hilltop near the center of the polity in the intermediate rugged zone sandwiched between two zones of relatively flat land good for extensive farming (the environmental micro-zones of the Morelos Piedmont are defined in Chapter 4). From its hilltop perch, MR 57 enjoys a commanding view of nearly all parts of the core of the polity (Figure 3-7). Of the polity's five second-tier civic centers two, MR 24 and MR 18, are located in the slopes of the northwestern portion of the polity. MR 24 is on the northwestern edge of the polity and is bordered on the western side by a deep ravine forming a formidable natural boundary. MR 18 is situated upon a hilltop less than 1 km southeast of MR 24. MR 5 is located in the north-central part of the polity in the intermediate rugged zone on gently sloping terrain. The two remaining second-tier civic centers, MR 46 and MR 62, are situated in best extensive farming zones. MR 46 is in the western portion of the polity and is surrounded by relatively flat terrain good for farming. MR 62 is located near the southeastern edge of the polity on flat terrain which the locals say is some of the best agricultural land in the zone. To the south and southwest, the Morelos polity is bounded by hilly ground that separates it from the upper ends of the Rosario and Concepción polities (Figure 3-7). There are no clear topographic breaks to the southeast of the polity where relatively flat terrain runs all the way to the Mexico-Guatemala international border. With no discernable topographic features in this zone, a break in population distribution which might represent a political buffer zone would be a useful indicator of where the polity's boundary was located. Light reconnaissance of the zones to the south and east did not result in the documentation of settlements. But, because these zones have not been systematically surveyed it is impossible to say with certainty that the Morelos polity does not extend beyond the limits of the 2005 survey boundary.

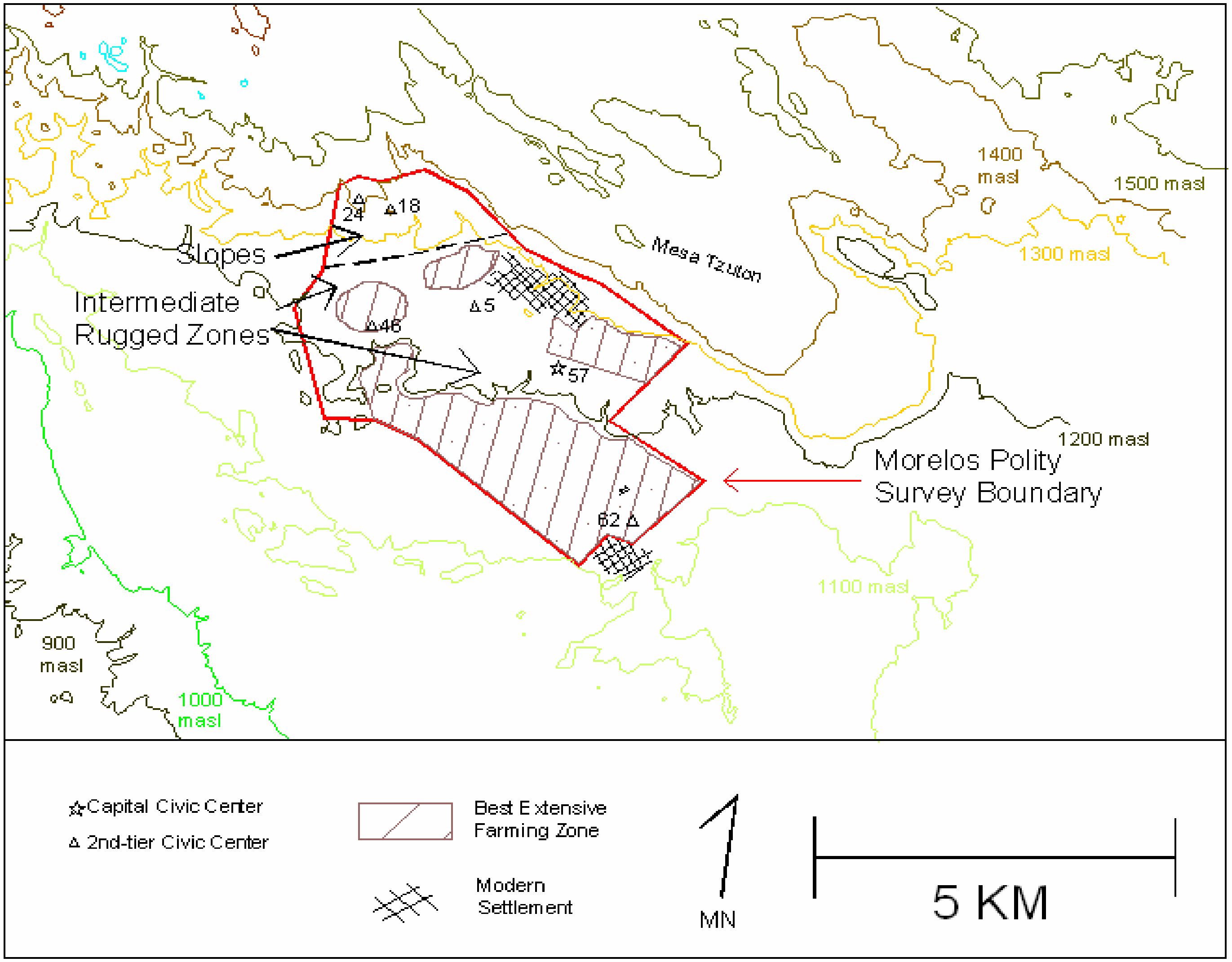


Figure 3-5 Morelos Polity Late-Terminal Classic Period: Polity Capital and Second-Tier Civic Centers

Figure 3-6 Hilltop Setting of Morelos Polity Capital (MR 57)

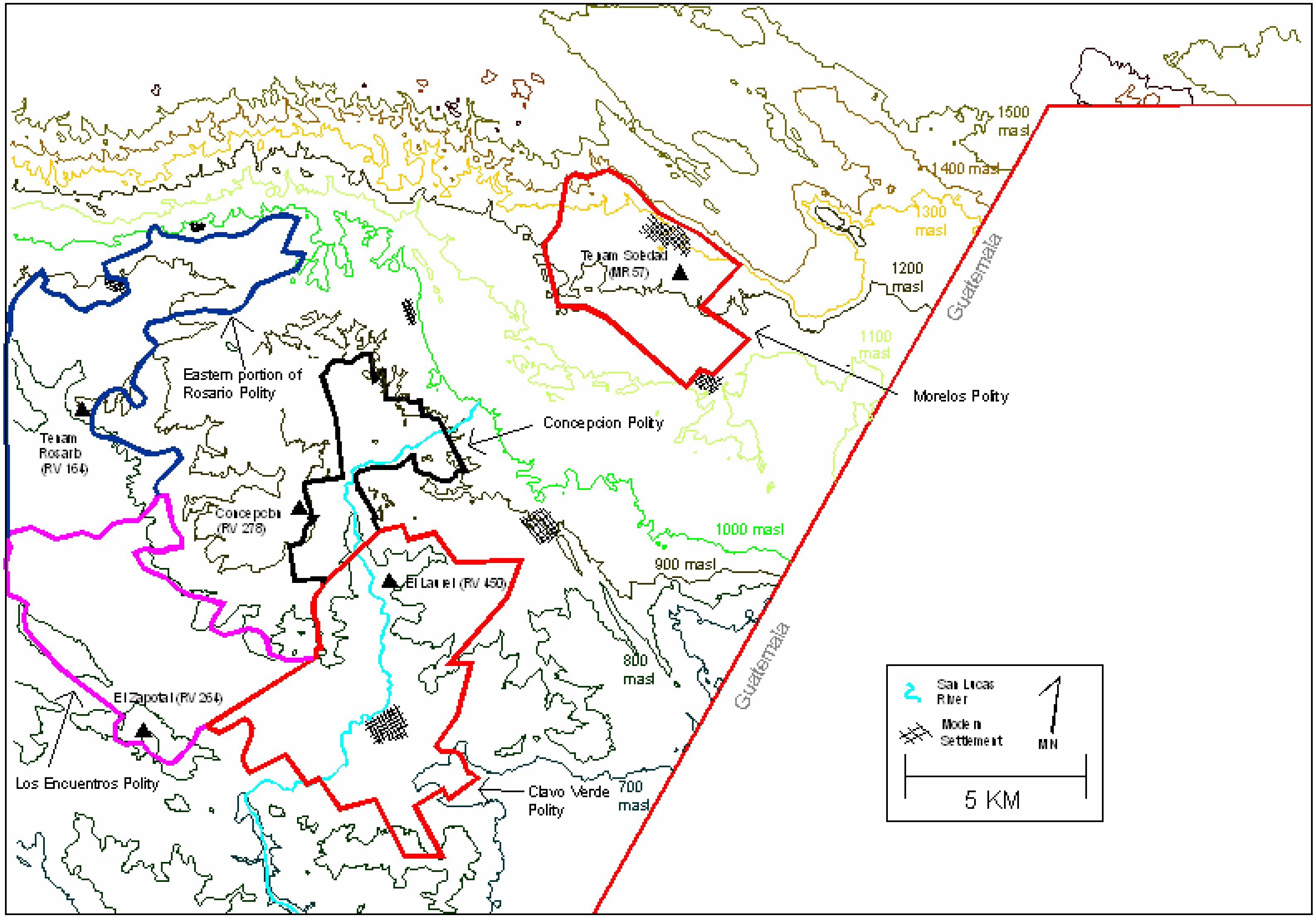


Figure 3-7 Selected Survey Boundaries and Polity Capitals in the Upper Tributaries of the Upper Grijalva Basin

The Clavo Verde polity is defined primarily by the course of the San Lucas river which flows through the core of the polity (Figure 2-5, Figure 3-8). The vast majority of settlement is confined to the relatively flat valley floor which extends away from the river on the eastern and western sides. The valley is bordered on the east, south, and west sides by small hills rising to between 50 m and 100 m above the valley floor forming a natural boundary for the polity. To the north, a series of small hills separate the Clavo Verde polity from the southern limit of the Concepción polity (de Montmollin 1997). De Montmollin (1997: 4) has divided the Clavo Verde polity into two districts, north and south, based on a natural boundary created by a jog in the San Lucas River where it changes course, and on the scarcity of settlement in gently sloping terrain on the southwestern portion of the survey zone (Figure 3-8). However, the majority of settlement is concentrated in the northern district, especially near the capital civic center, RV 450.

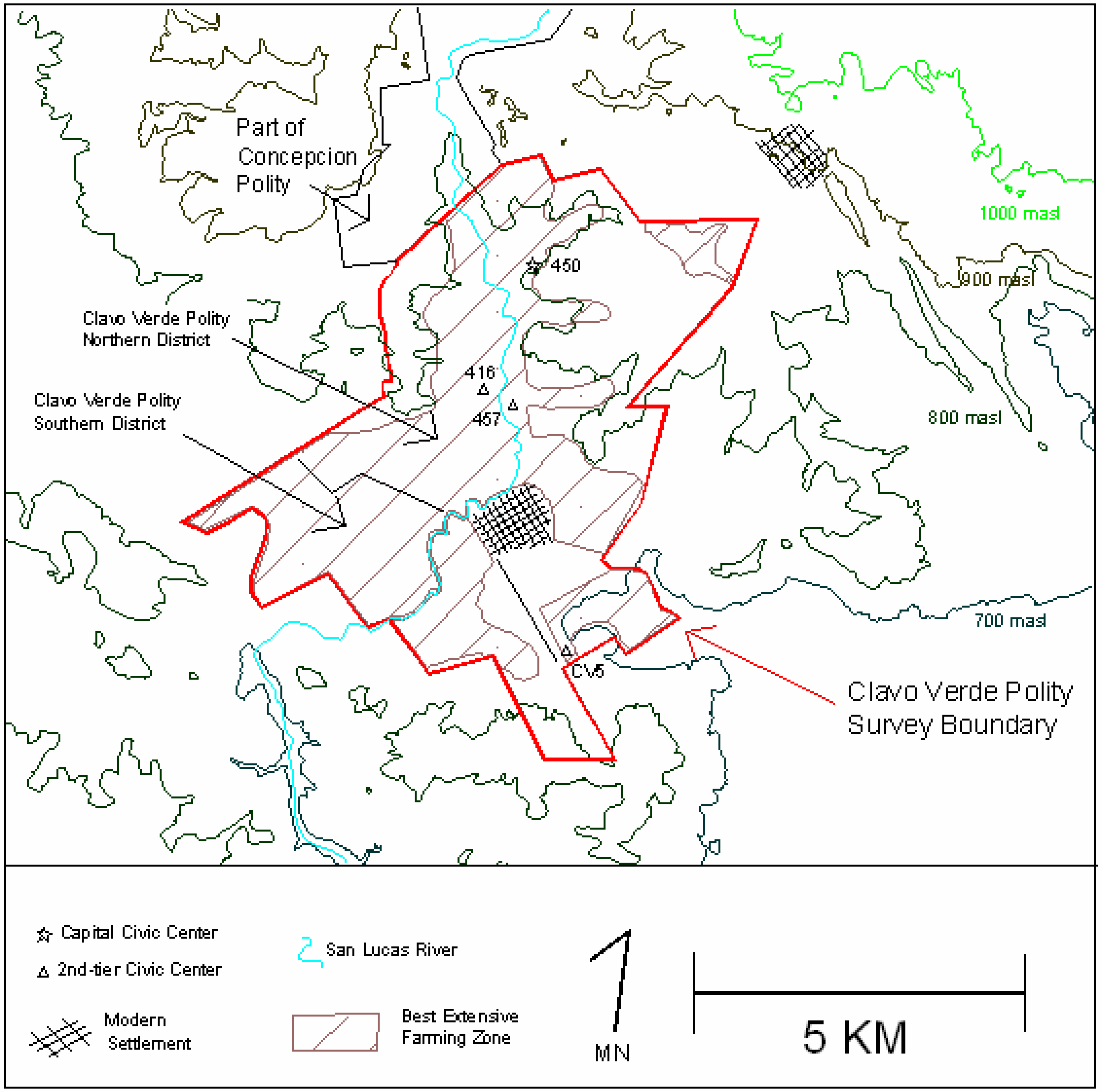


Figure 3-8 Clavo Verde Polity Late-Terminal Classic Period: Polity Capital and Second-Tier Civic Centers

4.0 NATURAL SETTING, AGRICULTURAL TERRACES, CARRYING CAPACITY, AND MAIZE PRODUCTION AND CONSUMPTION

4.1 THE NATURAL SETTING

Comparison of the natural environments of the San Lucas River Valley and Morelos Piedmont is related to the relative need for intensive agricultural production in each zone. Environmental variables such as climate, hydrography, and the distribution of soils good for farming all influence the long-fallow, swidden productive potential of each zone, and therefore factor strongly in the calculation of carrying capacity estimates. The Clavo Verde polity is situated in the San Lucas River Valley where the flat valley floor and alluvial deposits along the river results in the extensive distribution of soils good for farming. This level terrain suggests good water retention of soils and low risk of erosion. In addition to seasonal rainfall, the San Lucas river would have provided a year-round water source to nourish crops. The Morelos polity is situated on a ledge in rugged, upland terrain. The lack of reliable water sources and the sloping, erosion-prone topography would have presented distinct challenges to farmers unlike those faced in the Clavo Verde polity. Soils good for farming are dispersed throughout the Morelos Piedmont occurring in a few isolated pockets, and one relatively large expanse, of flat, cultivable land among a predominantly stony, sloping hillside with poor water retention and high risk of erosion. With no perennial water source, farmers would have had to rely solely on seasonal rainfall. The Morelos Piedmont has been divided into three micro-zones based on topography and distribution of flat-lying soils: slopes, intermediate rugged, best extensive farming zones. The San Lucas Valley has been divided into two micro-zones: best extensive farming zones and less desirable rugged.

4.1.1 Climate

The climate of the Upper Tributaries of the UGB has been classified as Tropical Savanna with a marked seasonality defined by a wet and dry season. Altitude in the San Lucas River zone ranges between 600 – 900 masl, and in the Morelos Piedmont zone between 1,100 – 1,400 masl (Figure 2-2). The mean annual temperature in both zones is 24° C and frost is rare (Echeagaray 1957; INEGI 1984). The relatively warm, year-round temperature and low risk of frost result in favorable conditions for maize cultivation.

Typically, rainfall is high from June through July and decreases throughout August until climaxing in September and early October. The question of whether there was enough precipitation during the Late-Terminal Classic period to support extensive agricultural production is of particular interest in the present study. The relative ability of the inhabitants in both zones to support themselves through long-fallow swidden cultivation on the best agricultural lands relates directly to the need to expand cultivation into the less productive slopes, potentially using terraces to help bring this marginal land into production. Therefore, climatic conditions favorable to maize cultivation would have been important to the ancient inhabitants of both the Morelos Piedmont and San Lucas Valley.

Successful cultivation of maize requires a minimum of about 500 mm of rainfall during the growing period (Wellhausen 1957). Although paleo-climatic data is currently unavailable for the UGB, contemporary rainfall figures indicate that this minimum requirement would have been comfortably met. Within the survey zones, the annual precipitation varies from about 875 mm in the south, to just over 1,000 mm in the north (Figure 4-1) (INEGI 1984). There are, on average, 125 days of rain per year, but this number varies widely from one year to the next (Echeagaray 1957; INEGI 1984). Although year-to-year fluctuations in the amount and frequency of rainfall were probably common during the Late-Terminal Classic period, the absence of paleo-climatic data makes it impossible to estimate how widely annual precipitation varied. Here, estimating the annual variability of rainfall is less important to the calculation of a hypothetical maximum carrying capacity than is the demonstration that, on average, there would have been enough precipitation to support long-fallow swidden cultivation. Although concern about the amount of annual rainfall is a popular topic among contemporary farmers in both zones, when asked none could recall a time when rainfall was so scarce that the maize yield was so low as to affect their subsistence requirements and production of surplus for cash crop.

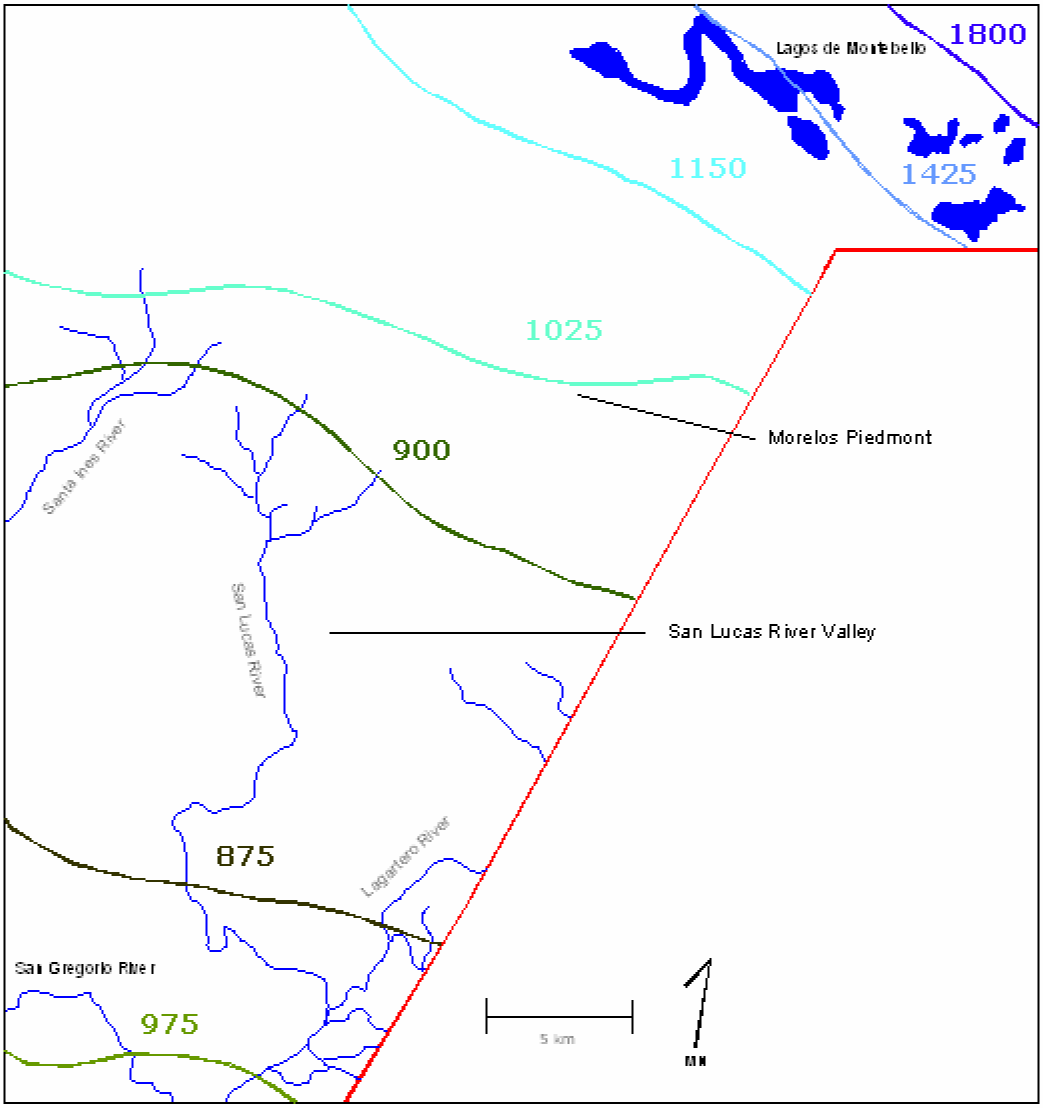


Figure 4-1 Regional Average Annual Rainfall (mm)

Paleolimnological study of the paleoclimate of the Maya lowlands has determined that regional drying began about 3,000 years ago, and that the past three millennia were characterized by variable moisture availability (Brenner et al. 2002). Furthermore, these studies found that drought events over the past 2,600 years were cyclical, occurring approximately every two centuries, with the driest period occurring between A.D. 800 – 1,000, coincident with the Terminal Classic Maya collapse (ibid.). One possibility is that deforestation in the tropical forest zones of the southern Maya lowlands affected the regional climate (ibid.: 152). Human-induced deforestation appears to have begun about 3,000 years ago (Rosenmeier et al. 2002) and is evidenced by a thick, inorganic, fine-grained deposit popularly referred to as "Maya Clay" in the sedimentary record of lakes in the region (Brenner et al. 2002: 146). This evidence for deforestation generally coincided with early agricultural activity in the region (Rice and Rice 1983; 1990). The Maya Clay would have been deposited in lake beds as agricultural activity intensified. With more land cleared for slash-and-burn farming, presumably to feed the growing Classic period Maya population, surface soils would have been exposed and vulnerable to erosion. Evidence for forest regrowth is not found until after about A.D. 850, roughly equivalent with the Terminal Classic collapse, but the exact timing and cause of reforestation in the southern Maya lowlands remains uncertain (Brenner et al. 2002: 152). Recent paleoclimate investigations at distant locations, in the Yucatan Peninsula, Haiti, and Venezuela, suggest that climatic drying began about 3,000 years ago, indicating that this climatic trend probably occurred on a regional scale (ibid.: 152). Whether widespread human land clearance in the Maya lowlands affected regional climate remains uncertain, and whether the climatic trends identified by paleolimnologists would have impacted the Late-Terminal Classic inhabitants of the UGB is unknown. The Lagos de Montebello, a closed-basin lake system located on the Comitan plateau about 10 km north of the core of the Morelos Piedmont, represents a potential future research site for paleolimnological study.

4.1.2 Hydrography

In addition to seasonal rainfall, numerous water sources were recorded during the survey and would have served as important resources for both farming and drinking purposes. The San Lucas river would have provided a year-round water source to the ancient inhabitants of the Clavo Verde polity. The San Lucas river is a tributary of the Lagartero and San Gregorio rivers to the south (Figure 4-1, Figure 4-2). The San Lucas river meanders through the core of the polity and has deep banks but relatively shallow waters. The river would have provided a valuable source of water for farming and drinking.

Local inhabitants of the San Lucas Valley said that on occasion during the rainy season the river breaches its banks flooding the flat adjacent terrain and leaving behind a fine, silty sediment good for cultivating maize. But this only happens during prolonged periods of especially heavy rainfall, and does not appear to be an annual event that would have reliably replenished the nutrient supply of soils along the floodplain. Due to the relatively deep channel, the irrigation potential is limited and no evidence for irrigation was noted during the surveys.

The San Lucas river would have also provided a valuable, year-round source of drinking water. Although water flow is reduced during the dry season, local inhabitants could not remember a time when the river dried-up completely.

Figure 4-2 The San Lucas River

In the Morelos polity there is no perennial water source, therefore farmers would have had to rely solely on seasonal rainfall. A series of intermittent streams which carry run-off water from the steep escarpment on the northern edge of the polity drain onto terraced lands which check the flow of water and trap eroding soils (see for example MR 54, MR 28, and MR 40 & 52 in Appendix A). These streams would have been important sources of water for nourishing crops during the rainy season, but during the dry season they are completely devoid of water. Seasonal streams also flow through three deep crevices located in the northwestern portion of the polity, one crevice located in the north-central part of the polity, and one smaller crevice in the southeastern portion of the polity (Figure 4-3). These crevices swell with water in the rainy season, but because they cut deeply into the earth and are surrounded by steeply sloping terrain on all sides they would have been difficult to exploit for agricultural purposes. Although some pooling of water in natural depressions within the crevices was noted during the survey, this occurrence is rare and they are mostly dry during the dry season.

A few natural, low-lying depressions were noted during the survey and could have played a role in agricultural production. Low-lying depressions recorded near MR 14, MR 46, MR 54, and MR 62 (see Appendix A) could have been used for recessional farming (Figure 4-3, Figure 4-4). These natural depressions inundate with water during the rainy season, but it’s possible to cultivate maize on the relatively rich, organic soils left behind as the water recedes during the dry season. These depressions were found to range between 0.1 and 1 m in depth and between just over 3,000 and 14,000 m^2 in area, and therefore are generally too small to have provided much in the way of bulk staples. But they may have provided a reliable source of fertile farm land to supplement the food supply of the local populations.

A low-lying zone near MR 28 is referred to locally as *la cieneguilla* (the marsh or swamp) (Figure 4-3). During the rainy season, this zone lives up to its’ name filling shallowly with water and scrub-like vegetation. But during the dry season the water evaporates leaving behind a hard, cracked surface that is difficult to work and therefore not good land for farming according to the local inhabitants.

In addition to the seasonal streams, natural depressions, and swamp described above, two waterholes and a walk-in-well were recorded during the survey and could have provided important sources of drinking water. Two waterholes were noted near MR 28, one of which is used by the contemporary residents of Morelos. Both fill with water during the rainy season, but nearly dry-up completely during the dry season. Although it is unknown if one or both of these waterholes existed during the Late-Terminal Classic period, they could have provided a supplementary water source to the nearby swamp.

At MR 24, which is situated high in the hills on the western edge of the polity remote from any low-lying zones, a walk-in well was recorded (Figure 4-5). The well measures 7 m in diameter at the top, and each row is smaller in diameter as the well does down, forming a steeply sloping stepped cone. This well is similar to the two wells recorded at the site of Pueblo Viejo de Los Limones in the Upper Grijalva Basin which were dated to the Late Classic period (Matheny and Gurr 1979: 445, Figure 4).

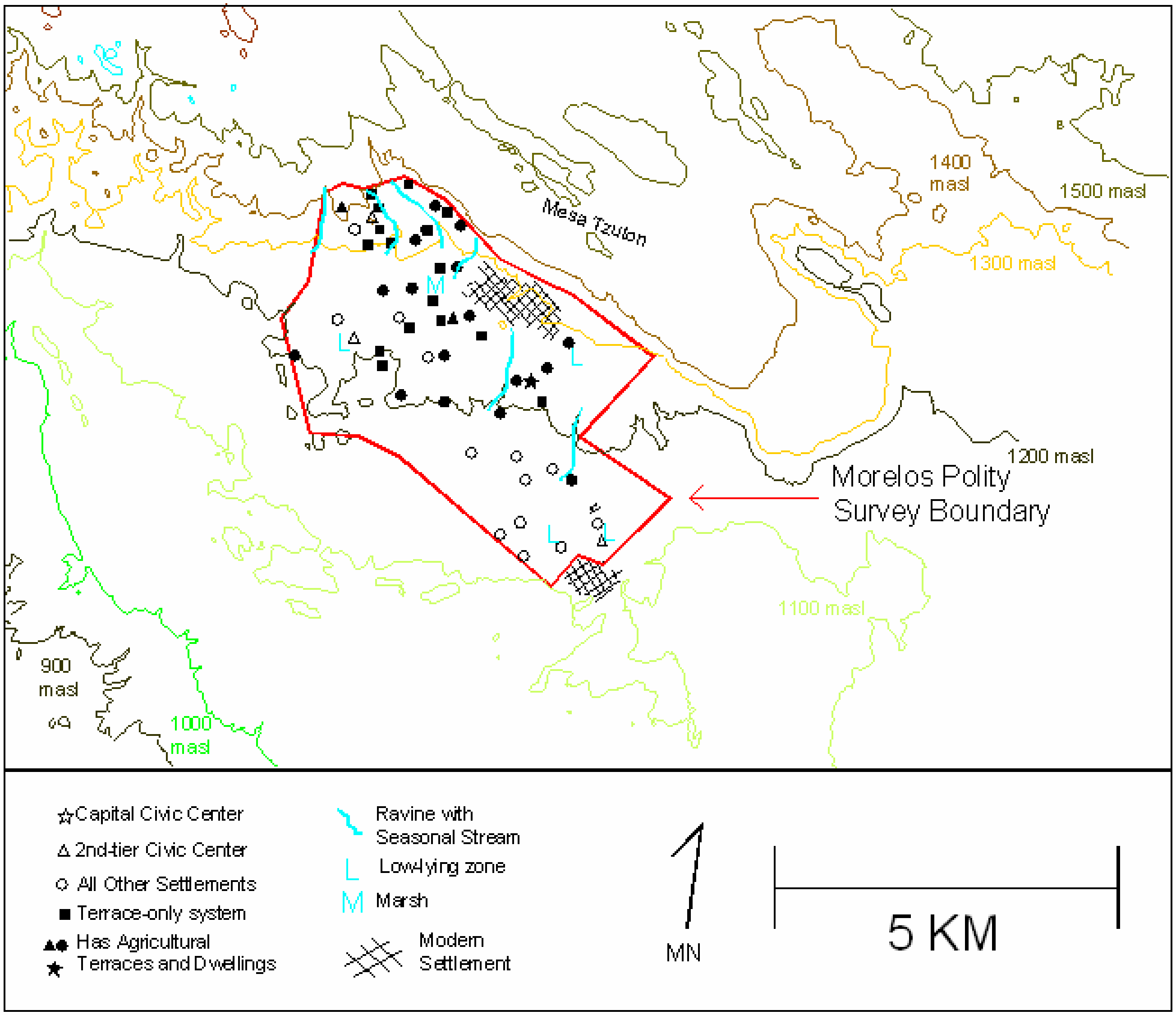


Figure 4-3 Morelos Polity Late-Terminal Classic Period: Location of Seasonal Water Sources

Figure 4-4 Low-lying zone at MR 46 filled with water after a rain storm

Figure 4-5 Walk-in well at MR 24

4.1.3 Phytogeography

The phytogeography of the state of Chiapas has been comprehensively documented by Breedlove (1973) and Miranda (1952, 1975). But these accounts are too general for examination of the distribution of vegetation formations in the Morelos Piedmont and San Lucas River Valley. The vegetation formations of much of the Upper Tributaries of the UGB were mapped by Voorhies (1984 – see Appendix E). Voorhies' survey included the San Lucas River Valley but stopped just short of the Morelos Piedmont. That study, as well as vegetation formations mapped during the present survey, are used here.

Voorhies (1984) identified eight vegetation formations within the Upper Tributaries of the UGB: Tropical Deciduous Forest, Riparian Forest, Evergreen Seasonal Forest, Palm Forest, Herbaceous Marsh, Short Tree Savanna, Pine-Oak Forest, and Grassland. The most widespread formation is Tropical Deciduous Forest, a warm climate forest commonly found where a fairly long dry season occurs. The primary factors affecting the presence of other vegetation formations throughout the basin are differences in soil nutrients, the amount of water and degree of drainage (ibid.: 17). Therefore, because of the fundamental importance of soil characteristics, water, and drainage to successful maize cultivation, the distribution of particular vegetation formations might yield clues as to the relative degree of fertility for agricultural production and aid in the identification of the best agricultural zones. Evergreen Seasonal Forest, for example, occurs in zones with deep soils that are well-watered and well-drained (ibid.: 9-11). Deep soils, abundant moisture, and adequate drainage so as not to saturate crops are all favorable conditions for maize cultivation. Palm Forest, on the other hand, forms where soils are deep and water is abundant but drainage is poor (ibid.: 14-15). The presence of this formation might indicate poor agricultural land because of water inundation. Unfortunately, the vast majority of vegetation in both survey zones has been cleared for farming or grazing and therefore do not represent primary formations that can be linked to the natural productive potential of the landscape.

In the Morelos Piedmont, the primary vegetation formations are Grasslands and Tropical Deciduous Forest, although most of the zone has been cleared for farming. Grasslands predominate over much of the central, southern, and eastern portions of the zone. Grasslands are typically the result of human interference with the climax vegetation (Voorhies 1984: 17-18), especially clearing for cattle grazing. Tropical Deciduous Forest is confined mostly to the hilly northwestern portion of the zone where the undulating topography makes it more difficult to clear for pasture or farming. This zone is too hilly to be considered part of the Morelos Piedmont's best agricultural lands. Tropical Deciduous Forest forms on rocky or shallow soils which are generally poor for farming (Miranda 1975: 84).

In the San Lucas River Valley, much of the vegetation has been cleared for farming or pasture, but Short Tree Savanna is found in some zones near the river (see Appendix E). Short Tree Savanna commonly forms on deep, poorly drained soils on gradually sloping plains or flat bottomlands (Breedlove 1973: 159). But, it is often difficult to distinguish between primary Short Tree Savanna formations and Tropical Deciduous Forest that has been thinned due to human activities (Voorhies 1984: 13). Miranda (1975: 95) believes that much of the savannas recorded throughout Chiapas were once vegetated by Tropical Deciduous Forest.

As described above, most of the survey zones consist of lands cleared for farming or grazing, and primary vegetative growth is a rarity. Furthermore, the present day distribution of plant communities cannot be taken to represent those of the ancient environments to which inhabitants of the UGB would have adapted. An in-depth study of paleoenvironments in the

UGB is required to determine how closely the present day distribution approximates ancient conditions, and such a study is not presently available. Therefore, the distribution of vegetation formations offers little value in assessing the agricultural productive potential of the these two zones, at least until such a time when paleoecological data are in hand.

4.1.4 Best Extensive Farming Zones, Slopes, and Intermediate Rugged Zones

Soil classification is relevant to the present study for determining which parts of each survey zone would have been best for extensive farming. Presumably, the Late-Terminal Classic inhabitants of the Morelos Piedmont and San Lucas River Valley would have concentrated their farming efforts on the best agricultural lands first (as is the case in the region today), shifting cultivation to less productive zones only after the productive potential of the best lands was eclipsed due to depletion of soil nutrients, population growth, or a combination of the two.

Edaphic maps of the State of Chiapas indicate that three primary soil formations are found in the survey zones: luvisols, vertisols, and lithosols (SSP 1981). But the coarse scale of 1:1,000,000 makes it impossible to tie particular formations to specific features within the survey zones. Luvisols and vertisols are both generally considered good for farming, whereas lithosols are considered poor. But absolute productivity figures cannot be assigned to each soil class. Local characteristics such as slope, soil depth and amount of rainfall are important factors that must be considered in order to assess each formations relative productive potential.

Luvisols have an accumulation of clay in the subsoil. They are found in temperate and tropical rain zones where the natural vegetation is jungle or forest. Their mixed mineralogy, high nutrient content, and good drainage make them suitable for a wide range of agriculture, but their susceptibility to erosion is high (FAO 2004).

Vertisols are hard, clayey soils typically found in temperate and hot climates with a marked dry and rainy season. Wide, deep fissures in the soil occur during the dry season. They are good for farming with adequate rainfall or irrigation but require large energy input, especially where traditional methods are used. The natural vegetation is variable and susceptibility to erosion is low (FAO 2004).

Lithosols are found in all climates and with diverse types of vegetation. The surface layer of the soils is a mixture of crushed stones with some slightly humisified earth. They are soils with little depth and are susceptible to erosion depending on the slope of the terrain, the risk being moderate to high. They are poor for agriculture (FAO 2004).

Because soil samples were not collected during the survey, and detailed edaphic studies of the zones have not been undertaken, less precise methods were used to provide a simplified classification of the land. The terrain within the San Lucas Valley survey zone is divided into two classes based on slope and amount of bedrock protrusions. Relatively flat-lying soils on slopes less than 10 percent grade and with minimal bedrock protrusions (less than 90 percent of the landscape) were classified as best extensive farming zones. Soils on slopes greater than 10 percent grade and/or with ubiquitous bedrock protrusions (greater than 10 percent of the landscape) were classified as less desirable rugged zones. This simplified methodology was also used in the Morelos Piedmont to distinguish between zones good for farming, and those poor for farming. Additionally, local farmers in both zones were informally interviewed to learn about the location of the best agricultural lands. This information was used to confirm the observations about slope and bedrock, and is reflected in the maps of the distribution of best extensive farming zones (Figure 4-6 and Figure 4-7). The total area of best extensive farming zones within the survey zones was found to be 800 ha in the Morelos Piedmont, and 2,096 ha in the San Lucas Valley.

In the Morelos Piedmont, the terrain has been further divided into three micro-zones based on the local topography and amount of bedrock protrusions (Figure 4-6). The first is *best extensive farming zones* based on the criteria described in the previous paragraph. The second is *slopes* which refers to the extremely hilly, sloping terrain of the northwest portion of the survey zone. And the third is *intermediate rugged* which refers to zones which are not as undulating as the slopes, but generally have a large amount of bedrock protrusions and stony terrain which results in conditions poor for farming. The word "intermediate" is used because these zones are generally confined between the slopes and best extensive farming zones. All three of the zones can be ranked according to their value for extensive farming:

1) *Best extensive farming zones* which, as the name implies, are best for extensive farming because of the relatively flat-lying soils with few bedrock protrusions and stony terrain.
2) *Intermediate rugged* which is not as good as best extensive farming zones for cultivation due to its stony nature, but is better than the slopes because it is not as undulating.
3) *Slopes* which are the poorest farming zones because of extremely undulating, hilly terrain.

A similar classificatory system was not applied to the San Lucas Valley because there is no equivalent to the slopes found in the Morelos Piedmont. Portions of the San Lucas Valley not categorized as best extensive farming zones conform most closely to the intermediate rugged category as they are characterized by ubiquitous bedrock protrusions and/or moderately sloping terrain. Although more detailed information about soil characteristics is desirable and would almost certainly result in a more accurate estimate of the amount of land deemed best for extensive farming, the classification of agricultural lands using the methods described above is meant to provide a reasonable estimate of the amount of best extensive farming zones available to the Late-Terminal Classic inhabitants of both polities, and represents a starting point for future investigations concerned with the agricultural productive potential of the region. This information is used in the forthcoming analyses to calculate estimates for how much food could have been grown using extensive farming techniques before cultivation of more marginal zones would have been necessary.

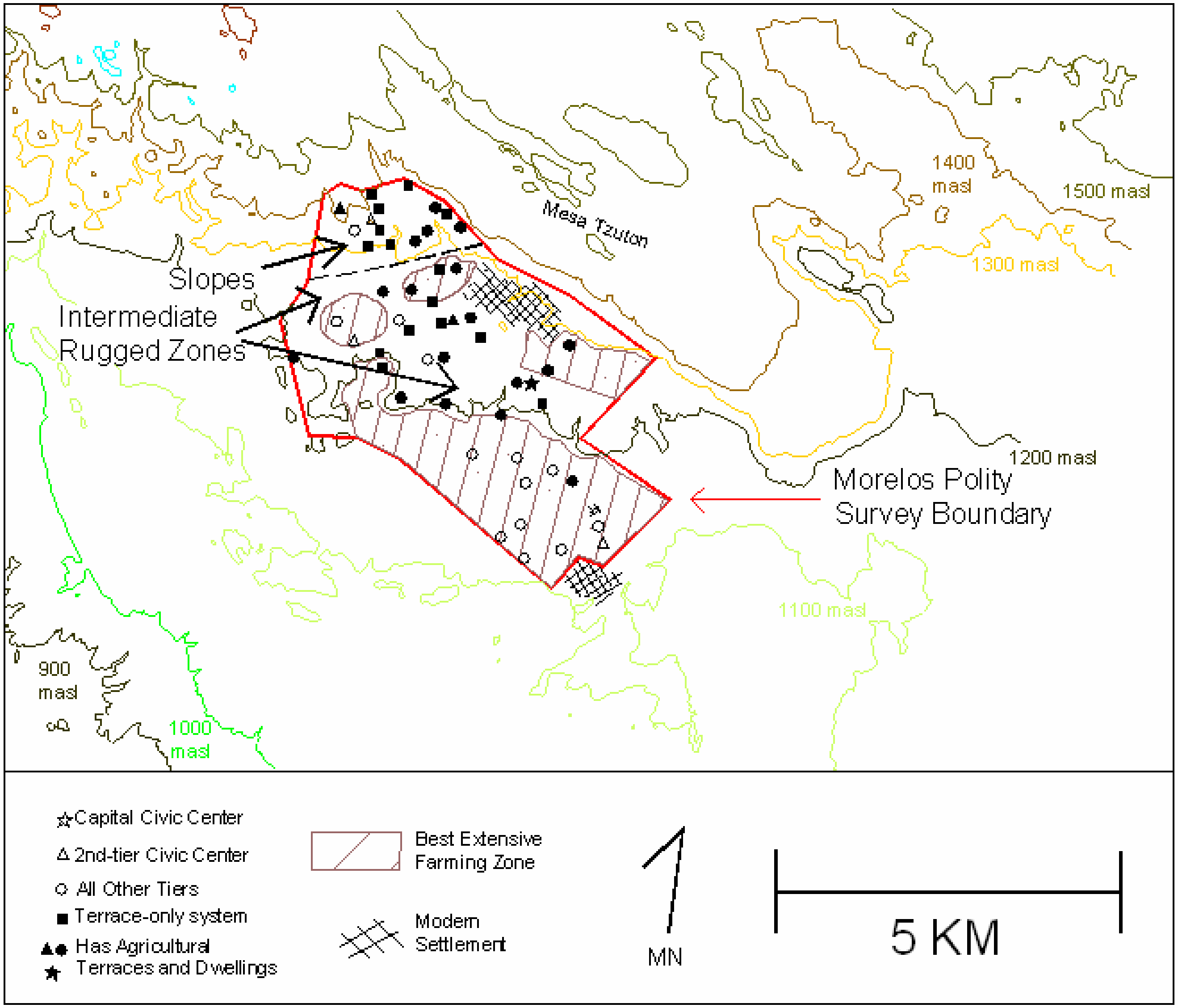


Figure 4-6 Environmental Micro-zones within the Morelos Piedmont

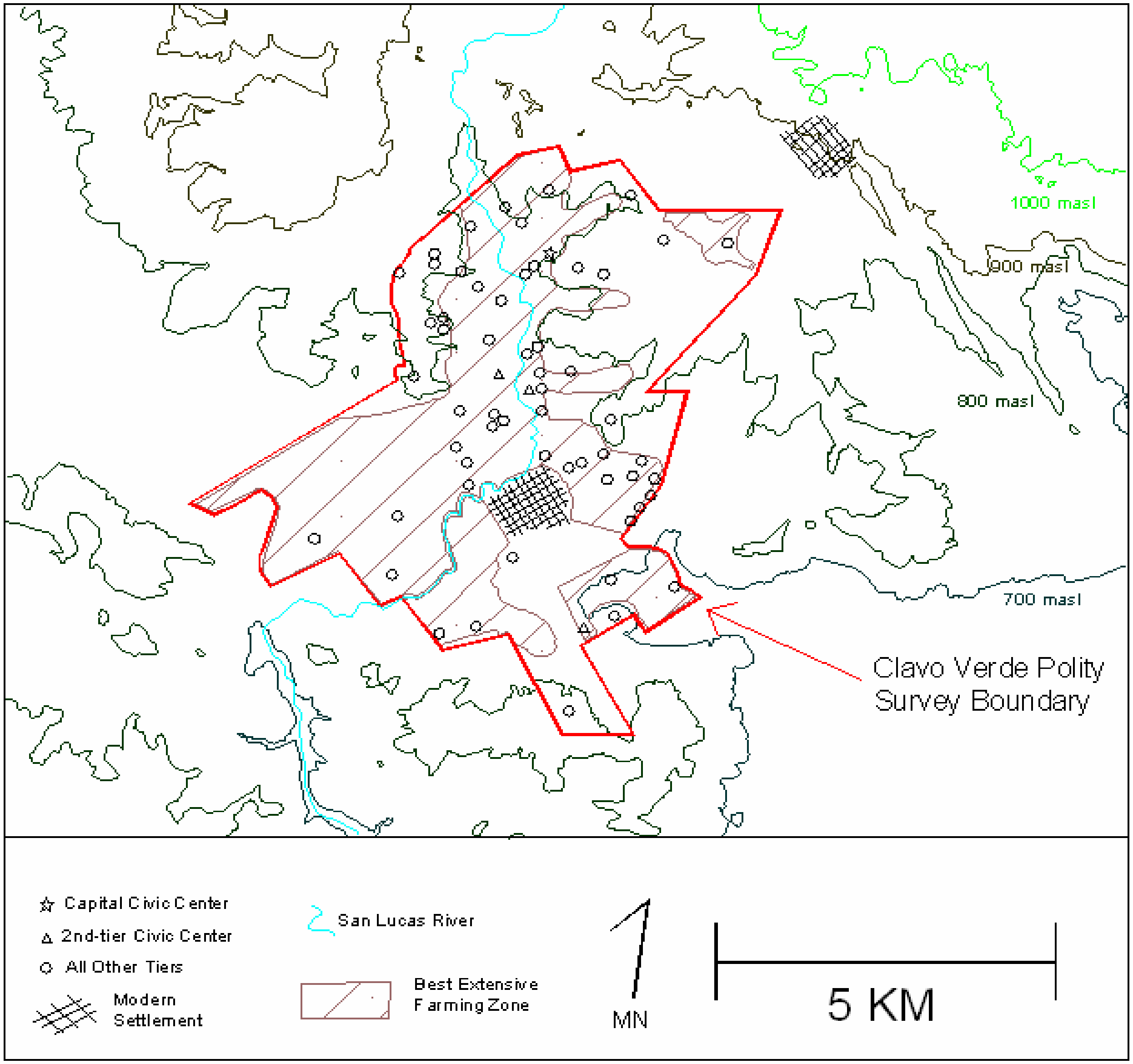


Figure 4-7 Best Extensive Farming Zones within the San Lucas Valley

4.2 AGRICULTURAL TERRACE DESCRIPTIONS

As intensive agricultural production on terraces is a central theme of this study, here the agricultural terrace forms recorded during the survey are described. Relict agricultural terraces have been documented throughout the Maya realm (Donkin 1979; Matheny and Gurr 1983; Turner 1983), but only recently have their economic implications in ancient Maya society been more fully explored (Chase and Chase 1998; Dunning et al. 1997; Liendo 2002). Agricultural terracing has been extensively studied in five regions of the Maya lowlands: the Rio Bec region of Campeche, Mexico; the Upper Belize River Valley in western Belize; the Vaca Plateau of central Belize; the Petexbatun region of the Peten, Guatemala; and the Puuc hills of northern Yucatan (Chase and Chase 1998; Dunning 1992; Dunning and Beach 1994; Dunning et al. 1997; Fedick 1994; Healy et al. 1983; Turner 1983). These studies, in conjunction with other agrarian studies focused on upland environments for mixed cropping and wetlands for raised- and drained-field cultivation, have contributed to the present characterization of the Maya lowlands as a mosaic of micro-environments to which the Maya developed various agricultural techniques tailored to the particularities of local conditions (Fedick 1996a).

4.2.1 Agricultural Terrace Function and Form

Although agricultural terraces function somewhat differently based on form and local topographic and climatic conditions, most serve four basic purposes: soil deepening, erosion control, microclimatic control, and moisture retention.

Soil build-up behind terrace walls obviously results in soils deeper than the original soil depth. However, soil deepening is usually a secondary function of terraces except in cases where cropping surfaces are created on thin or non-existent soils (Treacy and Denevan 1994: 93). Soil deepening is usually a by-product of soil build-up over long periods of time, and not one of the primary reasons why traditional farmers decide to build terraces in the first place.

One of the major reasons farmers build terraces is to counter soil loss due to erosion. The construction of terrace walls across slopes halts, or at least significantly reduces, the downslope transport of soils nutrients by retarding colluvial processes. Terrace systems restrict this movement to the segments of slope between each terrace wall embankment (Turner 1983: 93).

In hilly or mountainous zones terraced fields can provide favorable microclimates for crops due to frost avoidance (Treacy and Denevan 1994: 94). Frost typically occurs in mountainous zones because of night time radiational cooling under clear skies, and downslope movements of cold air toward valley floors. Re-radiation from terrace walls warms planting surfaces, and the hillside location for most terraces above valley floors provides protection from frost (ibid.).

Many terrace systems also facilitate the retention of soil moisture during dry interludes (e.g. canicula) or during the dry season (Turner 1983: 94). The slope between terrace walls encourages water to flow to the deeper, more level soil sections behind terrace wall embankments resulting in prolonged moisture retention and generally more moist soil conditions (ibid.).

Terrace forms recorded throughout the Maya zone can be categorized according to four general types: footslope, bench (or flat), dryslope, and check dam (or channel-bottom weir). All of the terraces recorded in the Morelos Piedmont are of either the dryslope or check dam form.

Footslope terraces are large terraces located at the base of steep slopes (Figure 4-8). They consist of large retaining walls that collect slope wash. Excavation of footslope terraces in the Petexbatun region found that they were built of two parallel walls, about 25 cm apart, between which was a fill of gravel (Beach and Dunning 1995). Footslope terraces appear to function as traps for eroded sediment at the base of hillsides, rather than embankments to slow erosion farther up slope.

Bench (or flat) terraces represent the ultimate in slope management because their use transforms sloping hillsides into level fields (Figure 4-9). Bench terraces have high retaining walls (or risers) made of stacked stones that are sometimes tilted back towards the hillside in order to create level platform surfaces. In some instances, a portion of the hillside is cut away and used as fill in order to create a level surface. The basic function of bench terraces is to produce the degree of levelness needed to control surface water (Wilken 1987: 115).

Dryslope terraces are small (usually less than 1 m in height) and alter the original slope of the hillside only slightly or not at all (Beach and Dunning 1995) (Figure 4-8). In their simplest form, dryslope terraces consist of nothing more than rows of stones laid across the hillside to partially check the down-slope wash of surface soils. More elaborate dryslope terraces have carefully shaped stone embankments that follow hill contours (Wilken 1987: 105). Over time, as deposition builds-up behind the terrace walls, the slope of the hillside may be slightly modified, but slope angles are not deliberately changed during the construction process (ibid.: 105). The primary function of dyslope terraces is to retard erosion and accumulate moisture (Treacy and Denevan 1994: 98).

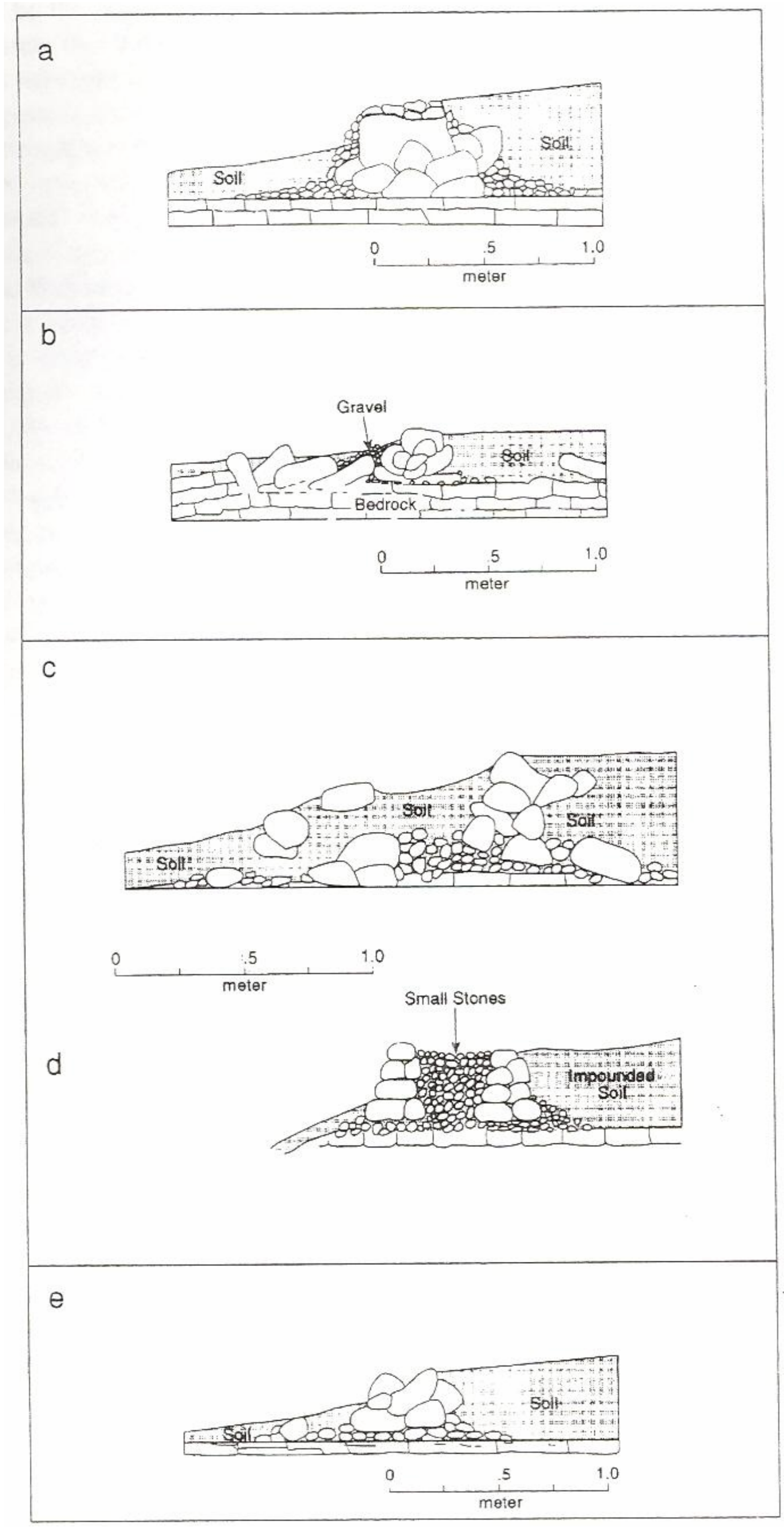


Figure 4-8 Agricultural Terrace Forms: (a) excavated check dam, (b) excavated box terrace, (c) excavated footslope terrace, (d) reconstructed view of footslope terrace, (e) excavated dryslope terrace (from Beach and Dunning 1995: Figure 4)

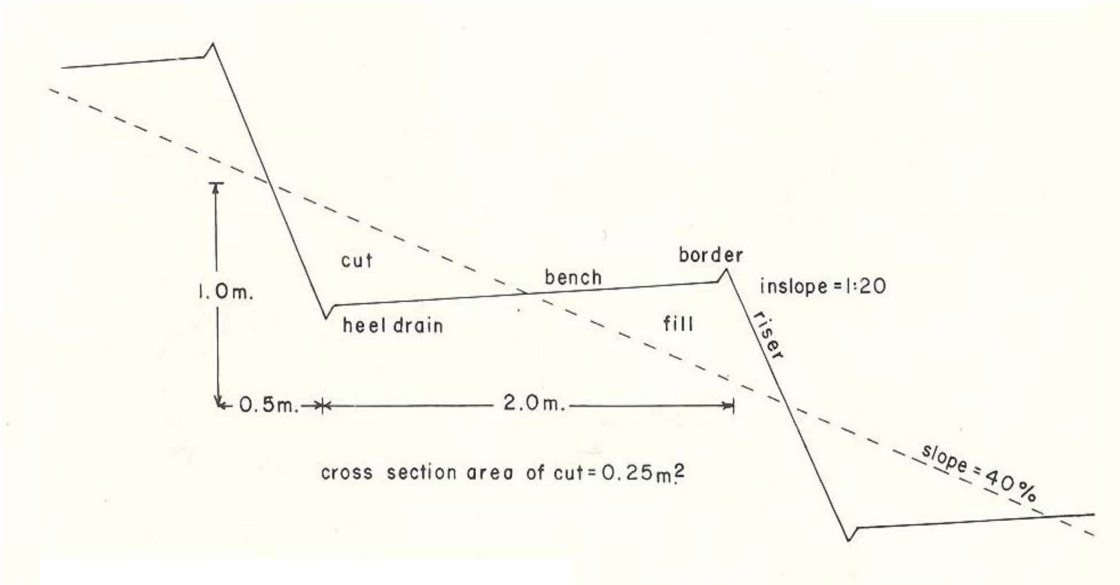


Figure 4-9 Simplified Profile of Bench Terraces (from Wilken 1987: Figure 6-11)

The vast majority of terraces recorded during the survey are of the dryslope form. The dryslope terraces in the Morelos Piedmont were built on hillsides of varying slopes with the gradient ranging from less than 5, to over 25 percent (Figure 4-10, Figure 4-11). A total of 44 terrace systems were recorded during the survey ranging in area from 0.05 to 15.8 ha. Most of the dryslope terraces recorded were simplistic forms, consisting of only a few courses of stone stretching for short distances across the hillside.

Check dams are built across intermittent drainage channels where they serve to "check" the flow of water during rain storms and capture eroding soils (Figure 4-8). As the water slows, suspended debris is deposited resulting in a relatively flat planting surface behind check dam walls (Wilken 1987: 99). Because check dams slow, but do not completely retain, heavier stream flows, they must provide for overflow. Therefore, check dams are typically constructed in a step-like sequence along the bottom of drainage channels, with each dam checking the flow of water and capturing some of the suspended debris (ibid.: 100). A relatively small number of check dams were recorded during the survey, and all appear to have functioned as described above (Figure 4-12, Figure 4-13).

Figure 4-10 Dryslope Terraces at MR 24

Figure 4-11 Dryslope Terraces at MR 45

Figure 4-12 Check Dams at MR 24

Figure 4-13 Check Dams in the Background and Dryslope Terraces in the Foreground at MR 52

4.2.2 Agricultural Terraces Size and Labor Requirements; Form and Field Patterning

4.2.2.1 Labor for Construction

The scale of agricultural terraces has been used in previous studies of ancient Maya intensive agriculture to explore whether elite management would have been necessary to mobilize and organize the labor required to build the terraces (Chase and Chase 1998; Healy et al. 1983). The argument is that if the scale of agricultural terracing is so large that small, cooperating groups of local households could not have provided the necessary labor to build them, then elites likely provided the administrative directive to mobilize and organize the labor. On the other hand, if the scale of the terraces is of a smaller size such that local household groups could have provided the labor to build them, then their construction may have been managed at the local or community level without elite input. An important caveat to this argument is that even if the scale of the terraces is small, and local household groups could have provided the labor to build them, that does not necessarily preclude elite, top-down supervision of terrace construction. And even if the scale of terracing is large, is it not possible that cooperating groups of local households could have provided the labor to build them in an accretionary fashion over time? Nevertheless, the scale of agricultural terrace systems has been frequently cited as evidence in support for elite management of the labor required to build them.

Chase and Chase (1998) have argued that the large-scale, organized nature of the terrace systems at Caracol indicates that they were not merely the accreditive result of individual family efforts. They state,

> "the magnitude and formality of the landscape modification involved in Caracol's large-scale terracing indicates planning and implementation of the fields by something larger than the family unit. How centralized this planning and implementation may have been is only conjectural (ibid.: 72-73)"

Others have argued that the relatively small scale of terraces indicates the absence of elite administration of their construction. In the Upper Belize River Area, Fedick (1994: 124) states,

"Given the small scale of terrace systems observed in the study area, there is no basis for suggesting the existence of a centrally controlled program of terrace development."

At the site of Tamarandito in the Petexbatun region of Guatemala, Dunning et al. (1997: 263) cite the simplicity and small scale of check dams as evidence for local cooperation and incremental growth in their construction.

In the Morelos polity during the Late-Terminal Classic period, the locally available commoner labor would have been more than enough to satisfy the labor required to build all of the agricultural terraces in the Morelos Piedmont (Table 4-1). Therefore, the argument that the scale of agricultural terracing is so large that elites would have had to mobilize and organize the labor to build them does not apply.

Table 4-1 shows the labor requirements necessary for the construction of agricultural terraces in the Morelos polity during the Late-Terminal Classic period. They are based on Wilken's (1987: 116-117) ethnographic study of Mexico and Central American traditional agricultural technology and Turner's (1983: 108-111) research on prehistoric terracing in the Rio Bec region. I consider these figures to be a reasonable estimate for labor costs associated with terraces in the Morelos piedmont zone since terrace types, construction techniques, and the topographic characteristics where terraces are found are similar to those described by Wilken and Turner.

Wilken (1987: 109) estimates that an experienced workman on moderate slopes (less than 40 percent) with soft or sandy soils can produce a hectare of sloping terraces averaging 10 m wide in 44 days (average terrace width within the survey zone is approximately 13 m). The labor requirement rises to more than 100 days in hard soil conditions. I use these as minimum and maximum estimates for construction for all terraces in the Morelos Piedmont. The vast majority of terraces recorded during the survey are of the dryslope form similar to those used in Wilken's estimates, but a small number of check dams were also documented. For the purpose of estimating labor requirements for all terracing in the Morelos polity, check dam terraces are included in Table 4-1. This has been done because the labor requirements for the construction of check dams are typically smaller than that of dryslope terraces and therefore would only serve to lower the overall construction estimates which, as Table 4-1 illustrates, are already quite small. This is because check dams are often built in stages, rather than in a single event, resulting in a reduction of the labor input needed at any one point in time (Wilken 1987: 100, 103). The reason why check dams are built in stages is related to how they are expected to function. Wilken (1987: 100-101) cites an indigenous farmer from Hidalgo, Mexico who explained,

> "*Atajadizos* (Check dams) need to be strong in order to withstand the force of the water when it rushes down the gully….Usually a farmer starts with a low wall across the path of an arroyo. It takes a few years until the water has brought down enough debris and soil to level with the top of the wall. Then, the farmer will build up the wall a bit more, and so on, little by little until s(he) has built up a tall strong wall and a large level field."

Finally, check dams constitute a small percentage of the total terrace count (about 15 percent) in the Morelos zone, and therefore, their inclusion does not do much violence to the data used to calculate labor requirements for terrace construction.

As Table 4-1 illustrates, terrace labor requirements throughout the Morelos polity are very small. Applying the minimum and maximum labor estimates respectively, the range of person-days required to construct individual terrace systems is between about 3 and 695; and 6 and 1,580. If the locally available commoner labor is applied to specific agricultural terrace systems associated with house group clusters, the per capita labor requirement ranges from less than 1 day to 16 days for the minimum estimate, and from 1 day to 36 days for the maximum estimate. Locally available commoner labor is calculated by multiplying 5 (the presumed nuclear family size) by the total number of commoner dwellings within a house group cluster associated with an agricultural terrace system, applying the logic that those who built and worked the terraces inhabited the areas that were spatially close to them (Rodríguez 2006; e.g., Beach and Dunning 1997). Furthermore, only commoner dwellings are used as it is assumed that commoners provided the bulk of the agricultural labor (Lohse and Valdez 2004: 8). For thirteen terrace systems, no associated dwelling or non-dwelling structures were found. It is possible that poor preservation of surface remains near these particular terraces resulted in the inability to document dwelling structures during the survey. But preservation and visibility was generally fair to good throughout the survey zone. Assuming that no dwelling structures were situated adjacent to these terrace systems, and that the labor required to build them was provided by farmers residing at the documented house group clusters in the zone, the additional labor has little impact on the overall labor requirement estimate. When the total commoner population associated with agricultural terraces is compared to the person-days required for all terraces documented during the survey, the number of days required for construction is between only 3 and 6 (Table 4-1). If the entire Morelos commoner population during the Late-Terminal Classic period is considered, those numbers decrease to between 1 and 3 days (Table 4-1).

It is important to note that Wilken's estimates are for construction labor costs (not maintenance which is addressed in the next section), and do not include costs associated with quarrying and transport of stone. Likewise, Turner's estimates do not factor in quarrying and transport costs (1983: 110). Turner suggests that it is unlikely that the terraces in the Rio Bec region were constructed solely of surface rocks, and therefore the majority of stone would have been quarried. But the possibility that rock could be excavated on slope near the construction sites diminishes transportation costs (ibid.: 110). Presumably, in the Morelos Piedmont quarrying and transport costs would have been trivial because of the relatively small scale of the terrace systems and ubiquity of bedrock outcrops throughout the zone. In other words, terrace stones could have been quarried "on slope" near the construction sites in a similar fashion to that described by Turner.

The small scale of the terraces throughout the Morelos Piedmont result in low labor requirement estimates. Clearly, not every commoner man, woman, and child would have been involved in terrace construction. But it is also likely that labor would have been drawn from other parts of the population as well, possibly from the junior relatives or retainers. Therefore, using all of the commoner dwellings associated with terraces in the labor estimate probably represents a reasonable estimate for the locally available labor. Even if the labor estimates were doubled, the labor requirement would remain small compared to the size of the commoner population of the Morelos polity during the Late-Terminal Classic period. The point to be made here is that no matter how you estimate the labor available for terrace construction, the result is still going to be a small labor requirement. Because of this, the argument that the scale of agricultural terracing is so large that small, cooperating groups of local households could not have provided the necessary labor to build them, and therefore elite management would have been necessary to mobilize and organize the labor, does not apply. The locally available commoner population was more than sufficient to have provided the labor to build the terraces.

A related argument in support of elite management of terrace construction is concerned with when the terraces were built. Some researchers have argued that contemporaneity between the time when intensive agricultural works were built and the rise of powerful elites in the region is indicative of top-down management of intensive agriculture (Chase and Chase 1998: 73; Kolata 1986, 1991). If the agricultural terraces in the Morelos piedmont zone were constructed through a top-down administrative effort during the Late-Terminal Classic period, then it would be expected that the majority of terraces of would contain ceramics dating *only* to this particular time period (Chase and Chase 1998: 71). Of the 44 agricultural terrace systems recorded during the survey, 29 have ceramics dating to the Proto-Classic period, compared to 15 agricultural terrace systems for which *only* Late-Terminal Classic ceramics were recovered (Table 4-2). Agricultural terrace systems for which Proto-Classic period ceramics were found indicate that at least some of the terraces would have been constructed during this time period, and given that the vast majority of agricultural terraces also contain Late-Terminal Classic ceramics (a total of 39), it appears that terraces were constructed in an accretionary fashion. Therefore, the argument that elites managed the construction of terraces during the Late-Terminal Classic period in the Morelos Piedmont would seem to not apply. But, regardless of when the terraces systems were built, it appears likely that most were in use during the Late-Terminal Classic period because the vast majority (39 of 44) contain ceramics dating to this time period.

Table 4-1 Morelos Polity Late-Terminal Classic Period: Labor Requirements for Construction of Agricultural Terraces

House Group Cluster / Terrace System	Area of Terraces (ha)	Labor Person-days Minimum	Labor Person-days Maximum	Number of Commoners Locally Available	Minimum # Days Required to Construct	Maximum # Days Required to Construct
MR1	1.1	48	110	15	3	7
MR2	1	44	100	5	9	20
MR4	2.6	114	260	35	3	7
MR5 & MR51	15.8	695	1,580	60	12	26
MR8	0.5	22	50	25	1	2
MR9, MR10 & MR11	0.7	31	70	20	2	4
MR15	1.8	79	180	5	16	36
MR24	4.3	189	430	755	< 1	1
MR26	0.2	9	20	10	1	2
MR27	0.7	31	70	40	1	2
MR35	0.3	13	30	20	1	2
MR40 & MR52	2.1	92	210	15	6	14
MR45	1.3	57	130	25	2	5
MR53	2.8	123	280	30	4	9
MR57	2.4	106	240	75	1	3
MR28	13.7	603	1,370	160	4	9
MR32	1.3	57	130	30	2	4
MR43	1.7	75	170	25	3	7
MR54	15.1	664	1,510	115	6	13
MR55	0.5	22	50	65	< 1	1
MR64	1.6	70	160	15	5	11
MR33	0.4	18	40	0	N/A	N/A
MR17	7.7	339	770	0	N/A	N/A
MR20	0.7	31	70	0	N/A	N/A
MR21	.07	3	7	0	N/A	N/A
MR22	.08	4	8	0	N/A	N/A
MR25	0.3	13	30	0	N/A	N/A
MR37	0.4	18	40	0	N/A	N/A
MR39	0.1	4	10	0	N/A	N/A
MR41	1.6	70	160	0	N/A	N/A
MR58	0.2	9	20	0	N/A	N/A
MR30	0.5	22	50	0	N/A	N/A
MR29	3.3	145	330	0	N/A	N/A
MR50	2.3	101	230	0	N/A	N/A
MR31	.05	2.2	5	0	N/A	N/A
TOTAL	89.2	3,925	8,920	1,545	3	6
TOTAL Morelos Polity	89.2	3,925	8,920	2,855	1	3

Table 4-2 Morelos Polity: Breakdown of Agricultural Terrace Systems by Time Period

	Only Proto-Classic Ceramics Recovered	Proto-Classic and Late-Terminal Classic Ceramics Recovered	*Only* Late-Terminal Classic Ceramics Recovered
Total Number of Agricultural Terrace Systems	5	24	15

4.2.2.2 Labor for Maintenance and Cultivation

Examination of the labor required for terrace maintenance and cultivation can yield clues about where commoners were living and why. If the commoner labor available near agricultural terrace systems is in balance with the labor required to maintain and cultivate the terraces, then it is likely that commoners were living where they were farming. If the commoner labor available near agricultural terrace systems is less than the labor required to maintain and cultivate the terraces, then importing labor to farm the terraces might have been necessary. In this scenario, it is possible that elites could have mobilized the labor for terrace maintenance and cultivation. In the Morelos polity during the Late-Terminal Classic period, I have found that neither of these scenarios apply. Instead, the commoner labor available near agricultural terrace systems is much greater than the labor required to maintain and cultivate the terraces. This indicates that the commoners living near agricultural terraces may have supplied the labor to farm those terraces, but that they were probably not restricted to farming solely on terraces. There would have been little need for elites to mobilize the labor for terrace maintenance and cultivation.

Previous attempts to estimate the labor required to maintain agricultural terraces could not be found. This is probably because labor for maintenance is a continuous process that varies widely based on terrace form, size, and local topographic and climatic conditions (Wilken 1987). The two types of terraces recorded in the Morelos Piedmont, check dams and dryslope, are typically associated with small labor maintenance costs. Not only are check dams inexpensive to build (as described in the previous section), but once they are in place, field development proceeds with little additional effort (Wilken 1987: 103). As soil deposition behind check dam walls slowly accumulates over time, additional stone courses may be added in an accretionary fashion. But check dams require little maintenance in terms of weekly, monthly, or even annual input. One exception is that check dams are susceptible to failure during sudden, heavy stream flows which may topple terrace walls, especially if enough soil has not built-up anchoring the stones in place. But these instances would require a concentrated labor effort over a short period of time to repair the damage, and would not significantly raise the otherwise trivial labor maintenance requirement.

Dryslope terraces have low labor maintenance requirements because of their relative simplicity and stability compared to other more complex terrace forms. Bench (or flat) terraces, for example, transform sloping hillsides into level fields which requires that steep risers be built. Down-slope movement of soil and water are controlled only as long as the risers remain intact, and failure of one riser may damage terrace walls downslope. For this reason, constant surveillance and maintenance are necessary continuing costs of bench terraces (Wilken 1987: 119). Dryslope terraces, on the other hand, modify the slope of the hillside only slightly, and are constructed by placing rows of stones along the natural contour of the hill. Over time, deposition builds up behind the terrace walls anchoring stones in place. The result is a more stable terrace construction which, although still subject to erosional forces, require little by way of routine maintenance.

Previous estimates for the labor required to cultivate agricultural terraces could not be found. Therefore, labor estimates have been extrapolated from ethnographic study of the labor required for maize cultivation on levees. The seasonally dry levees farmed by the Kekchi Maya of coastal Belize share some similar characteristics with terraces. They are both naturally fertile, do not require felling of trees or clearing of dense brush before they can be planted, weeding is necessary once crops are planted, and they both have minimal maintenance requirements (Wilk 1997: 79). Wilk estimates that on average 431 person-hours per hectare per year is required to cultivate maize on levees (Wilk 1997: 98, Table 6.2). This equates to about 1.18 person-hours per hectare per day (431 person-hours per hectare per year divided by 365 days). Applying these figures to the Morelos polity during the Late-Terminal Classic period, it is clear that many more commoners were living near agricultural terrace systems than would have been required to farm them (Table 4-3). Even if Wilk's (1997: 98, Table 6.2) estimate for the labor required to clear and cultivate primary forest is used (805 person-hours per hectare per year; 2.21 person-hours per hectare per day), in every case there would have been more than enough labor to cultivate the terraces (Table 4-3).

These results indicate that importing labor to farm terraces would not have been necessary. And although the commoners living near agricultural terraces may have supplied the labor to farm those terraces, they were probably not restricted to farming solely on terraces. No dwelling structures were recorded in association with thirteen agricultural terrace systems, but the small combined area of these systems (17.7 ha) indicates that the labor could have been provided by other commoners residing within the Morelos polity. According to Wilk (1997: 105-106) about two hours is the limit to which a Maya farmer will walk to work a field. And each of the terrace systems without dwelling structures are easily within two hours walking distance from multiple house group clusters containing relatively large commoner populations (Figure 3-4). The argument that elites would have been required to mobilize the labor for terrace maintenance and cultivation does not apply.

Table 4-3 Morelos Polity Late-Terminal Classic Period: Amount of Locally Available Commoner Labor to Cultivate Agricultural Terraces

House Group Cluster / Terrace System	Area of Terraces (ha)	Labor Required to Farm Terrace System (person-hours per day)*	Number of Commoners Locally Available^	Total Amount of Locally Available Commoner Labor (person-hours per day)+	Net Surplus / Deficit of Locally Available Labor
MR1	1.1	1.3	15	90	89
MR2	1	1.2	5	30	29
MR4	2.6	3.1	35	210	207
MR5 & MR51	15.8	18.6	60	360	341
MR8	0.5	0.6	25	150	149
MR9, MR10 & MR11	0.7	0.8	20	120	119
MR15	1.8	2.1	5	30	28
MR24	4.3	5.1	755	4,530	4,525
MR26	0.2	0.2	10	60	60
MR27	0.7	0.8	40	240	239
MR35	0.3	0.4	20	120	120
MR40 & MR52	2.1	2.5	15	90	88
MR45	1.3	1.5	25	150	148
MR53	2.8	3.3	30	180	177
MR57	2.4	2.8	75	450	447
MR28	13.7	16.2	160	960	944
MR32	1.3	1.5	30	180	178
MR43	1.7	2.0	25	150	148
MR54	15.1	17.8	115	690	672
MR55	0.5	0.6	65	390	389
MR64	1.6	1.9	15	90	88
MR33	0.4	0.5	0	0	- 0.5
MR17	7.7	9.1	0	0	- 9.1
MR20	0.7	0.8	0	0	- 0.8
MR21	.07	0.1	0	0	- 0.1
MR22	.08	0.1	0	0	- 0.1
MR25	0.3	0.4	0	0	- 0.4
MR37	0.4	0.5	0	0	- 0.5
MR39	0.1	0.1	0	0	- 0.1
MR41	1.6	1.9	0	0	- 1.9
MR58	0.2	0.2	0	0	- 0.2
MR30	0.5	0.6	0	0	- 0.6
MR29	3.3	3.9	0	0	- 3.9
MR50	2.3	2.7	0	0	- 2.7
MR31	.05	.01	0	0	- 0.1

*Area of terrace system x 1.18 person-hours required to farm 1 ha of terraces per day.
^5 (presumed nuclear family size) x total number of commoner dwellings associated with the terrace system.
+Number of commoners locally available x 6 hour work day (conservative estimate based on Wilk's (1997) ethnographic study of Kekchi Maya farmers).

4.2.2.3 Agricultural Terrace Field Patterns

Maya scholars have long debated whether terraced fields represent the large-scale, centrally planned construction of intensive agricultural works (Chase and Chase 1998; Healy et al. 1983), or the incremental development of intensive works over a long period of time (Demarest 1992; Dunning and Beach 1994; Fedick 1994; Turner 1983). In the previous section, it was demonstrated that the size of the agricultural terraces throughout the Morelos Piedmont were small. Therefore, the argument that the terraces were of such a large scale that top-down administration would have been necessary to mobilize and coordinate the labor to build and maintain them does not apply. But the small scale of the terraces does not entirely negate the possibility that their construction was planned by elite administrators. Another way to address this issue is by examining the spatial patterning of the terraces. The argument is that standardization in the form and field patterning of agricultural terraces is indicative of top-down planning, as elites would have possessed the engineering know-how to plan and construct complex intensive agricultural works in a systematic fashion. In some parts of the Maya lowlands the orderly, uniform appearance of terraces has been interpreted as a well-coordinated program of planning and labor investment indicative of top-down administration of agricultural intensification by a centralized elite (Chase and Chase 1996; Healy et al. 1983). In other cases, the irregular, discontinuous pattern of terraces has been interpreted as evidence for an incremental or piecemeal intensification of agriculture representative of the small-scale responses of individual farmers or smallholder families to the demands of production within their localized resource base (Fedick 1994). In the Andes, Erickson (1993) has argued that standardization in form and field patterning of intensive agricultural works is not a reliable indicator of centralized management because the planning skills necessary are not beyond the abilities of small, cooperating groups of local farmers. This point-of-view would seem to be particularly relevant to agricultural terracing as the planning required to build terrace walls or expand terrace systems is trivial compared to that required to build or expand a more hyper-coherent system like irrigation canals or raised fields. Nevertheless, many researchers interested in ancient Maya intensive farming have explored standardization as a potentially meaningful variable in determining the relative degree of top-down administration in the planning of field systems (Chase and Chase 1996; Dunning et al. 1997; Fedick 1994; Healy et al. 1983).

The spatial patterning of agricultural terraces in the Morelos Piedmont conforms most closely with an irregular, discontinuous pattern. The arrangement of terraces does not support the interpretation that these intensive agricultural works would have required top-down planning by an administrative elite. The terraces are not carefully interspersed among dwellings within house group clusters, and are not large, uniformly spaced, or regular in shape or size (see Appendix A for plan views of house group clusters and agricultural terrace systems). Rather, the discrete, hodge-podge nature and small-scale of the terrace systems throughout the Morelos Piedmont indicates that they were likely the accretionary result of construction efforts over time that could have been accomplished by individual family or community efforts. Therefore, the argument that standardization in the form and field patterning of agricultural terraces is indicative of centralized planning does not apply to the Morelos polity during the Late-Terminal Classic period.

Based on the reports available to me, few researchers concerned with Maya terrace farming have attempted to directly measure the degree of standardization in terrace systems using quantitative methods. But many have offered opinions based on subjective assessments of terrace form and field patterns. Demarest (1992: 146) argues that the irregular distribution and alternation of agricultural features throughout the southern Maya lowlands, such as swidden plots, raised fields, terraces and canal systems, are illustrative of growth by accretion of many small, local efforts. But he does not explicitly address standardization in terrace form or field patterning. At the site of Tamarandito in the Petexbatun region of Guatemala, Dunning et al. (1997: 263) cite the simplicity and small scale of check dams as evidence for local cooperation and incremental growth in their construction. But no quantitative method for measuring simplicity is provided. At Caracol, Chase and Chase (1996: 808) state,

> "The regularity seen in the alignment and organization of the terraces, combined with the hierarchy of integrative or administrative plazas evident in the Caracol causeway system, may be taken as the often difficult-to-identify direct archaeological evidence for state involvement in agricultural management."

But, they do not provide a quantitative measure for "regularity in the alignment and organization of the terraces." (see Figure 4-14 for plan view of Caracol settlement and terraces)

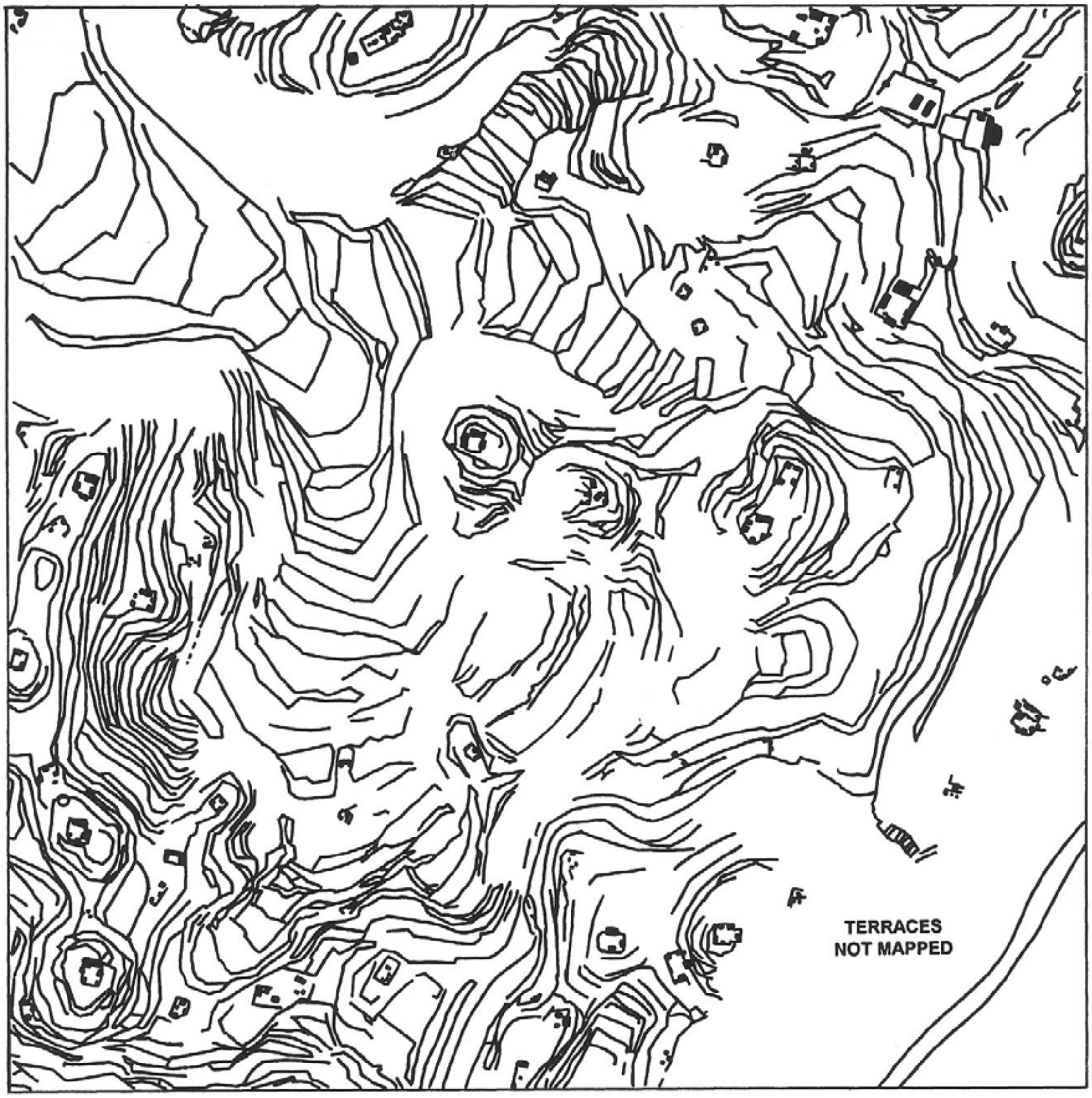


Figure 4-14 A 1 km^2 Area of Outlying Settlement and terraces at Caracol (from Chase and Chase 1996: Figure 4)

A previous attempt to measure the degree of regularity in the terrace systems at Caracol has resulted in a similarly subjective assessment, but also a quantitative measure based on the "average range of dimensions" of terrace walls. Healy et al. (1983) excavated five terrace walls at Caracol Hill "A" and found that they ranged in height from 60 to 165 cm, and in width from 150 to 340 cm. Average wall height was 120 cm, and average wall width was 183 cm (Healy et al. 1983: Table 3). These dimensions, they suggest, compare reasonably well with dimensions extracted from excavated terrace walls at other sites in the region. Healy et al. (1983: 402) observed,

> "The layout, distribution, and placement of the Caracol terraces more closely approximated the orderly arrangement of terrace constructions seen previously at Zayden Creek (a site northeast of Caracol). They were unlike the terraces at Mountain Cow (a site east of Caracol), which were revealed to be more irregularly positioned, and almost helter-skelter in layout. The terraces of Caracol Hill "A" were quite uniform, giving the appearance of being well coordinated and planned. Also,….the Caracol wall constructions tended to be within the average range of dimensions of other terrace walls previously examined in Belize and Mexico. All indications are that the terraces at Caracol were built at roughly the same time, and under well-organized, centralized direction."

The above examples (with the exception of Healy et al.'s quantitative measure) illustrate the subjective nature of trying to determine what regularity in the alignment and organization of terraces would look like, and whether such regularity, assuming that it can be reliably measured, is indicative of elite planning and/or coordination of the construction labor. Furthermore, formal structure can be found in all prehispanic agricultural systems, whether they were constructed with elite supervision or not. As Erickson (1993: 389-390) succinctly explains,

> "The argument is commonly made that, if raised fields or other forms of intensive agriculture show patterning, planning, and formal structure, the construction must have been centrally planned and organized. All prehispanic and modern raised fields found in the Americas and elsewhere demonstrate formal structure, as do most agricultural systems. Since scholars disagree on their subjective evaluations of how to classify the continuous variation between unstructured and structured landscapes, this issue may never be resolved."

Here, the quantitative measure used by Healy et al. (1983) at Caracol is applied. Although no terraces were excavated during the field work, in every case where terraces were sufficiently well-preserved to be mapped the height and width of terrace walls was recorded. The figures for terrace wall height are low because they are based only on the portion of the terrace wall exposed above the earth's surface, and do not include the unobservable stones potentially buried beneath the surface. Although this creates a problem for comparison to terrace wall height in other zones, it results in figures that can be compared within the Morelos Piedmont. I have found that the height of terrace walls ranged from a low of 0.3 m to a high of 2.1 m, and averaged 0.6 m. Terrace wall width ranged from a low of 0.2 m to a high of 0.9 m, and averaged 0.5 m. Terrace wall height probably exhibits a wider range than terrace wall width because of the variable number of stone courses in terrace walls. In most cases only one or two stones were visible on the ground surface, but in other cases five or more stones were still intact. As stone courses would have likely toppled over the years, and in modern times many farmers stack stones on top of ancient terrace walls, it is impossible to know how accurately the observed terrace wall height reflects the ancient construction. All terraces in the Morelos Piedmont were found to consist of only one row of stones, so the range for terrace wall width is actually the range of the stone widths used in terrace constructions. But additional rows of stones may have been buried beneath the surface of the earth preventing their detection during the survey. All of these complicating factors result in figures for terrace wall height and width that do not provide a fair test of the measure of standardization applied by Healy et al. (1983). A future program of terrace excavations may help to clarify the issue.

Another potentially useful quantitative measure for assessing the potential standardization in terrace field patterning is the distance between terrace walls, or in other words, the width of terrace fields. Standardization in terrace field width might be an indication of elite design according to a prescribed template. Left to their own, presumably local household groups would construct terrace walls at an appropriate width for the slope of the hillside: the steeper the slope, the narrower the fields; the gentler the slope, the wider the fields. If terrace field widths were found to violate this principle, then the possibility exists that a template for standardized terrace construction was applied. I have found that terrace width is greater on gentle slopes (17.1 m average; range from 7 to 33.8 m) and less on steeper slopes (9.6 m average; range from 4.9 to 12.7 m), as would be expected if terraces were being constructed in accordance with the natural slope of the hillside. Therefore, no evidence is found that an arbitrary design template that might be interpreted as elite management of terrace construction was applied.

The arrangement of terraces in the Morelos polity during the Late-Terminal Classic period does not support the interpretation that central planning would have been necessary for their construction. The terraces are not carefully interspersed among dwellings within house group clusters, and are not large, uniformly spaced, or regular in shape or size. Rather, the discrete, hodge-podge nature and small-scale of the terrace systems lacking standardization in terrace wall height and width, and terrace field width, throughout the Morelos Piedmont indicates that individual families or small communities could have planned and built the terraces without elite supervision. Therefore, the argument that elites would have had to provide the engineering know-how to plan and construct complex field systems does not apply to the Morelos polity during the Late-Terminal Classic period.

4.3 CARRYING CAPACITY; MAIZE PRODUCTION AND CONSUMPTION

In this section, the carrying capacity of the best extensive farming zones is estimated for the Morelos Piedmont and San Lucas River Valley using previous ethnographic studies and information obtained through informal interviews of local farmers during the survey. Carrying capacity refers to the maximum population that can be sustained indefinitely within a specified environment without major degradation to that environment. The calculation of carrying capacity is based on making reasonable estimates for maize yield and consumption in each zone. Estimating the carrying capacity of the best extensive farming zones for each polity allows for the assessment of how population pressure impacted the farming strategy. Was extensive farming of the best agricultural lands sufficient to support the population indefinitely? Or, was it necessary to cultivate the less productive slopes? Were intensive farming techniques adopted where the polity's population exceeded the carrying capacity of the best agricultural lands? Or, was population pressure not a factor in the decision to adopt intensive farming strategies? For the Late-Terminal Classic period in the Morelos Piedmont, I have found that the population of the Morelos polity exceeded the long-fallow swidden carrying capacity of the best extensive farming zones. Therefore, the decision to intensify production through terrace farming of the slopes was based, at least in part, on population pressure on the best agricultural lands. Extensive farming on the best extensive farming zones, intermediate rugged zones, and slopes combined with intensive production within settlements and on agricultural terraces could have provided enough maize to satisfy the minimum subsistence requirement of the population. For the San Lucas River Valley during the same time period, the population of the Clavo Verde polity was below the carrying capacity of the best extensive farming zones. The lack of evidence for agricultural terracing in the hilly terrain surrounding the San Lucas Valley indicates that enough maize could have been produced to satisfy the subsistence requirements of the population without the use of this intensive strategy.

4.3.1 Carrying Capacity

Relating population to agricultural production is nothing new in Maya studies, in fact, revision of the "Milpa Model" depended in large part on the documentation of greater population densities in the Maya lowlands (Harrison and Turner 1978; Rice and Puleston 1981). According to the Milpa Model, the Maya lowlands was characterized as a homogenous, undifferentiated environment capable of supporting relatively low populations through long-fallow, swidden agricultural strategies. The publication of "Prehispanic Maya Agriculture" (Harrison and Turner 1978) proposed a new interpretation of ancient Maya society, and presented alternatives to the "myth of the milpa" (Hammond 1978) portraying Maya society as having high regional population levels and intensive agricultural technologies. The Maya lowlands came to be characterized as a differentiated landscape with varied possibilities for agricultural intensification: uplands for mixed cropping, hillsides for terrace farming, and wetlands for raised- and drained-field cultivation (Fedick 1996a: 2).

Here, how population pressure on the best agricultural lands impacted the farming strategy in each polity is of primary interest. In cases where population densities were high, how was enough food produced to provide for such large numbers of people? I have found that extensive farming of the best agricultural lands was sufficient to support the Late-Terminal Classic population in the Clavo Verde polity, but was not sufficient to support the population in the Morelos polity during the same time period. In Morelos, it was necessary to shift cultivation to the less productive slopes where terrace farming played an important role in provisioning the inhabitants of this zone.

As Maya lowland population grew throughout the Classic period, progressively greater demands would have been placed on the agricultural base that long-fallow, swidden cultivation alone could not have satisfied. Previous research has shown that as population density increased, the Maya responded by intensifying production (Chase and Chase 1998; Dunning and Beach 1994; Healy et al. 1983; Pope and Dahlin 1989). This intensification is evidenced by relict agricultural features such as terraces and raised- and drained-fields, but other, less archaeologically visible forms of intensification were most likely applied as well. Sanders (1973) and Rice (1978, 1993) propose that fallow shortening strategies such as "bush swidden" cultivation, in which the crop-to-fallow ratio is reduced to 1:3, or "grass swidden" cultivation, in which the ratio is further reduced to 1:1, may have been used during the Late Classic period in densely settled zones. Although it is unlikely that either strategy could have been sustained for long due to exhaustion of soil nutrients, debate persists over whether they could have produced enough food to provision the Late Classic populations during the period of their greatest density (Culbert 1988: 95; Scarborough 1993: 25).

Actual estimates of carrying capacity – of population limits related to specific land uses – for the Maya lowlands are almost always related to swidden or milpa cultivation as historically practiced in various parts of the region (Turner et al. 2003: 368, 369, Table 20.1). These ethnographic estimates indicate that the carrying capacity for long-fallow, swidden cultivation, in which more land than is cultivated must be in various stages of fallow, ranges from about 20 to 80 people per km^2 (Table 4-4). Therefore, the swidden carrying capacity estimates for the Maya lowlands are well below the population density estimates for ancient Maya society, indicating that some form of intensification was probably necessary (see Table 3-9). Sanders (1973: Table 22) calculates that bush swidden cultivation, in which the fallow period is reduced to about 6 years, could have supported Maya lowland population densities of about 100 people per km^2. This is still below the rural population density estimates for many ancient Maya zones. Grass swidden cultivation, in which cultivation and fallow times are equivalent, might have supported about 154 people per km^2 (Sanders 1973: Table 22). But this strategy would have been sustainable for only a short period of time as intensively farmed soils are quickly stripped of their nutrients. If Sanders' and Turner's estimates are correct, and assuming that the settlement evidence is not grossly inaccurate, the populations of several zones of the Maya lowlands and the Upper Grijalva Basin would have exceeded their respective carrying capacities during the Late Classic period. But, before this conclusion can be reached for the Morelos and Clavo Verde polities during the Late-Terminal Classic period, it is necessary to assess the maximum productive potential of the best agricultural lands in these two zones and compare the results to the respective population estimates. The swidden carrying capacity estimates derived from the ethnographic studies cited in Table 4-4 are based on actual production and consumption figures at a particular point in time, and do not necessarily represent maximum estimates for maize yield, and minimum estimates for maize consumption, as are required to calculate a hypothetical maximum carrying capacity (i.e. the maximum number of people that a given area could support before the productive environment begins to degrade and/or people begin to starve). Therefore, simply applying these figures to archaeological case studies without exploring the potential maximum productivity of the zone in question, and minimum consumption requirements of the population, would result in carrying capacity estimates well below the hypothetical maximum carrying capacity.

Table 4-4 Previous Carrying Capacity Estimates for the Maya Lowlands

Location	Production System[a]	Density (people per km^2)	Source
Northern Yucatan	Swidden/milpa	19	Cook (1972: 31)
Northern Yucatan	Swidden/milpa	23	Hester (1954: 129)
Copan Valley	Swidden/milpa	25-32[b]	Wingard (1996)
Southern Peten	Swidden/milpa	41[c]	Carter (1969: 185)
Greater Yucatan	Intensive swidden	57	Wagner (1968: 185)
Central Peten	Swidden/milpa	77[d]	Cowgill (1961)

a. Swidden/milpa = maize-based systems in which fallow exceeds cultivation (1:4 plus); intensive swidden = maize-based system in which length of fallow and cultivation are equal (1:1)
b. The lower figure for longer fallow (10 yr); the higher figure for shorter fallow.
c. Figure for "available land" or cropped land, not total area of some bounded unit; noncroppped land eliminated from estimate.
d. Figure assumes that virtually all land is high quality and suitable for maize cultivation. It is very high by world standards for swidden systems.

Source: Turner et al. 2003: 369, Table 20.1

Table 4-5 shows the estimated carrying capacities for the Northern Lowlands, Central Peten, and Southern Peten based on the production and consumption figures derived from three oft-cited ethnographic studies (Carter 1969; Cook 1972; Cowgill 1961, 1962). For the Morelos and Clavo Verde polities, the consumption figure represents the average of the three ethnographic cases, and the production figures represent those used here to calculate carrying capacity (Section 4.3.1.3). This was done to illustrate that if the greater annual consumption figures used in the ethnographic cases is compared to the production figures used in the present study, that the resulting population density estimates are within the range of those predicted by the ethnographic cases (20 to 80 people per km^2), with the exception of the maximum productive figure of 2,000 kg per hectare. As explained below in Section 4.3.1.1, 2,000 kg of maize per hectare per year represents a hypothetical maximum yield for the best extensive farming zones in the Morelos Piedmont and San Lucas Valley based on other ethnographic studies of maize yields and information obtained from local farmers during the survey. Importantly, the production figures used in the three ethnographies in Table 4-5 are on the lower end compared to other ethnographic studies of Maya maize yields (see Table 4-6). Because of this, the population density figures for the Morelos Piedmont and San Lucas Valley are high even though the consumption figures have been adjusted.

Here, I have calculated maximum maize yield and minimum maize consumption figures in order to estimate the hypothetical maximum carrying capacity for swidden cultivation on the best agricultural lands in the Morelos Piedmont and San Lucas River Valley. I have found that the Late-Terminal Classic population in the Morelos polity was over carrying capacity and the population in the Clavo Verde polity was under carrying capacity. A discussion of how production and consumption figures were obtained in the ethnographic cases is provided below, followed by a detailed explanation for how carrying capacity was calculated in the present study.

Table 4-5 Carrying Capacity Estimates for the Morelos Piedmont and San Lucas Valley Based On the Average of the Maize Consumption Figures Reported In Ethnographies

Zone	Area of Cultivable Land (km^2)	Production* (kg maize / km^2)	Total Production (kg maize)	Fallow Factor**	Production per Year (kg maize)	Consumption (kg maize / person / year)	Total People Supported	People Per km^2
Northern Lowlands	46,602	106,400	4.9 billion	0.12	588,000,000	215	2,734,883	59
Central Peten	35,854^	75,020	2.7 billion	0.12	324,000,000	288	1,125,000	31
Southern Peten	324.4	84,600	27,444,240	0.12	3,293,308	232	14,195	43
Morelos Piedmont	8$^+$	100,000	800,000	0.12	96,000	245	392	49
San Lucas Valley	21$^+$	100,000	2,100,000	0.12	252,000	245	1,029	49
Morelos Piedmont	8$^+$	150,000	1,200,000	0.12	144,000	245	588	73
San Lucas Valley	21$^+$	150,000	3,150,000	0.12	378,000	245	1,543	73
Morelos Piedmont	8$^+$	200,000	1,600,000	0.12	192,000	245	786	98
San Lucas Valley	21$^+$	200,000	4,192,000	0.12	503,040	245	2,061	98

*Average for first year and second year production of shelled maize.
**Conservative average of 12 percent of cultivable land under production each year (or 88 percent in reserve) derived from the ethnographies.
^Total area of central Peten.
$^+$Area of best extensive farming zones.
Sources: Northern Lowlands (Cook 1972; Morley 1946), Central Peten (Cowgill 1961, 1962), Southern Peten (Carter 1969)

4.3.1.1 Maize Production

The maize production figures used for the Northern Lowlands, Central Peten, and Southern Peten in the carrying capacity estimates in Table 4-5 are within the range of other ethnographic studies concerned with maize production, but fall near the lower end (see Table 4-6). All maize production figures are for unfertilized lands unless otherwise noted. Cowgill (1961; 1962) interviewed 40 farmers from eight localities within the vicinity of Lake Peten in the southern Maya lowlands. She questioned the farmers about yields from first year milpas, second year milpas, and in some cases, milpas cultivated for three-plus years, and averaged the responses for each type of milpa. She found that most farmers cultivate a milpa for only one or two years before moving on to another plot. Rarely was a particular milpa cultivated beyond two years in succession which she attributes to the fact that there is no shortage of land available for cultivation (Cowgill 1962: 276). Cowgill (1962: 276) reported an average yield for first year and second year milpas combined of 670 pounds of shelled maize per acre (750 kg per ha; 75,020 kg per km^2).

Carter (1969) interviewed 30 Kekchi farmers from the municipality of Chichipate in the southern Peten district of Guatemala. He questioned the farmers about yields on first and second year milpas and averaged their responses. Carter (1969: 136) reported an average yield of 755 pounds of shelled maize per acre (846 kg per ha; 84,600 kg per km^2). Like Cowgill's estimate, this figure represents the average production of both first and second year milpas.

Cook (1972) applies maize production figures provided by Morley (1946) to estimate the productive potential of the Northern Lowlands comprised of the three modern Mexican states of Yucatan, Campeche, and Quintana Roo. Morley's production figures represent average yields for first year milpas and second year milpas based upon a survey of 265 households in northern Yucatan (Cook 1972: 31; Morley 1946: 152-154). Morley's yield value is 950 pounds of shelled maize per acre (1,064 kg per ha; 106,400 kg per km^2) (Cook 1972: 30; Morley 1946: 152-154).

Table 4-6 Maya Ethnographic Estimates for Maize Yields

Kg of Shelled Maize per Hectare*	Cultural Group or Zone	Source
1,500	Kekchi	Wilk (1997: 98)
1,000 – 250	Komchen	Shuman (1974: 158)
750	Piste	Steggerda (1941)
1,700 – 800	Lamanai	Arneson et al. (1982)
2,200 – 200	Tzeltal	Nations and Nigh (1980)
1,400 – 430	Tzotzil	Nations and Nigh (1980)
846	Southern Peten	Carter (1969: 136)
750	Central Peten	Cowgill (1961, 1962)
1,064	Northern Lowlands	Cook (1972); Morley (1946)
*Average production for first and second year milpas.		

Previous ethnographic studies of maize yields are used to estimate the agricultural productive potential of the Morelos and Clavo Verde polities. As Table 4-6 illustrates, ethnographic studies of Maya groups have provided long-fallow swidden yields for shelled maize per hectare per year of non-fertilized land ranging from 2,200 to 200 kg per hectare. During the survey of the Morelos Piedmont and San Lucas River Valley, local farmers were informally interviewed to acquire information about the productive potential of the land. For both zones, local farmers said that in a good year with adequate rainfall and with the use of chemical fertilizer they can get about 4,000 kg of shelled maize per hectare. Without fertilizer, local farmers in the Morelos zone estimate that the yield would be a little under half that, and in the San Lucas River zone about 2,000 kg of maize per hectare. 2,000 kg per hectare is near the high end of the productive figures obtained by other ethnographic studies and is used here as the hypothetical high yield of maize in the carrying capacity estimates (Table 4-8). Information obtained from local informants indicate that 2,000 kg per hectare is a good high estimate of the productive potential of both zones given adequate rainfall.

In Table 4-8, the high yield estimate of 2,000 kg per hectare is reduced by increments of 500 kg in order to provide a plausible range of values that can be used to calculate a reasonable estimate of the carrying capacity for each polity. These figures may provide a rough approximation of yield variability from one year to the next as fluctuations in the amount of rainfall would have directly impacted the amount of maize that could have been produced. Currently there is no data available to reconstruct the annual precipitation for the UGB during prehistoric times. Successful cultivation of maize requires a minimum of about 500 mm of rainfall during the growing period (Wellhausen 1957). Contemporary rainfall figures indicate that this minimum requirement would have been comfortably met. Within the survey zones, the annual precipitation varies from about 875 mm in the south, to just over 1,000 mm in the north (Figure 4-1). Based on these figures, it appears likely that there is enough precipitation, on average, to support long-fallow swidden cultivation.

Although concern about the amount of annual rainfall is a popular topic among contemporary farmers in both zones, when asked none could recall a time when rainfall was so scarce that the maize yield was low enough to affect their subsistence requirements and production of surplus for cash crop. Similarly to the ethnographic cases cited above, the contemporary inhabitants of the Morelos Piedmont and San Lucas Valley are not entirely dependent upon their own production to satisfy their subsistence needs. Many food items are purchased at the local market to supplement locally grown food (purchased food probably constitutes the majority of food consumed, but no attempt to estimate the proportion was made during the survey). This practice is aided by cash in the form of remittances that flows into the community from family members living and working in the United States. The current population of the village of Morelos (situated in the core of the Morelos Piedmont zone) is about

3,000 people. This is approximately 1,000 fewer people than the estimated climax population during the Late-Terminal Classic period. However, population pressure on the natural environment are attenuated by the use of chemical fertilizers and the purchasing of many food items at local markets. Additionally, thanks in no small part to the North American Free Trade Agreement (NAFTA), the people of this region have been swept-up into the world economy where the capitalistic forces of globalization have probably impacted their lives in subtle ways beyond the scope of the present study. Because of this, no attempt is made here to draw parallels between the contemporary situation in the region and that of the prehispanic inhabitants.

4.3.1.2 Maize Consumption

The consumption figures in Table 4-5 were derived from the same ethnographic studies as the maize production figures. In all three ethnographic cases, the annual per person consumption figures were derived by multiplying 365 days by the reported daily consumption of maize for people of all ages. The daily consumption of maize for people of all ages was calculated by averaging the amount eaten by members of the nuclear family including men, women and children. The results range from 474 to 636 pounds (215 to 288 kg) of maize consumed per person per year. For the Central Peten, Cowgill (1962: 277) reports that 1.7 pounds (0.77 kg) of shelled maize was consumed per person per day, with an average annual consumption of 636 pounds (288 kg) per person. Although she does not provide an estimate for the proportion of maize in the total diet, she does report that maize constitutes between 73 and 85 percent of all food consumed in northern Yucatan (Cowgill 1961: 28). For Chichipate households in the Southern Peten, Carter (1969: 138) reports that the average individual consumes 1.4 pounds (0.63 kg) of shelled maize per day, and 511 pounds (232 kg) per year. He suggests that the people in Chichipate consumed less maize than in the Central Peten because they may have made greater use of other crops. But he does not provide an estimate of the proportion of maize in relation to all foods consumed citing too little information on intercropping in both zones (ibid.: 138). In the Northern Lowlands, Morley's survey found an average of 1.3 pounds (0.59 kg) of shelled maize eaten per person per day, with a corresponding annual consumption of 474 pounds (215 kg) per person (Morley 1946: 154). He estimates that corn constituted between 75 and 83 percent of the total diet (ibid.: 158).

It should be noted that these figures represent *observed* values obtained through interviews of farmers at a particular point in time and are not estimates of the amount of maize required to satisfy the average person's minimum nutritional requirement. A good approximation of the latter is a necessary requisite in order to calculate a hypothetical maximum carrying capacity. In other words, to estimate the maximum number of people a particular area of land could have supported indefinitely, it is necessary to determine the minimum amount of maize that would have had to be grown in order for every person to get by. Calculation of this figure depends on assumptions concerning total caloric requirements and the portion of these requirements met through maize consumption. Two oft-cited studies concerned with these issues in prehispanic Mesoamerica are used here. Whitmore and Williams' (1998: 86, Table 1) study of famine vulnerability in the contact-era Basin of Mexico used nutritional studies from the Food and Agricultural Organization and World Health Organization (1973) to calculate the daily energy needs of each household member constituting the nuclear family. They determined that the average individual requires a minimum of almost 1,600 kilocalories (Cal) per day. Davidson et al.'s (1979: 167) study of human nutrition and dietetics determined that 1 kg of shelled maize yields on average 3,560 Cal. These figures are used here to calculate the minimum requirement of 100 kg of maize per person per year, representing a 60 percent dependence on maize (Table 4-7). 1,600 Cal per person per day is adopted because it represents an estimate very near the minimum annual maize requirement necessary to satisfy the average individual's annual nutritional needs. This estimate, and such a heavy dependence on maize, are supported by the following contemporary, ethnographic, and archaeological studies.

In Honduras, a United States Department of Agriculture (USDA) study found that the average Honduran today consumes approximately 1,900 kilocalories (Cal) per day, deriving almost 50 percent from maize (Garcia U. et al. 1988: 178-182). Given that 1 kg of dry maize yields 3,560 Cal (Davidson et al. 1979: 167), the average Honduran requires about 97 kg of maize per year. The USDA (1991) gives an average figure of 120 kg of maize per person for Mexico. William T. Sanders (1976: 145), assuming an 80 percent dependence on maize and applying a caloric requirement of almost 2,000 Cal per day, calculated a requirement of 160 kg of maize per year for application in his study of the agricultural history of the Basin of Mexico. This figure has been used elsewhere (see for example Denevan and Turner 1985: 167), and has been supported by Barbara J. Williams's (1989) study of contact-era overpopulation in the Basin of Mexico. For Tikal, William Loker (1989) applied a caloric requirement of 2,200 and a maize dependency figure of 40 percent to calculate an annual maize requirement of 90 kg per person. Ethnographic study of the Chorti Maya indicates that maize constituted as much as 70 percent of the diet (Wisdom 1940: 98). Evidence for such a heavy dependence on maize has also been found in archaeological contexts at Copan where analysis of plant macrofossils indicates that maize constituted about 60 percent of the diet (Lentz 1991). For his study of Copan, Wingard (1996: 216-217) uses the figure of 120 kg of maize per person per year, representing a 60 percent dependence.

Table 4-7 Calculation of the Minimum Annual Maize Requirement per Person

Minimum Cal per Person per Day*	Cal in 1 kg of Maize^	Kg of Maize per Person per Day	Kg of Maize per Person per Year	Maize Dependency Factor	Minimum Kg of Maize Required per Person per Year
1,600	3,560	0.45	164.3	.60	100
*Source: Whitmore and Williams (1998: 86, Table 1) ^Source: Davidson et al. (1979: 167)					

4.3.1.3 Carrying Capacity of the Best Extensive Farming Zones in the Morelos Piedmont and San Lucas Valley

The carrying capacity of the best extensive farming zones in the Morelos and Clavo Verde polities is determined by multiplying the area in hectares of best extensive farming zones by the maximum productive potential of maize per hectare per year which results in the total amount of maize that could have been produced annually (Table 4-8). Next, the fallow cycle is factored in to calculate the yearly amount of maize that could have been produced indefinitely without degrading the environment. Crop-fallow cycles vary by the time and location in question, but 2-3 years of cultivation followed by 7-15 years of fallow were historically typical for Maya groups and remain so today (Turner et al. 2003: 368). This results in the need for about two to seven times more land in fallow than in cultivation (Reina 1967; Reina and Hill 1980). Wingard (1996: 213) has determined that under the long-fallow swidden system, at most only 20 percent of the land is under cultivation at any given time. In order to bring additional land under cultivation intensive techniques such as fallow-shortening are required. Here, the 20 percent figure is multiplied by the figure for total maize production per year to determine how much maize could have been produced annually without the use of intensive farming techniques.

Use of this figure is desirable because it represents the hypothetical maximum amount of land that could be under cultivation without degradation to the natural environment. Lastly, the annual maize requirement per person is factored in to result in the number of people that could have been supported, or carrying capacity.

As explained above in Section 4.3.1.1, the maximum long-fallow, swidden productive potential of the best extensive farming zones in the Morelos piedmont and San Lucas River Valley is estimated to have been 2,000 kg of maize per hectare. The minimum annual maize requirement per person is estimated to have been 100 kg (see Section 4.3.1.2). Using these figures, and assuming that 20 percent of the land is under cultivation (the maximum amount of land that can be under cultivation at any one time and be sustained indefinitely) (Wingard 1996: 213), the hypothetical maximum carrying capacity of the best extensive farming zones in each polity is 3,200 people for Morelos and 8,384 people for Clavo Verde (Table 4-8). Given the Late-Terminal Classic period population estimates of 4,020 and 4,620 respectively, it is clear that the population in the Morelos polity was over the carrying capacity of the best extensive farming zones, and that the population in the Clavo Verde polity was under carrying capacity. Because the maximum long-fallow maize yield and minimum maize consumption figures were used, it should be made clear that these carrying capacity estimates represent hypothetical maximums. In other words, 3,200 people in the Morelos piedmont and 8,384 people in the San Lucas River Valley represent population levels at the brink of what would have been possible using long-fallow swidden cultivation in the best extensive farming zones. In light of this, the high population density estimates of 400 people per km^2 is explicable has a hypothetical maximum if the annual maize consumption figure is reduced to the minimum required to satisfy the average person's nutritional needs. As Table 4-5 illustrates, using these same maize yield figures, and adjusting the maize consumption figures to levels commensurate with ethnographically known cases, the population density estimates fall within the range of those predicted by the ethnographies (20 to 80 people per km^2). The one exception is the maximum yield estimate of 2,000 kg per ha which is explained by the fact that the maize yield estimates provided in the ethnographies concerned with carrying capacity are on the lower end compared to other ethnographic studies of Maya maize yields (Table 4-4). For the present study, comparison of the Morelos and Clavo Verde polities is of fundamental importance. Therefore, the calculation of reasonable estimates that can be uniformly applied to each polity's best extensive farming zones is of greater relevance here, than is the further explication of nuances between the production and consumption figures used in the present study with those derived from the ethnographies.

Table 4-8 Carrying Capacity Calculations for Best Extensive Farming Zones in the Morelos Piedmont and San Lucas Valley

Zone	Area of Best Extensive Farming Zones (ha)	Maize Productive Potential (kg per ha)	Total Maize Production per Year (kg)	% of Land Farmed to Allow Adequate Fallow Period	Maize Production per Year (kg)	Annual Minimum Maize Requirement per Person (kg)	Maximum Number of People Supported (Carrying Capacity)	People per km^2
Morelos Piedmont	800	2,000	1,600,000	0.2	320,000	100	3,200	400
San Lucas Valley	2,096	2,000	4,192,000	0.2	838,400	100	8,384	400
Morelos Piedmont	800	1,500	1,200,000	0.2	240,000	100	2,400	300
San Lucas Valley	2,096	1,500	3,144,000	0.2	628,800	100	6,288	300
Morelos Piedmont	800	1,000	800,000	0.2	160,000	100	1,600	200
San Lucas Valley	2,096	1,000	2,096,000	0.2	419,200	100	4,192	200
Morelos Piedmont	800	500	400,000	0.2	80,000	100	800	100
San Lucas Valley	2,096	500	1,048,000	0.2	209,600	100	2,096	100
Morelos polity Late-Terminal Classic population = 4,020 Clavo Verde polity Late-Terminal Classic population = 4,620								

4.3.1.4 Production Within House Group Clusters

Intensive gardening on plots of land located near Maya residences was noted by Landa during the Conquest period (Tozzer 1941), and studies at ancient Maya sites like Sayil (Dunning 1989, 1996), and Seibal (Tourtellot 1988; Santley et al. 1986) have underscored the potential importance of “infield” gardening in supporting the large Classic period populations. These intensive, fertilized gardens (fertilized with household waste) could have been very productive, having had a major impact on Maya diet and population carrying capacity (Demarest 2004: 132). Because they are situated around and between residences, clues for the existence of infield plots can be found by examining the number of dwellings per hectare for a given settlement. The assumption is that dispersed dwellings within settlements is indicative of intensive farming on infield plots because the houses are separated by their respective infields (Drennan 1988). A more direct measure of infield cultivation is phosphate isotope studies of soils at Maya sites to gauge the intensity of agricultural usage and application of natural fertilizers (Dunning 1994, 1996; Killion 1992).

In light of the long-fallow, swidden carrying capacity estimates for best extensive farming zones provided in the previous section, here the possibility of intensive farming within house group clusters is explored. The Late-Terminal Classic population in the Morelos piedmont was found to be over the carrying capacity of the best extensive farming zones, therefore, intensive production on infield plots might have been a useful technique to increase food production. In the San Lucas River Valley during the same time period, the population was found to be under the carrying capacity of the best extensive farming zones. Therefore, intensive cultivation of infield plots, although still a possibility, would appear to have been less necessary. Because of the greater amount of land available per person within house group clusters in the Morelos polity compared to those in Clavo Verde polity, I have found that infield cultivation appears to have been a strategy adopted in the Morelos Piedmont. Although I cannot rule out the possibility that it was also practiced in the San Lucas Valley, it would have likely been less necessary as a source of food. Infields could have made a significant contribution to the annual amount of food that could have be grown in the Morelos polity, thereby raising the maximum number of people that could have been supported. But intensive farming on infields combined with extensive farming in best extensive farming zones would likely not have been sufficient to support the Late-Terminal Classic climax population. Therefore, it would still have been necessary to farm the slopes where the use of agricultural terraces likely contributed to improving the productive potential of this marginal terrain.

The intensive cultivation of small plots of land adjacent to ancient Maya dwellings has received much attention over the last few decades (Drennan 1988; Dunning 1996; Killion 1992; Sanders and Killion 1992; Santley et al. 1986; Tourtellot 1993). Killion (1992: 8) notes that most non-industrial agrarian societies exhibit a mixture of intensive cultivation practices near the residence, with extensive strategies applied farther away. The activities of people living and working in such a system can be envisioned as taking place within three generalized areas: 1) the residential lot, 2) the area outside the lot but within or adjacent to settlement, and 3) areas located at greater distances from the residence. This argument has previously been stated more generally through terminological distinctions made between "infield" and "outfield" agricultural systems (see Sanders 1979: 495, 1981; Vogt 1969). In this (ethnographic) model infield plots were intensively farmed near residences (by virtue of increasing the labor input in order to increase the productive output, especially through the application of natural fertilizers), while less labor intensive swidden agriculture was practiced at a greater distance away from the settlement (Chase and Chase 1998: 61).

Infield plots adjacent to and separating dwelling structures have variably been referred to as "dooryard gardens," "house-lot gardens," and "kitchen gardens." Unlike outfield plots, infields can be naturally fertilized by the continuous deposition of food waste, excrement, and other debris produced by household members and dooryard animals (Killion 1992: 6). Because of this, kitchen gardens represent more fertile and agriculturally more resilient settings for cultivation than do outfield plots which, because of their greater size and distance from the household, are impractical, if not impossible, to fertilize in these ways.

One possibility is that intensive cultivation of infield plots would have been particularly important to the inhabitants of the Morelos Piedmont during the Late-Terminal Classic period because long-fallow swidden cultivation of the best extensive farming zones could not have supported the population. But how are infields identified in the archaeological record? Perhaps the best, and certainly most direct, indicator of the presence of infield gardens is chemical distinctions within settlements between open areas of artificial soil enrichment, and areas of ordinary garbage disposal around buildings (Tourtellot 1993: 221). At the site of Sayil in the Puuc region, for example, Dunning (1996) found higher values of phosphate Fraction I and lower Fraction III than expected in tests of open zones compared to zones along building walls. He suggests this contrast is due to prolonged artificial fertilization of gardens in the open zones.

In the absence of data derived from soil analyses, as is the case here, indirect lines of evidence must be used to try to determine the relative extent to which infield gardens might have been utilized in the past. Tourtellot (1982, 1993: 222) suggests that the open space around and separating households, as is commonly found at many Maya lowland settlements, most likely represent the use of infield gardens. This suggestion is supported by Dunning's findings at Sayil. During the Late Classic period at Seibal, Tourtellot estimates that approximately one hectare of cultivable land was available to each residential structure that could have been utilized for infield gardening (Tourtellot 1982). Prompted by Tourtellot's observations at Seibal, Santley et al. (1986: 134, Table 3) calculated the average amount of cultivable land per residential structure at a sample of Late Classic Lowland Maya settlements (Table 4-10). Although they do not suggest that all of this land was cultivated as infield plots, the differences between settlements in the amount of land available per residential structure can yield clues as to whether, and to what extent, infield gardens might have been utilized. Such a comparison is useful to the present study where a hypothesis is that infield gardening would have been particularly relevant to the inhabitants of the more marginal Morelos Piedmont zone where the climax population was over the carrying capacity of the best extensive farming zones. In the Clavo Verde polity, where population was under the carrying capacity of the best extensive farming zones, infield gardening might have been less necessary. More space per dwelling within house group clusters in the Morelos polity compared to those in the Clavo Verde polity might indicate that infield gardening was more prevalent. For all house group clusters one hectare in area or greater during the Late-Terminal Classic period, I have found that on average more space was available per dwelling in the Morelos polity than in Clavo Verde polity. The average amount of land available per dwelling structure in the Morelos polity was 0.24 ha compared to 0.06 ha in the Clavo Verde polity (Table 4-9). For the Morelos polity, if hilltop settings are omitted, applying the logic that the amount of land available per dwelling is skewed downwards due to the naturally circumscribing effect of settling on a hilltop, the average number of hectares available per dwelling increases to 0.49. The average amount of land per dwelling for house group clusters omitting hilltop settings and without agricultural terraces is 0.22 hectares. Agricultural terraces interspersed with dwellings results in an increase in the amount of land available per dwelling. Lastly, omitting hilltop settlements but including those with agricultural terraces 0.61 ha is available per dwelling (Table 4-9). No Clavo Verde house group clusters were situated on hilltops, and none have agricultural terracing.

Compared to the average number of hectares available per dwelling within other Late Classic Lowland Maya settlements, the Morelos polity falls near the middle, and the Clavo Verde polity is at the bottom (Table 4-10). Although it provides wider context to the present analysis, the comparison of the amount of land available per dwelling within these two polities to other Maya zones is not very useful because variables such as differences in the natural settings and other cultural factors are not controlled for. Of much greater relevance here is the comparison of house group clusters in the Morelos polity to those in the Clavo Verde polity where it is clear that, on average, a much greater amount of land was available to the inhabitants of the Morelos polity than was available to those in the Clavo Verde polity (Table 4-9). This greater amount of land surrounding and separating dwellings within house group clusters in the Morelos polity suggests that intensive farming of infield plots was a subsistence strategy likely utilized in the past.

Table 4-9 Late-Terminal Classic Period: Average Number of Hectares Available per Dwelling within House Group Clusters Greater than One Hectare

	All	Omitting Hilltop Settings	Omitting Hilltop Settings and Without Agricultural Terraces	Omitting Hilltop Settings but With Agricultural Terraces
Morelos Polity	0.24 (n = 26)	0.49 (n = 22)	0.22 (n = 16)	0.61 (n = 16)
Clavo Verde Polity	0.06 (n = 16)	N/A	N/A	N/A

Table 4-10 Morelos and Clavo Verde Polity Average Number of Hectares Available per Dwelling within House Group Clusters Compared to Other Selected Late Classic Lowland Maya Settlements (from Santley et al. 1986: 134, Table 3)

Settlement	Hectares per Dwelling
Peripheral Tikal	1.5 – 0.5
Seibal	0.98
Coba	0.81
Sayil	0.69
Morelos Polity (Omitting Hilltops, with Agricultural Terraces)	0.61
Dos Aguadas	0.60
Morelos Polity (Omitting Hilltop Settlements)	0.49
Chunchucmil	0.25
Mayapan (Late Classic)	0.25
Morelos Polity (All Settlements)	0.24
Morelos Polity (Omitting Hilltops and Agricultural Terraces)	0.22
Central Tikal	0.20 – 0.16
Clavo Verde Polity (All Settlements)	0.06

Another potential indicator of the presence or absence of intensively cultivated infields is the density of residential structures within settlements. Although residential density within settlements, and number of hectares per dwelling within settlements (see Table 4-10) are, proverbially speaking, “two sides of the same coin,” the former has been used in a comparative study of selected settlements throughout Mesoamerica (see Drennan 1988) and therefore is used here to further explore the possibility of infield gardening in the Morelos and Clavo Verde polities. Drennan (1988) suggested that swidden agriculture does not adequately explain why dwellings within Maya settlements during the Late Formative and Classic periods were much more dispersed than those of other periods and regions in Mesoamerica (as had been the widely accepted belief). Rather, he suggests that intensive agriculture better explains the dispersed settlement pattern (ibid.: 284-285). In the absence of intensive works such as terrace systems, dispersed dwellings within settlements can be interpreted as intensive farming on infield plots because the houses are separated by their respective infields. Conversely, compact dwellings within settlements may be interpreted as the absence of infield plots with farmers instead concentrating their efforts on the extensive cultivation of outfields. As would be expected, the presence of intensive agricultural works within settlements, such as terraces, correlates positively with low residential density because they contribute additional non-settled space between dwellings. Importantly, it is not just the larger agricultural labor input that infields and other intensive works require, but the concentration of that labor continually in a small area that makes it desirable for a household to locate its residence at its agricultural plot (ibid.: 287).

The calculation of residential density within house group clusters for both the Morelos and Clavo Verde polities yields results in accordance with those of the amount of land available per dwelling provided above. Although 5 persons per household was used for previous population estimates in this dissertation, 5.6 is used here for ease of comparison with other Mesoamerican settlements (Drennan 1988: 274). Residential density, measured as number of persons per hectare within house group clusters greater than one hectare in area is, when averaged for each polity, much lower in the Morelos polity than in the Clavo Verde polity (Table 4-11). Residential densities for the Morelos polity range from 6 to 82 persons per hectare, and for the Clavo Verde polity from 51 to 131 persons per hectare. In Table 4-11, the average residential density in the Morelos polity has also been broken down by presence or absence of agricultural terracing and whether the house group cluster is situated on a hilltop as these factors directly impact the amount of land available per dwelling structure potentially skewing the results.

When compared to the residential densities of other prehispanic Mesoamerican settlements, the Clavo Verde polity falls toward the higher end, and the Morelos polity falls further down the list (Table 4-12). But where these two polities rank compared to other prehispanic Mesoamerican settlements is less significant than the large difference in residential density when they are compared to one another (Table 4-11). Regardless of how house group clusters are grouped together in the Morelos polity, the result is always a residential density figure well below that of the Clavo Verde polity. Although this difference in residential density does not completely rule-out the possibility of infield cultivation in the Clavo Verde polity, it does suggest that infield farming may have played a more important role in the Morelos polity, whereas it was less necessary in the Clavo Verde polity.

Table 4-11 Late-Terminal Classic Period: Average Number of Persons per Hectare within House Group Clusters Greater than One Hectare in Area

	All	Omitting Hilltop Settings	Omitting Hilltop Settings and Without Agricultural Terraces	Omitting Hilltop Settings but With Agricultural Terraces
Morelos Polity	28 (n = 26)	20 (n = 22)	37 (n = 16)	14 (n = 16)
Clavo Verde Polity	91 (n = 16)	N/A	N/A	N/A

Table 4-12 Morelos and Clavo Verde Polity Residential Densities Compared to Other Selected Mesoamerican Settlements (from Drennan 1988: 275, Table 13.1)

Persons per Hectare	Settlement	Period	Region
130	Tenochtitlan	Postclassic	Mexico
98	Ts73, Tehuacan	Terminal Formative	Mexico
91	**Clavo Verde Polity Average**	**Late Classic**	**Maya**
87	Topoxte	Postclassic	Maya
63	Teotihuacan	Late Classic	Mexico
51	Zacpeten	Postclassic	Maya
44	Tierras Largas	Early Formative	Mexico
37	**Morelos Polity** (omitting hilltops, without terraces)	**Late Classic**	**Maya**
35	Monte Alban	Late Classic	Mexico
34	San Lorenzo	Early Formative	Mexico
33	Fabrica San Jose	Middle Formative	Mexico
28	San Jose Mogote	Early Formative	Mexico
28	Mayapan	Postclassic	Maya
28	**Morelos Polity Average**	**Late Classic**	**Maya**
26	Barton Ramie (Jenney Creek)	Middle Formative	Maya
22	Chunchucmil	Late Classic	Maya
22	Dzibilchaltun	Late Classic	Maya
20	**Morelos Polity** (omitting hilltops)	**Late Classic**	**Maya**
17	Komchen	Late Formative	Maya
14	**Morelos Polity** (omitting hilltops but with terraces)	**Late Classic**	**Maya**
12	Altar de Sacrificios	Late Classic	Maya
11	Seibal	Late Classic	Maya
11	Tikal “site” (Puleston)	Late Classic	Maya
10	Quirigua	Late Classic	Maya
10	Muralla de Leon	Late Formative	Maya
10	Becan	Late Classic	Maya
8	Coba	Late Classic	Maya
7	Tikal “core” (Haviland)	Late Classic	Maya
6	Barton Ramie (Spanish Lookout)	Late Classic	Maya
6	Dos Aguadas	Late Classic	Maya
5	Tikal “intersite” (Puleston)	Late Classic	Maya
1	Tikal “periphery” (Haviland)	Late Classic	Maya

If cultivation on infield plots was an important subsistence strategy in the Morelos polity, what difference did it make in the overall productive potential of the zone? How many more people could have been supported? Previous studies have provided estimates of the proportion of a family's food requirement met by production on infield plots. Sanders and Killion (1992: 18) estimate that in areas of high population density in twentieth-century Mexico, about one-third of a family's food requirements may be met from the production of a small household garden. For the Maya lowlands during the Late Classic period, Santley, Killion and Lycett (1986) suggest that crop production on infield areas between residences can be expected to have given higher and more sustainable yields than did outfield settings, but production could never have provided all of the staple dietary needs of the local population. Rather, they would have provided important food supplements without suffering the decreases in productivity from one year to the next characteristic of outfield plots (Santley et al. 1986: 134). The potential to farm infield gardens for successive years without major loss in soil fertility due to the application of natural fertilizers is perhaps the most important attribute of these infield plots. Although explicit attempts to calculate the actual productive potential of infield gardens could not been found, here an estimate is provided by extrapolating figures for the amount of land a family of five can fertilize each year (Kirkby 1973).

Kirkby (1973: 120) estimates that a family of five can produce enough human manure each year to fertilize an area of about 400 m^2 (0.04 ha). If fertilization was necessary every two to three years as soils become exhausted, approximately one-tenth of one hectare could have been fertilized with human manure in the immediate vicinity of a residence. A family of five requires minimally 500 kg of maize per year to meet their nutritional requirement. Assuming that the fertilized infield plot would produce maize yields at least as high as the 2,000 kg per hectare per year maximum for swidden cultivation, at least 200 kg of maize per year could have been grown. This represents about 40 percent of a family of five's annual maize consumption requirement of 500 kg. If this was the case during the Late-Terminal Classic period in the Morelos polity, where it has been demonstrated that population was over the long-fallow swidden carrying capacity of the best extensive farming zones, then intensive cultivation of infield plots might explain, at least in part, how such a large number of people were supported in the agriculturally marginal Morelos Piedmont. If 40 percent of a family's annual maize consumption was satisfied by production on infields, then the amount of maize that would have had to be grown on outfields is reduced to 60 percent of the annual maize consumption requirement. Applying the maximum swidden maize yield per year of 2,000 kg per hectare, and reducing the annual maize requirement per person derived from long-fallow swidden cultivation of the best extensive farming zones by 40 percent to 60 kg, the maximum number of people that could have been supported is 5,333 people (Table 4-13). Applying the swidden maize yield per year of 1,500 kg per hectare results in 4,000 people supported, just under the Late-Terminal Classic population estimate of 4,020 (Table 4-13). This indicates that intensive cultivation of infield plots likely contributed in a significant way to supporting the population of the Morelos polity during the Late-Terminal Classic period climax. Although, if swidden maize yields on outfields were in reality closer to 1,500 kg per hectare per year, then intensive farming on infield plots could not have produced enough food to satisfy the minimum subsistence requirement of the population. Therefore, although infield farming was probably an important source of food for the Late-Terminal Classic inhabitants of the Morelos polity, cultivation of the slopes was most likely necessary as well, and this is where farming on terraces could have served a vital role.

Table 4-13 Morelos Polity Late-Terminal Classic Period: Maximum Number of People Supported through Swidden Cultivation on Best Extensive Farming Zones if 40 percent of Food Requirement was Provided by Intensive Cultivation on Infield Plots

Zone	Area of Best Extensive Farming Zones (ha)	Maize Productive Potential (kg per ha)	Total Maize Production per Year (kg)	Fallow Factor	Maize Production per Year (kg)	Annual Minimum Maize Requirement per Person* (kg)	Maximum Number of People Supported
Morelos Piedmont	800	2,000	1,600,000	0.2	320,000	60	5,333
Morelos Piedmont	800	1,500	1,200,000	0.2	240,000	60	4,000
Morelos Piedmont	800	1,000	800,000	0.2	160,000	60	2,667
Morelos polity Late-Terminal Classic population = 4,020 *Reduced to reflect 40 percent of maize requirement satisfied by production on infield plots, see estimates in text.							

4.3.1.5 Production in Slopes and Intermediate Rugged Zones

Previous analyses in this chapter have demonstrated that during the Late-Terminal Classic period the population of the Morelos polity was over the carrying capacity of the best extensive farming zones, and the population of the Clavo Verde polity was under carrying capacity. When house group clusters in the two polities are compared, it is clear that there was a greater amount of land available per dwelling and per person, and a lower residential density, in the Morelos polity than in the Clavo Verde polity. These findings indicate that intensive cultivation of infield plots was likely a strategy adopted in the Morelos polity where the additional maize production would have served an important role in supporting the relatively large number of people living there. But, intensive cultivation of infield plots in conjunction with long-fallow swidden cultivation of outfields still probably did not produce enough food to support the climax population in the Morelos polity. Here, the productive potential of the slopes in the Morelos Piedmont is calculated in order to determine if this additional source of food was enough to support the maximum population of the Morelos polity during the Late-Terminal Classic period.

Table 4-14 shows the maximum productive potential of the agricultural terraces located outside of the best extensive farming zones in the Morelos polity during the Late-Terminal Classic period. Using the high yield estimate of 2,000 kg of maize per hectare per year, approximately 984 individuals could have been supported annually from maize grown on these terraces. The yield estimate assumes that the nutrient rich colluvial soils captured behind terrace walls, and better moisture retention in the soils, would have permitted yields at least as high as the potential maximum using swidden techniques. Additionally, the potential to back-fill with exogenous soils (e.g. Turner 1983: 33) and/or to fertilize terraced fields with household waste in a similar fashion to infield cultivation (as described above in section 4.3.1.4), would have resulted in fields that could have been farmed continuously without the need for long-term fallowing.

Applying the above estimate to the previous calculations of the productive potential of the Morelos Piedmont, which assumed that the best extensive farming zones were under long-fallow swidden cultivation and that 40 percent of the population's subsistence needs were acquired through cultivation of infield plots, the maximum number of people that could have been supported in the Morelos Piedmont rises to 6,317 if the maximum maize yield of 2,000 kg per hectare per year is applied to the long-fallow swidden cultivation of the best extensive farming zones (Table 4-17). If the lower maize yield of 1,500 kg per hectare per year is applied, the maximum number of people that could be supported is 4,984. Both of these figures indicate that extensive production on outfields combined with intensive production on infields and terraces could have provided enough food to satisfy the minimum nutritional requirements of the Late-Terminal Classic population in the Morelos polity. The long-fallow, swidden maize yield would have had to be reduced to just over 1,000 kg per hectare per year before the population would have exceeded the carrying capacity (Table 4-17).

Finally, long-fallow swidden cultivation on the slopes and intermediate rugged zones is considered. Because these zones are generally poor for agriculture, the low yield estimate of 500 kg of maize per hectare is used for the intermediate rugged zones (Table 4-15). Because the slopes represent the poorest agricultural lands in the zone, this low yield estimate has been reduced by one-half to 250 kg of maize per hectare (Table 4-16). Applying these figures to the previous calculations of the productive potential of the Morelos Piedmont, the maximum number of people that could have been supported rises to 7,251 if the maximum maize yield of 2,000 kg per hectare per year is applied to the long-fallow swidden cultivation of the best extensive farming zones (Table 4-17). Even if the extensive cultivation of the best extensive farming zones were producing half that amount (1,000 kg per hectare per year), it appears that cultivation on slopes and in the intermediate rugged zones could have produced enough food to satisfy the subsistence requirements of the Late-Terminal Classic period population of the Morelos polity (Table 4-17).

Table 4-14 Morelos Polity Late-Terminal Classic Period: Productive Potential of Agricultural Terraces Located Outside of Best Extensive Farming Zones

Area of Terraces (ha)	Productive Potential (kg of maize per year)	Amount Produced per Year (kg of maize)	Annual Food Requirement per Person (kg of maize)	Number of People Supported
49.2	2,000	98,400	100	984

Table 4-15 Morelos Polity Late-Terminal Classic Period: Long-Fallow Swidden Productive Potential of Intermediate Rugged Terrain

Area of Intermediate Rugged Terrain (ha)	Productive Potential (kg of maize per year)	Amount Produced per Year (kg of maize)	Fallow Factor	Maize Production per Year (kg)	Annual Food Requirement per Person (kg of maize)	Number of People Supported
843	500	412,500	0.2	82,500	100	825

Table 4-16 Morelos Polity Late-Terminal Classic Period: Long-Fallow Swidden Productive Potential of Slopes

Area of Slopes (ha)	Productive Potential (kg of maize per year)	Amount Produced per Year (kg of maize)	Fallow Factor	Maize Production per Year (kg)	Annual Food Requirement per Person (kg of maize)	Number of People Supported
218	250	54,500	0.2	10,900	100	109

Table 4-17 Morelos Polity Late-Terminal Classic Period: Maximum Number of People Supported by Maize Production on Best Extensive Farming Zones, Infields, Terraces, Intermediate Rugged Zones, and Slopes Combined

Number of people supported by extensive cultivation of Best Extensive Farming Zones and intensive cultivation of infields	5,333*	4,000**	2,667^
+	+	+	+
Number of people supported by terraces alone	984	984	984
+	+	+	+
Number of people supported by Intermediate Rugged Zones	825	825	825
+	+	+	+
Number of people supported by Slopes	109	109	109
=	=	=	=
Maximum Number of People Supported	7,251	5,918	4,585

Morelos Polity Late-Terminal Classic population = 4,020
*Best Extensive Farming Zone yield of 2,000 kg of maize per ha per year
**Best Extensive Farming Zone yield of 1,500 kg of maize per ha per year
^Best Extensive Farming Zone yield of 1,000 kg of maize per ha per year

5.0 DISTRIBUTION OF ELITES AND THE QUESTION OF ELITE MANAGEMENT OF AGRICULTURAL PRODUCTION

5.1 DISTRIBUTION OF ELITES IN RELATION TO AGRICULTURAL TERRACES

The spatial distribution of elite dwellings in relation to agricultural terraces yields clues as to the nature of elite management of intensive agricultural production. Spatial proximity is important based on the assumption that those who worked, maintained, and maybe managed terraces inhabited the areas that were spatially close to them (Beach and Dunning 1997; Rodriquez 2006: 8). Elite dwellings found in direct association with agricultural terraces can be interpreted as evidence for elite management of the production derived from those terraces (Chase and Chase 1996). Conversely, the absence of elite dwellings (and the presence of commoner dwellings) in direct association with agricultural terraces can be interpreted as local household or community management of intensive food production (Dunning et al. 1997).

In the Morelos polity during the Late-Terminal Classic period, the number of dwellings of all types associated with agricultural terraces is nearly one-half (in order for a dwelling to be classified as *associated* with an agricultural terrace system, it must be geographically located within 100 m of an agricultural terrace or part of a house group cluster containing agricultural terraces) (Table 5-1). Of those dwellings not associated with agricultural terraces, 44 percent are in best extensive farming zones (Table 5-2). This results in only about 4 percent of all dwellings that are not associated with agricultural terraces and not in best extensive farming zones. Of the range structure and non-range structure elites, all but 2 dwellings are located in the best extensive farming zones or are associated with agricultural terraces. This strong association of all dwellings with either agricultural terraces or the best farming zones underscores the importance of living near especially productive zones in an otherwise marginal agricultural setting.

Interestingly, the majority of agricultural terracing in the Morelos Piedmont is associated with at least one elite dwelling. In the Morelos polity during the Late-Terminal Classic period, 63.5 percent of the terraced landscape is associated with house group clusters containing elite dwellings (range or non-range structure elites), whereas only 12.4 percent of the terraced landscape is associated with house group clusters without elite dwellings (Table 5-3). For the remaining 24.1 percent of the terraced landscape no associated structures were detected during the survey. If agricultural terrace systems without elite dwellings or associated structures, but in view of the polity capital and/or second-tier civic centers containing elite dwellings are included in the tabulation, applying the logic that these systems might have been monitored from afar by elite personages, 87.1 percent of the terraced landscape is associated with elites (Table 5-4). Due to the hilltop setting of the polity capital and many of the second-tier civic centers, much of the Morelos survey zone is in elite view. Based on the sight lines from the capital and second-tier civic centers noted during the survey, approximately 72 percent of the entire survey zone would have been in view (Figure 5-1, Figure 5-2). Figure 5-1 is an approximation of how much, and which parts, of the polity are in view of the polity capital and second-tier civic centers. Because of the undulating topography, especially in the slopes of the northwest portion of the polity, there are some small pockets of terrain that were obscured from view that are not represented in Figure 5-1. However, these zones constitute a small proportion of the entire landscape and the house group clusters and terrace systems within the shaded zones can be seen from either the polity capital or at least one second-tier civic center. A gently rising ridge and undulating topography near the center of the polity results in a northeast to southwest swath of terrain that is largely out of view. But, the few house group clusters and terrace systems in this zone (see MR 10 and MR 17) can be seen from the polity capital (Figure 5-3).

The 15.1 percent difference between the proportion of agricultural terrace systems in view of the polity capital and/or second-tier civic centers (87.1 percent), and the proportion of the entire survey zone in direct view of the same civic centers (72 percent), suggests that elites may have had a particular interest in monitoring agricultural terrace systems. If the percentage was the same or less for agricultural terraces, then support would not be found for this interpretation. In some cases, agricultural terrace systems appear to have been built on naturally raised ledges or hilltop mesas, perhaps intentionally as to insure their direct view of the polity capital or second-tier civic centers (Figure 5-4, Figure 5-5). These data illustrate that there is a strong association of agricultural terraces with elite dwellings, and suggest that elites may have monitored intensive production on terraces in the Morelos polity during the Late-Terminal Classic period. But, if elites did monitor production on terraces, what benefit did they receive? Was the amount of maize that could be grown on terraces in the polity large enough to satisfy the subsistence requirements of the resident elite population? Or, was the amount of maize so small as to only make a marginal impact on the elites' overall subsistence base?

Table 5-5 shows the amount of maize per resident elite within house group clusters with agricultural terraces. Using the high yield estimate of 2,000 kg of maize per ha per year, assuming that the colluvial soils captured behind terrace walls would have resulted in highly productive planting surfaces that could also have been back-filled with exogenous soils and/or fertilized with household waste in a similar fashion to infield cultivation (see Chapter 4 for explanation of maize production figures), for every terrace system with range structure elites and/or non-range structure elites, enough maize could have been grown to satisfy their minimum annual maize requirement (Table 5-5). It is impossible to know if this apparent congruence between the number of range structure and non-range structure elites associated with agricultural terraces and the amount of maize that could be produced annually on those terraces is meaningful, or simply coincidental. To assume that all food produced on terraces was for elite consumption is an oversimplification; the relationship between intensive agricultural production and elite consumption was surely much more complicated than this. But, because the Late-Terminal Classic period population of the Morelos Piedmont was over the carrying capacity of the best extensive farming zones, and therefore cultivation of the less productive slopes and intermediate rugged zones was necessary, it is logical to assume that elites would, at the very least, have been interested in monitoring the food produced in these particularly productive zones within the polity. So, although it is impossible to know how much of the food grown on terraces was for elite consumption, given the strong association of elite dwellings with agricultural terraces it is likely that at least some of it was, and that elites may have monitored the output of intensive production on terraces.

The strong association between elites and agricultural terrace systems in the Morelos polity suggests that elites may have monitored the output of intensive production on the terraces. But, as was demonstrated in Chapter 4, there almost certainly would not have been a need for elite managers to oversee the planning and to organize the labor for construction, maintenance and cultivation of the terrace systems.

Table 5-1 Morelos Polity Late-Terminal Classic Period: Dwelling Distribution in Relation to Agricultural Terraces

	Associated with Agricultural Terraces	Not Associated with Agricultural Terraces
Range Structure Elites (n = 44)	22 (50%)	22 (50%)
Non-Range Structure Elites (n = 38)	21 (55%)	17 (45%)
Jr. Relatives/Retainers (n = 151)	60 (40%)	91 (60%)
Commoners (n = 571)	315 (55%)	256 (45%)

Table 5-2 Morelos Polity Late-Terminal Classic Period: Dwelling Distribution At Agricultural Terraces and Away from Agricultural Terraces

	Associated with Agricultural Terraces	In Best Extensive Farming Zones No Terraces	In Intermediate Rugged Zones No Terraces	In Slopes No Terraces
Range Structure Elites (n = 44)	22 (50%)	20 (45%)	-	2 (5%)
Non-Range Structure Elites (n = 38)	21 (55%)	17 (45%)	-	-
Jr. Relatives / Retainers (n = 151)	60 (40%)	86 (57%)	-	5 (3%)
Commoners (n = 571)	315 (55%)	230 (40%)	11 (2%)	15 (3%)
TOTAL (n = 804)	418 (52%)	353 (44%)	11 (1%)	22 (3%)

Table 5-3 Morelos Polity Late-Terminal Classic Period: Agricultural Terracing Associated with House Group Clusters with Elite Dwellings

	Combined Area of Agricultural Terraces (ha)	% of Total
Has Range or Non-Range Elites	56.6	63.5
Without Range or Non-Range Elites	11.1	12.4
No Associated Dwellings	21.5	24.1
TOTAL	89.2	100

Table 5-4 Morelos Polity Late-Terminal Classic Period: Agricultural Terracing Associated with House Group Clusters with Elite Dwellings or in View of the Polity Capital or Second-Tier Civic Center

	Combined Area of Agricultural Terraces (ha)	% of Total
Has Range or Non-Range Elites *or* in View of Capital or Second-Tier Civic Center	77.7	87.1
Without Range or Non-Range Elites and Not in View of Capital or Second-Tier Civic Center	6.9	7.7
No Associated Dwellings and Not in View of Capital or Second-Tier Civic Center	4.6	5.2
TOTAL	89.2	100

Table 5-5 Morelos Polity Late-Terminal Classic Period: Amount of Maize per Resident Elite at House Group Clusters with Agricultural Terraces

House Group Cluster / Terrace System	Area of Terraces (ha)	Maize Production per Year (2,000 kg per ha)	Number of Range Structure Elites*	Amount of Maize per Range Structure Elite^ (kg per person)	Number of Range and Non-Range Structure Elites	Amount of Maize per Range and Non-Range Structure Elite (kg per person)
MR 5, 51	15.8	31,600	15	**2,107**	35	**903**
MR 54	15.1	30,200	-	**-**	10	**3,020**
MR 28	13.7	27,400	10	**2,740**	15	**1,827**
MR 24	4.3	8,600	20	**430**	35	**246**
MR 53	2.8	5,600	-	**-**	5	**1,120**
MR 4	2.6	5,200	15	**347**	25	**208**
MR 57	2.4	4,800	25	**192**	40	**120**
MR 64	1.6	3,200	10	**320**	25	**128**
MR 8	0.5	1,000	5	**200**	10	**100**
MR 55	0.5	1,000	10	**100**	10	**100**

*Total number of dwellings multiplied by 5 individuals per dwelling.
^Minimum annual per person maize requirement of 100 kg

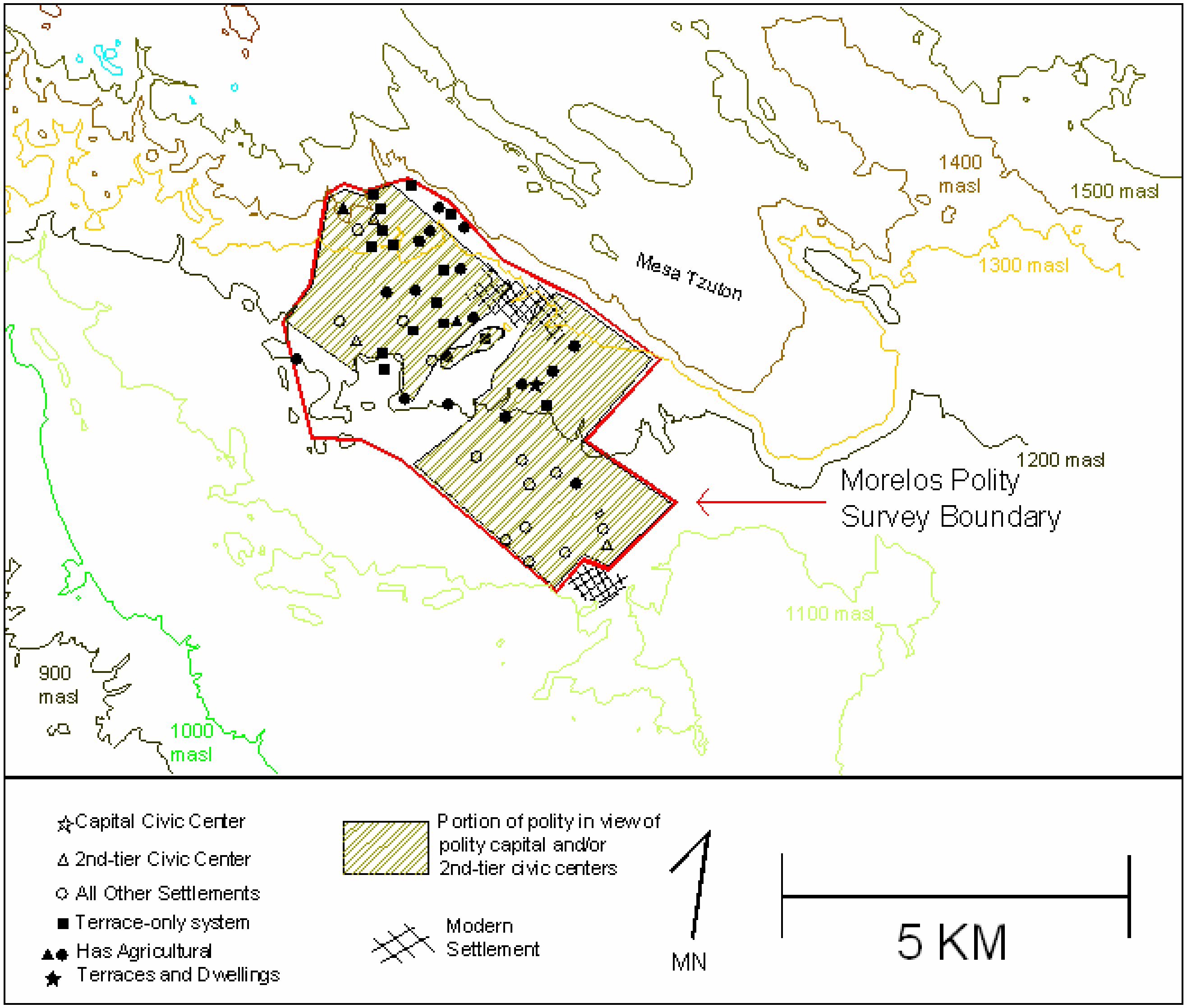


Figure 5-1 Morelos Polity Late-Terminal Classic Period: Estimate of the Proportion of Polity In View of Polity Capital and/or 2nd-Tier Civic Centers

Figure 5-2 View of Best Extensive Farming Zone from the Morelos Polity Capital (MR 57) Facing South

Figure 5-3 View of Terrace System MR 17 from Morelos Polity Capital (MR 57)

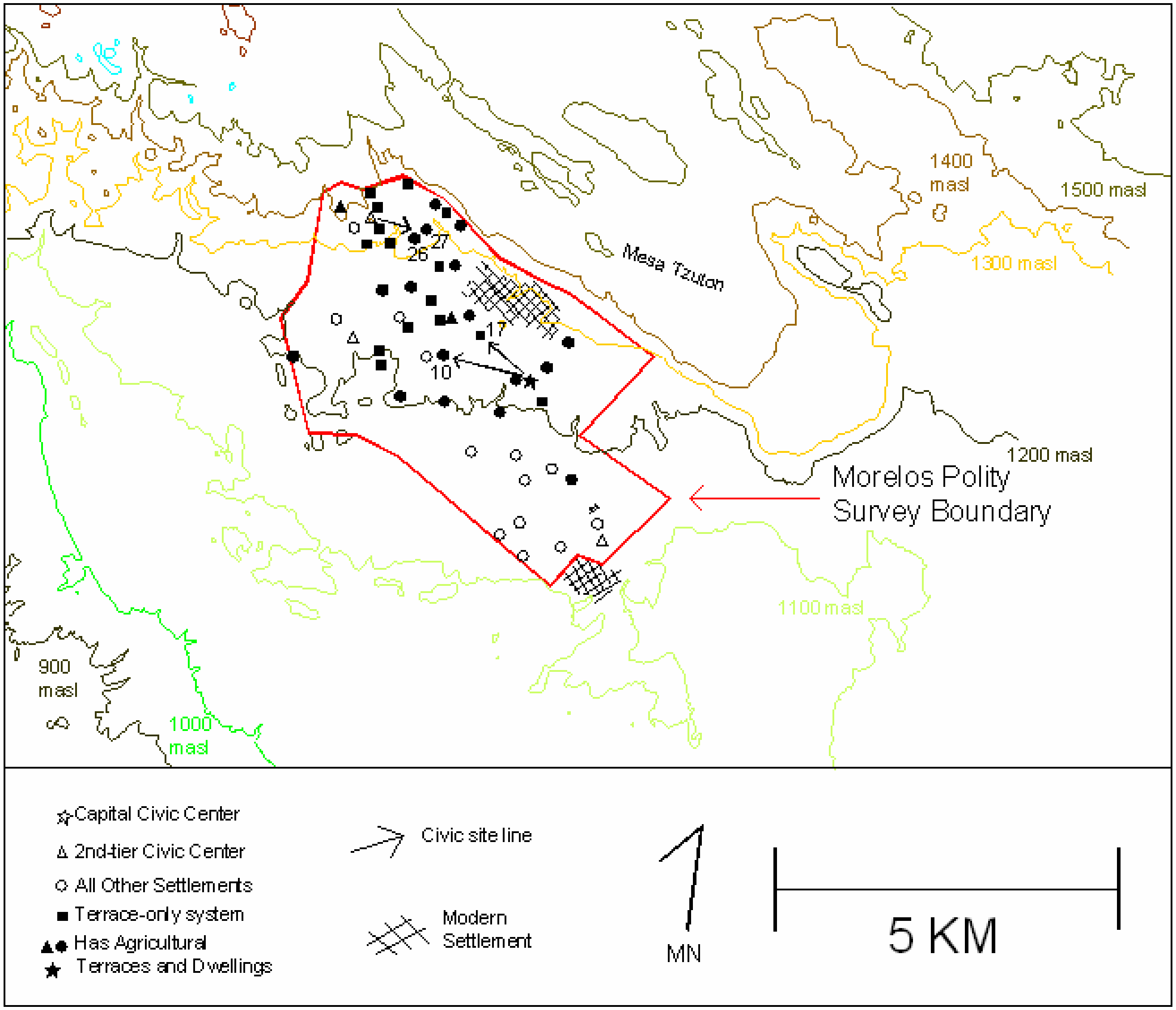


Figure 5-4 Morelos Polity Late-Terminal Classic Period: Agricultural Terrace Systems on Naturally Raised Ledges or Hilltop Mesas In View of the Polity Capital or 2nd-Tier Civic Centers

Figure 5-5 View of Hill that 2nd-Tier Civic Center MR 18 is on from Terrace System MR 27

5.2 DISTRIBUTION OF ELITES THROUGHOUT BEST EXTENSIVE FARMING ZONES

Because no agricultural terraces were recorded during the survey of the San Lucas Valley, comparison of elite distribution in relation to terraces between the Clavo Verde polity and Morelos polity was not possible in the previous section. Here, the distribution of elites throughout the best extensive farming zones in both polities is compared in order to determine if there is a difference in the elite presence in this zone. I have found that elites were more intrusively distributed across settlements in the best extensive farming zones in the Morelos polity than in the Clavo Verde polity. It is possible that the more intrusive distribution of elites in the Morelos polity is related to the marginal nature of the Morelos Piedmont where elites may have had a greater interest in monitoring production in the best extensive farming zones because the Late-Terminal Classic period population was over the long fallow, swidden carrying capacity.

In the Clavo Verde polity during the Late-Terminal Classic period, nearly all of the range structure and non-range structure elites, all of the retainers, and 87 percent of the commoner dwellings, are located in best extensive farming zones (Table 5-6). Of the 46 house group clusters located in best extensive farming zones, 22 contain at least one elite dwelling which is 48 percent (Table 5-7; Figure 5-6). So, nearly half of the house group clusters in the best extensive farming zones contain at least one elite dwelling. Additionally, 35 of the 57 (61 percent) house group clusters in the Clavo Verde polity are within 1 km of the San Lucas river (Figure 5-6). That number rises to 52 of 57 (91 percent) if distance to the San Lucas river is extended to 2 km. These figures indicate that population, both elite and commoner, was concentrated in best extensive farming zones near the San Lucas river which is not surprising given the extensive distribution of relatively deep, flat-lying soils on either side of the river extending through the north-south axis of the core of the polity. Because no agricultural terraces were found during the survey of the San Lucas Valley, and because the Late-Terminal Classic period population of the Clavo Verde polity was under the long fallow, swidden carrying capacity of the best extensive farming zones, it appears likely that extensive cultivation on the best soils was the predominant farming strategy applied.

The natural setting of the Morelos Piedmont is very different from that of the San Lucas Valley. In the Morelos zone, a large portion of the core of the polity is hilly, erosion-prone topography with shallow soils that are generally poor for farming. But, approximately 800 ha of best extensive farming zones do exist (see Chapter 4). In the Morelos polity during the Late-Terminal Classic period, 45 percent of the range structure elites and non-range structure elites are located in best extensive farming zones at house group clusters without terraces (Table 5-2, Figure 5-7) (only house group clusters in the best extensive farming zones without terraces are considered here to distinguish them from those with terraces, and to facilitate comparison with the Clavo Verde polity where no terraces were recorded). As was discussed above, the vast majority of elites outside of the best extensive farming zones are associated with agricultural terracing. Only 2 range structure elite dwellings are in the slopes and not associated with agricultural terracing (Table 5-2). To put it another way, the vast majority of all types of dwellings are either located in the best extensive farming zone or are associated with agricultural terraces (98 percent of elites, 97 percent of retainers, and 95 percent of commoners) (Table 5-2). So, population was clearly concentrated in these two zones. But how were elites distributed throughout the best extensive farming zone? Does the distribution indicate that elites may have had an interest in monitoring production in this zone similar to the production derived from agricultural terraces? In the Morelos polity, 67 percent of the house group clusters located in the best extensive farming zones without agricultural terraces have at least one elite dwelling (Table 5-7). In the Clavo Verde polity, 48 percent of the house group clusters in the best extensive farming zones have at least one elite dwelling. There is a 19 percent difference between the two polities in the proportion of house group clusters in the best extensive farming zones that have at least one elite dwelling. Furthermore, comparison of elite rural dispersal within the best extensive farming zones of both polities, that is to say away from the polity capital and second-tier civic centers, yields a similar result. In the Morelos polity, 60 percent of house group clusters contain at least one elite dwelling compared to 45 percent in the Clavo Verde polity

(Table 5-8). These data indicate that elites were more intrusively distributed across house group clusters in the best extensive farming zones in the Morelos polity than in the Clavo Verde polity. It is possible that this elite distributional pattern is related to differences in the natural settings between the two polities. In the more agriculturally marginal Morelos Piedmont, elites may have had a greater interest in monitoring production in the best extensive farming zones because the Late-Terminal Classic period population was over the long fallow, swidden carrying capacity. In the Clavo Verde polity, where the population was under the carrying capacity of the best agricultural lands, there would have been less need for elites to monitor production. Although this conclusion is dubious because of the much smaller overall number of house group clusters in best extensive farming zones in the Morelos polity compared to the Clavo Verde polity (see Table 5-7 and Table 5-8), it is an intriguing possibility that the more intrusive distribution of elites throughout the best extensive farming zones in the Morelos polity might be related to the more marginal nature of the Morelos Piedmont and thus the greater need for elites to monitor agricultural production, be it intensive production on terraces, or in this case, extensive cultivation in the best agricultural zones.

Table 5-6 Clavo Verde Polity Late-Terminal Classic Period: Distribution of Dwellings in Relation to Best Extensive Farming Zones

	Best Extensive Farming Zones	Outside of Best Extensive Farming Zones
Range Structure Elites (n = 13)	13 (100%)	-
Non-Range Structure Elites (n = 47)	46 (98%)	1 (2%)
Jr. Relatives / Retainers (n = 89)	89 (100%)	-
Commoners (n = 775)	675 (87%)	100 (13%)

Table 5-7 Clavo Verde Polity and Morelos Polity Late-Terminal Classic Period: Percentage of House Group Clusters in Best Extensive Farming Zones with at least One Elite Dwelling

	Number of House Group Clusters with at least One Elite Dwelling*	Number of House Group Clusters Without at least One Elite Dwelling	Total Number of House Group Clusters	Percentage of House Group Clusters with at least One Elite Dwelling
Clavo Verde Polity Best Extensive Farming Zones	22	24	46	48%
Morelos Polity Best Extensive Farming Zones	8	4	12	67%
**Elite dwelling* is defined as either one range or non-range structure elite				

Table 5-8 Clavo Verde Polity and Morelos Polity Late-Terminal Classic Period: Elite Rural Distribution (Away from Polity Capital and 2nd-Tier Civic Centers) within Best Extensive Farming Zones

	Number of House Group Clusters with at least One Elite Dwelling*	Number of House Group Clusters Without at least One Elite Dwelling	Total Number of House Group Clusters	Percentage of House Group Clusters with at least One Elite Dwelling
Clavo Verde Polity Best Extensive Farming Zones	19	23	42	45%
Morelos Polity Best Extensive Farming Zones	6	4	10	60%
**Elite dwelling* is defined as either one range or non-range structure elite				

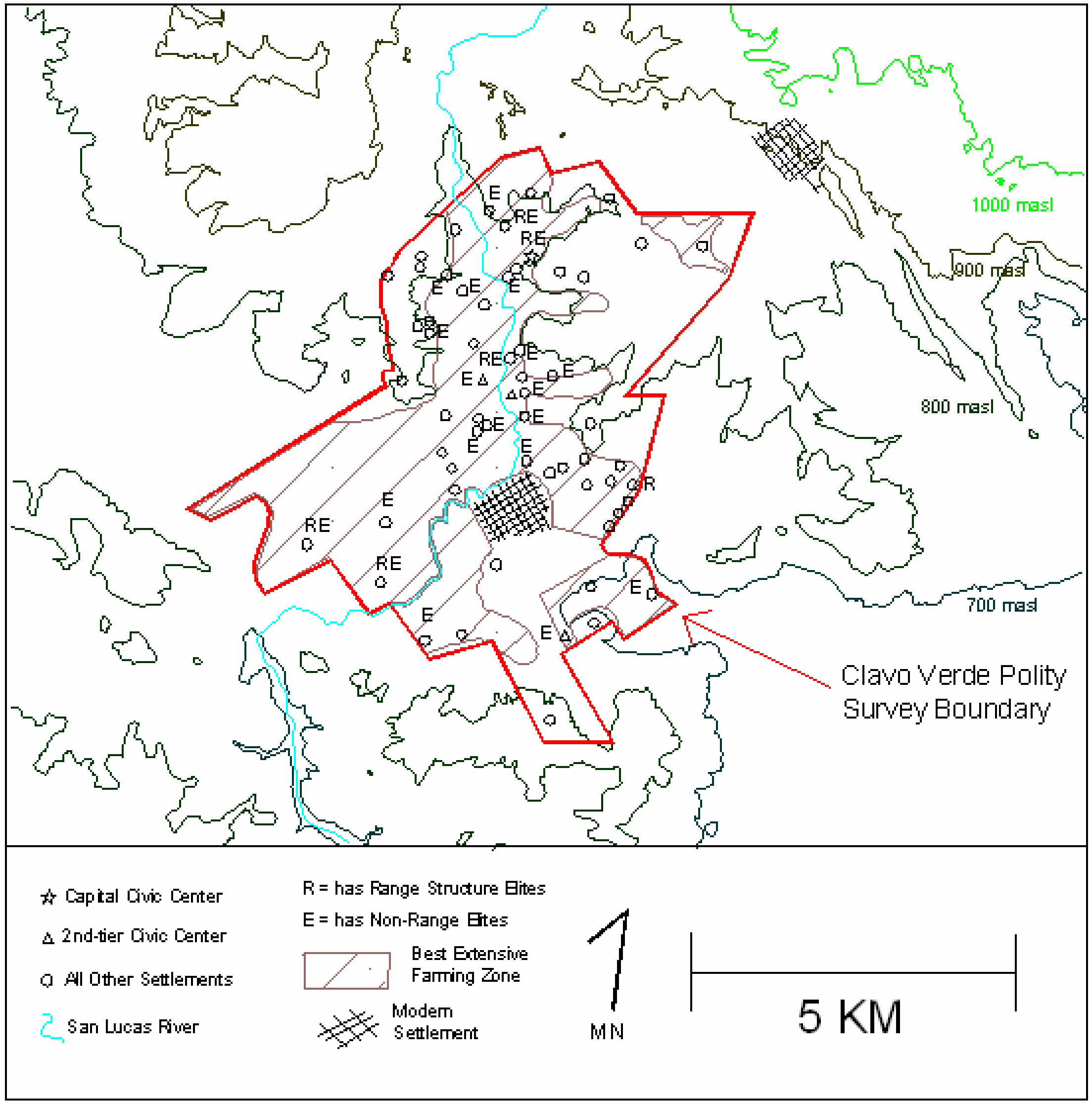


Figure 5-6 Clavo Verde Polity Late-Terminal Classic Period: Location of House Group Clusters with Range Structure Elites and Non-Range Structure Elites

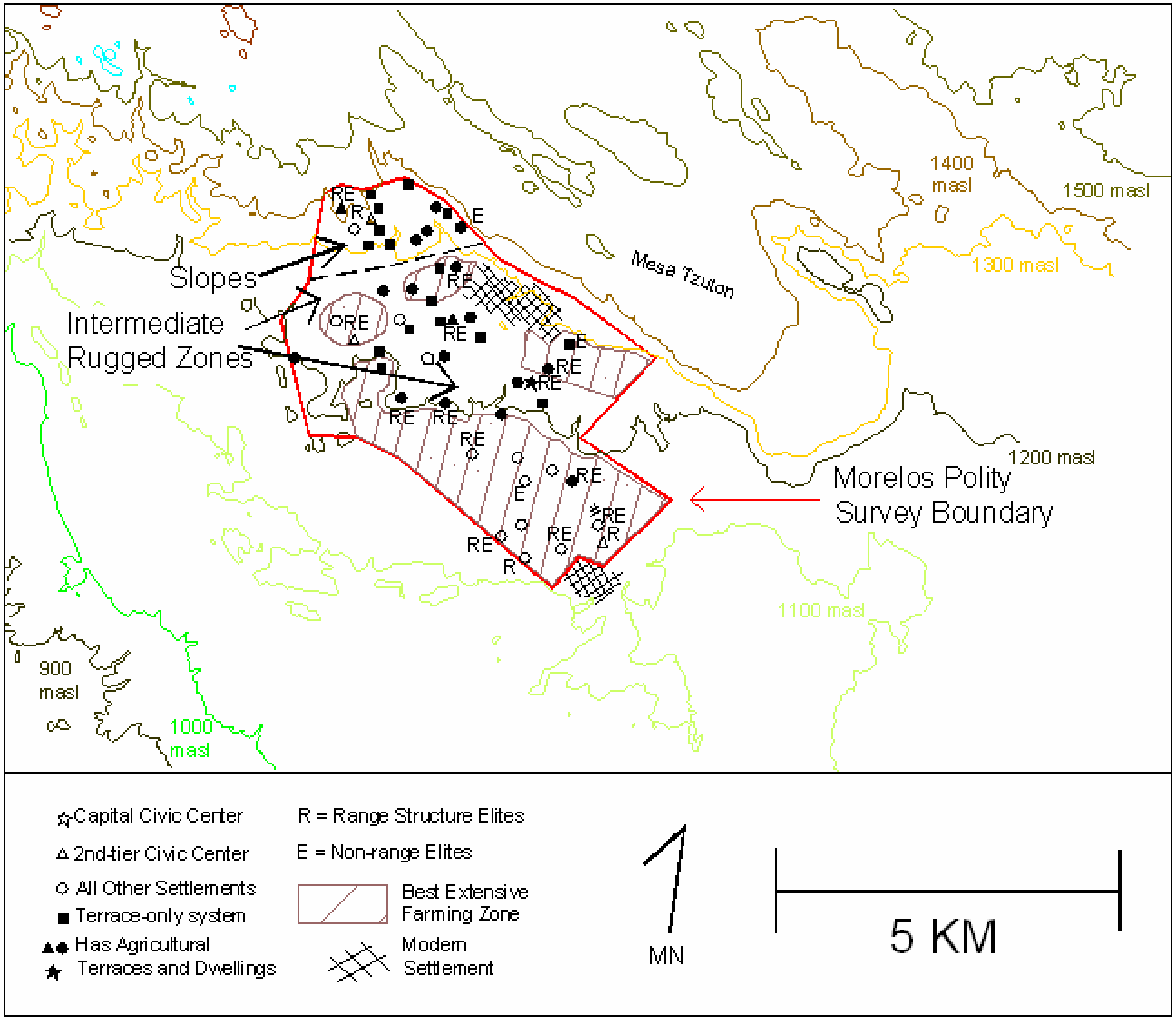


Figure 5-7 Morelos Polity Late-Terminal Classic Period: Location of House Group Clusters with Range Structure Elites and Non-Range Structure Elites

5.3 CONCLUSION

Examination of the distribution of elites in relation to agricultural terraces and best extensive farming zones in the Morelos polity has found that the vast majority of elites (98 percent) were either associated with agricultural terraces or located in the best farming zones. This indicates that there was an agrarian basis for where elites were living during the Late-Terminal Classic period in the Morelos polity. There also appears to have been an agrarian basis for where elites were living in the Clavo Verde polity, where 99 percent of elites are found in the best extensive farming zones. This conclusion is consistent with many previous studies of ancient Maya society (Chase and Chase 1998; Dunning 2004, 1996; Dunning et al. 1997; Lohse 2004), but does not preclude elites from also deriving wealth from other aspects of society such as exchange (McAnany et al. 2002; West 2002) or achieving status through ideological means (Demarest 1992).

The more intrusive distribution of elites throughout the best extensive farming zones in the Morelos polity compared to the Clavo Verde polity might be linked to the more marginal nature of the Morelos Piedmont where elites would have had a greater interest in monitoring production in these zones as well as on terraces. Although a strong association was found between elite dwellings and agricultural terraces in the Morelos polity, there almost certainly would not have been a need for top-down, elite management of terrace planning or the labor required for terrace construction, maintenance or cultivation. But that does not entirely dismiss the possibility for other kinds of elite managerial activities such as monitoring the output of intensive production on terraces. If this was indeed the case, then a variety of questions, especially related to tribute collection and land ownership, immediately come to mind that may merit exploration in the future. What, exactly, was the nature of elite involvement in the productive economy? Were agricultural lands communally owned by local groups with elites acquiring wealth by taxing the harvest? Or, was the situation more akin to a "feudal" or estate system, as inferred by some scholars from ethnohistorical documents from Yucatan, in which land estates are owned by elite nobles and worked by a lower strata of peasant farmers (Adams and Smith 1981; Foias 2002: 227). Closer examination of how elites and commoners are dispersed throughout the Morelos polity in association with agricultural terraces and best farming zones would appear to represent a good starting point for testing an estate model.

6.0 CONCLUSION

Although the population sizes of the Morelos polity and the Clavo Verde polity were not all that different during the Late-Terminal Classic period (4,020 and 4,620 respectively), differences in the natural environments of the Morelos Piedmont and San Lucas River Valley were found to be directly linked to the need for intensive agricultural production in each polity. The limited distribution of soils good for farming (best extensive farming zones) in the Morelos Piedmont resulted in a greater need for intensive cultivation in less desirable farming zones (slopes and intermediate rugged zones) where numerous agricultural terraces were recorded during the survey. In the San Lucas Valley, the greater amount of best extensive farming zones resulted in a lesser need for intensive cultivation in less desirable farming zones evidenced by the fact that no agricultural terraces were found in these zones during the survey. Furthermore, it appears likely that intensive production on infield plots played a greater role in food production in the Morelos Piedmont than in the San Lucas Valley. In the Morelos Piedmont, the average number of persons within house group clusters was found to be less, and the amount of land per person was found to be more, indicating that intensive infield cultivation on this additional land might have been an important component of the subsistence adaptation. Because of the greater amount of best extensive farming zones in the San Lucas Valley intensive infield cultivation would have been less necessary.

Long-fallow, swidden cultivation in the best extensive farming zones would not have been sufficient to support the Late-Terminal Classic period population of the Morelos polity. Therefore, cultivation of the less productive intermediate rugged zones and slopes would have been necessary. The combination of long-fallow, swidden farming of the best extensive farming zones with intensive farming on agricultural terraces and on infield plots within house group clusters likely could have provided enough maize to meet the minimum annual nutritional requirement of the population. In the Morelos polity where population exceeded the carrying capacity of the best extensive farming zones, intensive farming techniques were adopted.

In the Clavo Verde polity, enough maize could have been produced through long-fallow, swidden cultivation in the best extensive farming zones to support the Late-Terminal Classic period population. Therefore, population was under the carrying capacity of these zones. No agricultural terraces were found in the San Lucas Valley and, as explained above, it appears that intensive cultivation on infield plots would have been less necessary than in the Morelos polity. It is likely that long-fallow, swidden cultivation of the best agricultural lands was the predominant subsistence strategy, and cultivation of less desirable farming zones would not have been necessary.

Examination of the distribution of elites throughout the best extensive farming zones and in relation to agricultural terraces has indicated that there was an agrarian basis for where elites were living during the Late-Terminal Classic period in both the Clavo Verde and Morelos polities. Because of the extensive distribution of soils good for farming in the San Lucas Valley, it is not surprising that the vast majority of elite dwellings (99 percent) in the Clavo Verde polity were located in the best extensive farming zones. However, only 48 percent of the house group clusters in the best extensive farming zones contain at least one elite dwelling. In the Morelos polity, elites were equally distributed between the best extensive farming zones and agricultural terrace systems. At house group clusters in the best extensive farming zones without terraces, 67 percent contain at least one elite dwelling. Furthermore, comparison of elite rural dispersal within the best extensive farming zones of both polities, that is to say at non-civic settlements, yields a similar result. In the Morelos polity, 60 percent contain at least one elite dwelling compared to 45 percent in the Clavo Verde polity. These data indicate that elites were more intrusively distributed across settlements in the best extensive farming zones in the Morelos polity than in the Clavo Verde polity. It is possible that the more intrusive distribution of elites in the Morelos polity is related to the marginal nature of the Morelos Piedmont where elites may have had a greater interest in monitoring production in the best extensive farming zones because the Late-Terminal Classic period population was over the long fallow, swidden carrying capacity. In the Clavo Verde polity, where the population was under the carrying capacity of the best agricultural lands, there would have been less need for elites to monitor production.

In regards to agricultural terraces, it appears that adoption of intensive farming techniques was related to the relative need for intensification. In the Clavo Verde polity, where there was a lesser need for intensive farming, no agricultural terraces were found which indicates that this intensive farming technique was not adopted. In the Morelos polity, where there was a greater need for intensive farming, numerous agricultural terraces were recorded. The locally available commoner labor would have been sufficient to construct, maintain and cultivate all terrace systems. Therefore, there would not have been a need for elite managers to coordinate labor for these activities. Furthermore, the small scale and simplistic technology inherent to the dryslope and check dam terrace forms in the Morelos polity does not suggest the need for elite managers to provide the engineering know-how for their construction. A lack of evidence for standardization in terrace wall height and width, and in the width of terrace fields, indicates that a design template was not applied to the terrace systems which, if present, might indicate top-down elite management of terrace construction. A managerial aspect of intensive agricultural works not considered here is dispute resolution. Complex terrace forms, such as bench terraces, have a small degree of hyper-coherency that may result in the need for elite managers to mediate disputes. Because of the relatively great height of bench terraces and the cutting away of some of the hillside to create flat planting surfaces, failure of a terrace wall upslope can release debris that damages walls downslope (Wilken 1987). The possibility for dispute arises if the terrace wall that failed, and the downslope terrace wall that was damaged, are cultivated by different families or corporate groups. This is the closest terraces come to dispute issues inherent to other intensive agricultural works, such as irrigation systems, which are related to water scheduling or the expansion of the system which affects how much water plots of land receive in different parts of the system. The absence of complex terrace forms, like bench terraces, in the Morelos Piedmont indicates that there would have been little need for elite managers to mediate such disputes.

Although there was apparently little need for top-down, elite management of terrace planning, construction, maintenance and cultivation, that does not entirely dismiss the possibility that elites were involved in other ways with intensive farming on terraces. The strong association of elites with agricultural terraces in the Morelos polity, especially if those terrace systems without elite dwellings but in view of the polity capital or second-tier civic centers with elite dwellings are included, suggests that elites might have had an interest in monitoring the production on those terraces, perhaps controlling harvests.

In regards to the third research question posed in the introductory chapter, other studies concerned with agricultural terracing in the Maya lowlands, for example in the Petexbatun region and Upper Belize River Area, and at Palenque and Caracol, have reached differing conclusions as to whether the organization of intensive agricultural production on terraces was a top-down process managed by elites, or was a bottom-up process where the organizational initiatives were provided by commoners without elite input. Many of the analytical categories used here have been applied in the studies including 1) examination of the distribution of elites in relation to terraces, 2) assessment of the size of terrace systems which can be related to the labor required for construction and maintenance, and 3) assessment of the degree of uniformity in terrace field patterns. Comparatively, the Morelos polity during the Late-Terminal Classic period is most similar to the Petexabatun region.

In the Petexbatun region, especially near the Late Classic settlement of Tamarandito, some agricultural terraces are clearly associated with particular households, some of which have been identified as elite (Dunning et al. 1997). This led Beach and Dunning (1997) to conclude that "the various terrace systems seem to indicate that many elite urban households at Tamarandito were involved in agricultural production." But the relative simplicity and small scale of most of the terracing in the zone indicates that they could easily have been created by local cooperation and incremental growth (ibid.: 263). The degree of uniformity in terrace field patterning is not addressed. Conclusions concerning whether elites "managed" intensive agricultural production on terraces, and if they did to what degree, have not been determined.

In the Upper Belize River Area, Fedick (1994) found box terraces in direct association with residential sites, some of which may have contained elite personages. But given the small scale of the terrace systems, he asserts that there is no basis for suggesting the existence of a centrally controlled program of terrace development. Instead, he interprets the terracing as a localized component of intensive home gardening (ibid.: 124). Terrace field patterning is not discussed, and the issue of elite management of intensive agricultural production in this zone has not been further addressed.

Some dryslope agricultural terraces have recently been recorded in the immediate hinterland of Palenque in the Chiapas lowlands. Although these are relatively small in size, Liendo (2002: 157-159) interprets such terraced fields as farmsteads belonging to the elite residing at Palenque where surplus food could have been grown. Because the terrace systems required more labor for their construction than could have been provided by the population in nearby settlements, he suggests that elites at Palenque would have mobilized the requisite labor in a top-down fashion (ibid.: 189). The locally available commoner labor in the Morelos polity would have been sufficient for the construction of all terrace systems therefore it does not appear that there would have been a need for elites to mobilize labor groups.

The agricultural terrace systems in the Morelos polity differ most from the terraces recorded at the Classic period site of Caracol. At Caracol, elite dwellings in close proximity to agricultural terraces, the large scale and regularity in the form and field patterning of agricultural terraces, and a hierarchy of administrative plazas among terraced fields have been cited as evidence for elite management of intensive agricultural production (Chase and Chase 1996, 1998; Healy et al. 1983). In the Morelos polity, the relatively small size of agricultural terraces, lack of standardization in field patterning, and discrete, hodge-podge nature of their distribution throughout the piedmont zone would seem to represent the polar opposite of the enormous scale and complex patterning of the terraces at Caracol.

These studies have not only documented the enormous variability in agricultural terracing throughout the Maya lowlands, but also serve to illustrate the challenges inherent to linking elite behaviors to intensive agricultural production. My study reveals that assessment of terrace size, form, and patterning, although necessary for the investigation of managerial issues related to intensive agricultural works, cannot alone dispel the possibility that elites were involved in intensive agricultural production. Even if, as is the case here, there is little evidence to support the argument that elite, top-down management of intensive production would have been necessary using these criteria, examination of the distribution of elites over a broad zone, especially the proportion of elites in relation to agricultural terraces compared to other locations such as civic-ceremonial centers, can indicate that elites may have been involved in other kinds of activities such as monitoring the agricultural output on the terrace systems. The methods used here, both in the field and for pattern searching, might aid in the development of future research designs aimed at exploring the issue of elite management of intensive agricultural production. The use of full-coverage, systematic survey in which settlement and agricultural terraces were mapped in their entirety resulted in a data set that was usable for tracking the residences of elites over a broad area, and especially in relation to agricultural terraces. The distributional study of dwelling length in both polities made it possible to discern different types of dwelling structures which may correspond to differences in the status of their occupants. Defining range structure elites, non-range structure elites, junior relatives / retainers, and commoners, and then analyzing the distribution of these different types throughout the best agricultural lands and in relation to agricultural terraces, revealed that there was an agrarian basis for where elites were living. This data also made it possible to conclude that elites may have monitored intensive agricultural production on terraces in the Morelos polity, even though it is doubtful that other kinds of management, such as mobilization of the labor for terrace construction, would have been necessary. Although numerous studies over the past few decades have documented ancient Maya regional settlement patterns and agricultural features over broad regions and within sites, the methods used here are unique in that settlement and agricultural terraces were mapped in their entirety in two contemporaneous polities each with differing needs for agricultural intensification due to differences in natural settings. The methodology permits direct comparison of the similarities and differences in the human subsistence adaptation to different environments, and examination of how the role played by elites differed in them.

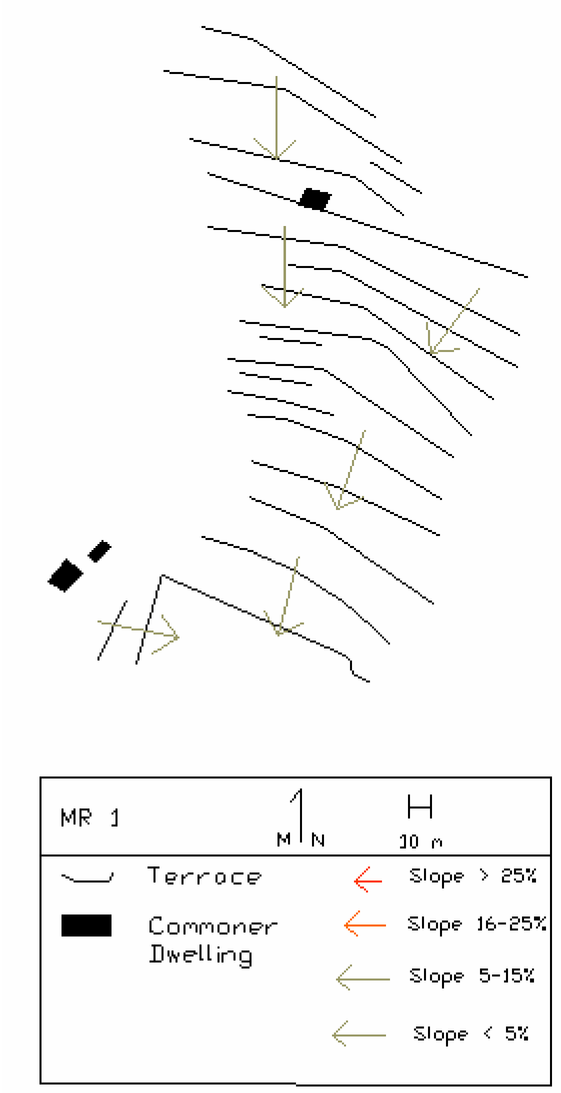
Future research in the Morelos Piedmont would build upon the findings presented here. Expansion of the survey zone to the south and southeast would result in a better delineation of the Morelos polity's boundary where the terrain runs on for several kilometers with few natural topographic barriers. Although light reconnaissance of these zones found no evidence for settlement, systematic survey is required to determine if the apparent dearth of settlement represents an empty buffer zone at the polity's boundary or if previously undetected sites exist. If survey results indicate that the polity's border should be expanded to include additional settlement, then the population and carrying capacity estimates provided here would have to be revised to accommodate the new data.

An excavation project in the Morelos Piedmont would advance understanding of the relationship between elites and intensive agricultural production on terraces. Excavation of a sample of range structures on civic plazas, and a sample away from civic plazas in association with agricultural terraces, would yield data that could be used to compare how the status of the occupants of range structures differed based on proximity to civic-ceremonial centers and to more rural intensive agricultural works. Differences in the quality of construction and/or artifact assemblages associated with range structures in these two zones might indicate that the inhabitants of these structures enjoyed differing status or performed different activities related to their proximity to either the ritual and political activities presumed to have taken place on civic plazas, or to the productive activities involved in terrace farming. This evidence could shed light on the relative importance placed on deriving wealth from directly monitoring production on terraces or from ideological means. I have argued that although there is no evidence to support the argument that elite, top-down management would have been necessary to plan the agricultural terraces, or to coordinate the labor for their construction, maintenance and cultivation, elites may have monitored intensive production on the terraces. In this scenario, the underlying assumption is that elites would have derived some wealth, and possibly status, from directly controlling this production. But that does not preclude elites from also deriving wealth from other aspects of society such as exchange or achieving status through ideological means. It is possible that elites' control may have been primarily in the long-distance exchange of exotic and status-reinforcing goods such as jade, fine polychrome ceramics, and finely chipped chert or obsidian eccentrics. Such goods functioned in the ideological sphere of society where they were used in the performance of religious rituals, and were needed by elites for the maintenance of their power (Demarest 2004: 160, 206). If elites in the Morelos polity during the Late-Terminal Classic period derived power and authority from ideology, and instead of directly monitoring agricultural production instead received tribute from a commoner population compelled to provide it, then the expectation would be to find the vast majority of elites residing at civic-ceremonial centers in association with relatively large quantities of exotic materials such as jade, fancy pottery, and obsidian eccentrics, and very few elites residing in the hinterland away from civic centers. Because I found that many elites were residing away from civic centers and were distributed throughout the best agricultural lands and in association with agricultural terraces, it appears that at the very least there was also an agrarian basis to where elites were living and that monitoring agricultural production would have been an important consideration.

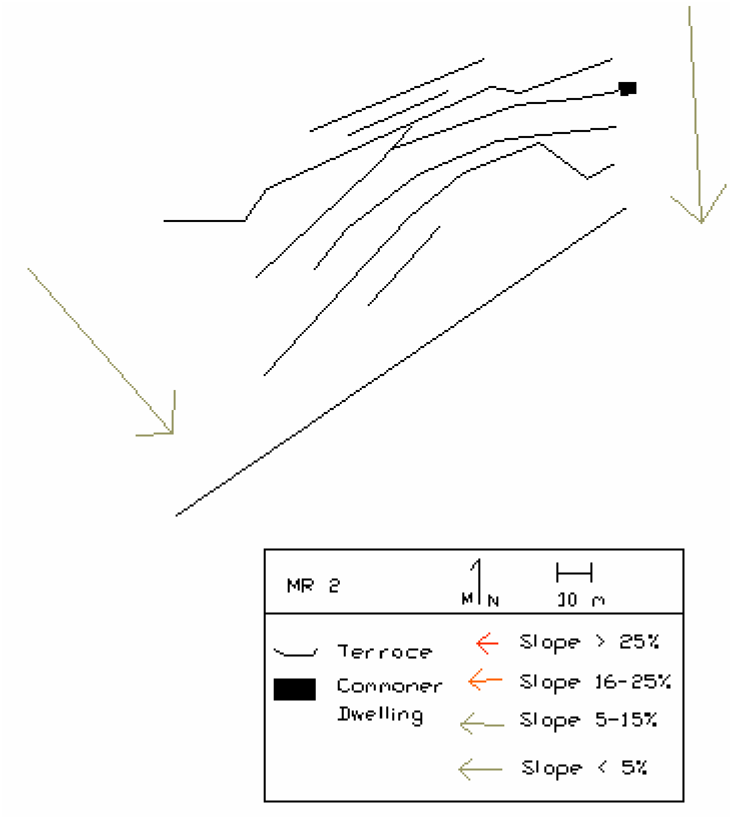
Another potential future project is to excavate a sample of dwelling structures associated with agricultural terracing in order to gather data to test Robert Netting's (1993) agrarian smallholder model. According to the model, farming households are seen as independent smallholders who practiced intensive agriculture, directly benefited from their own production, and invested capital and labor in their properties without elite input. A primary expectation of the model is that some households would have enjoyed greater wealth as a result of having stable rights to their homes and productive resources. This would be reflected archaeologically in the variable quality of house construction and associated artifacts, and the stability and longevity of house occupation. Testing the agrarian smallholder model would further elucidate the relationship between elites, commoners, and the productive economy in the Morelos polity.

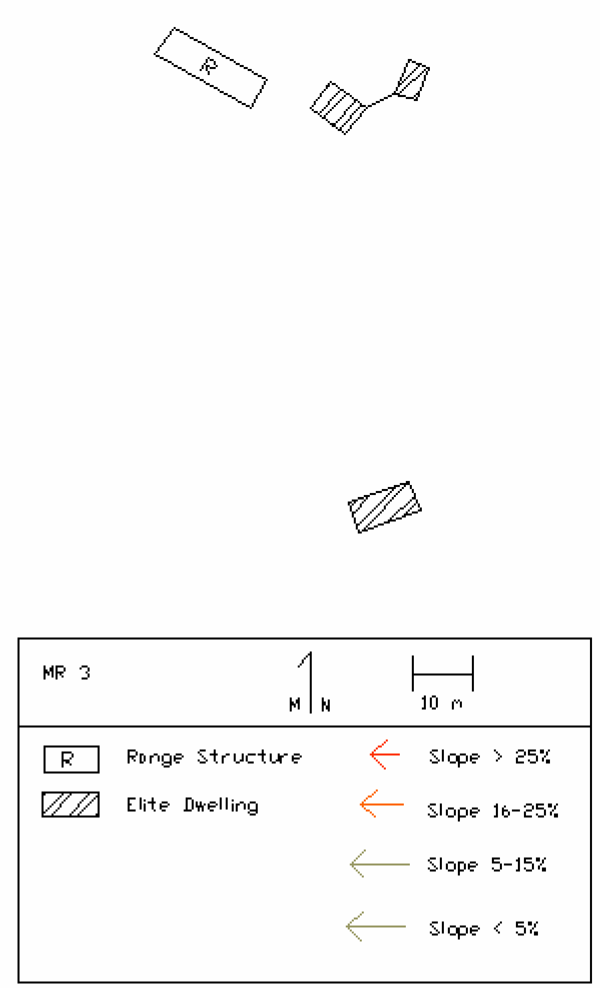
APPENDIX A

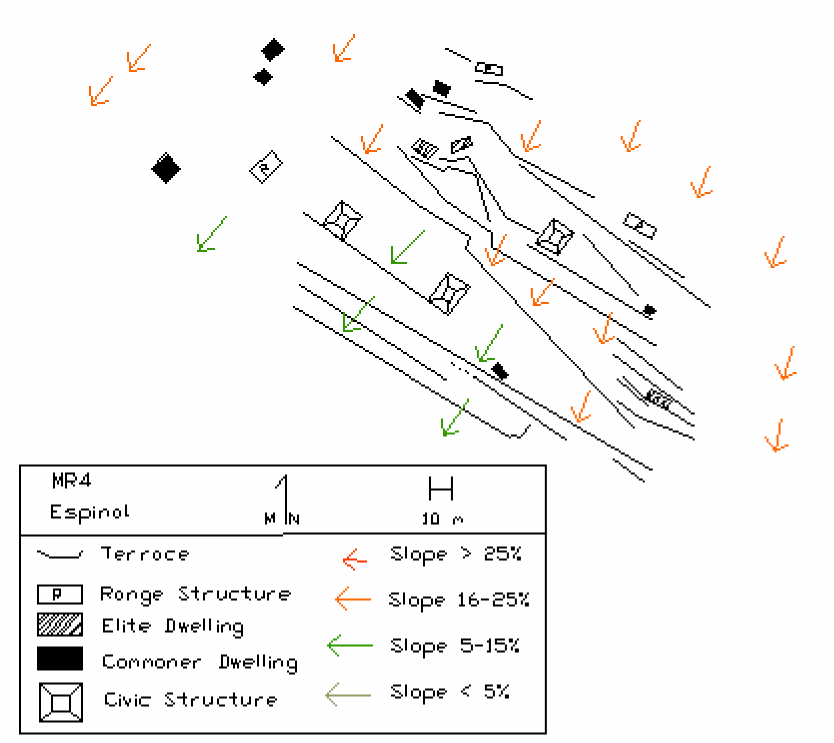
MAPS



MR 1
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

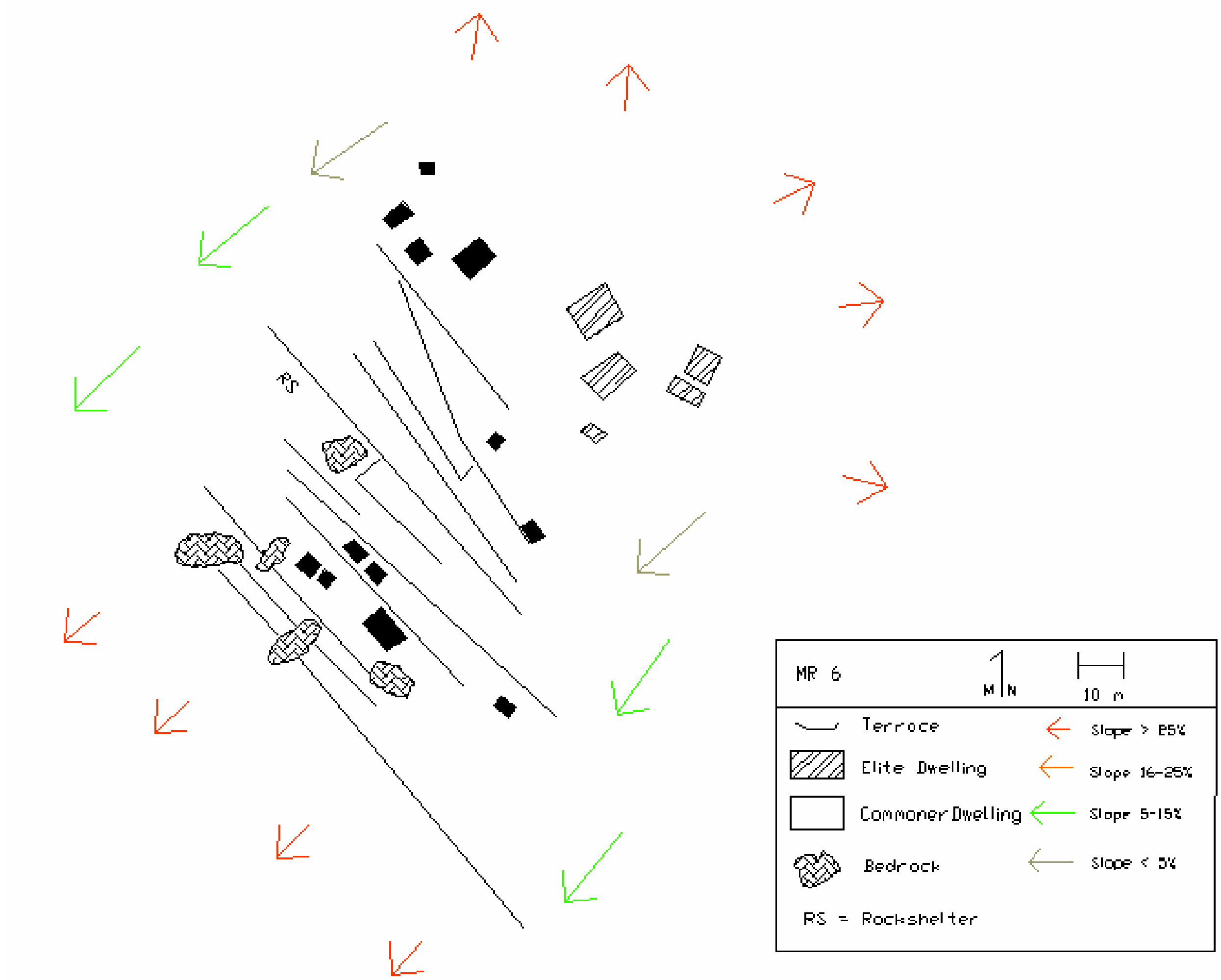

MR 2
M N
10 m
Terroce
Slope > 25%
Slope 16-25%
Connoner
Dwelling
Slope 5-15%
Slope < 5%

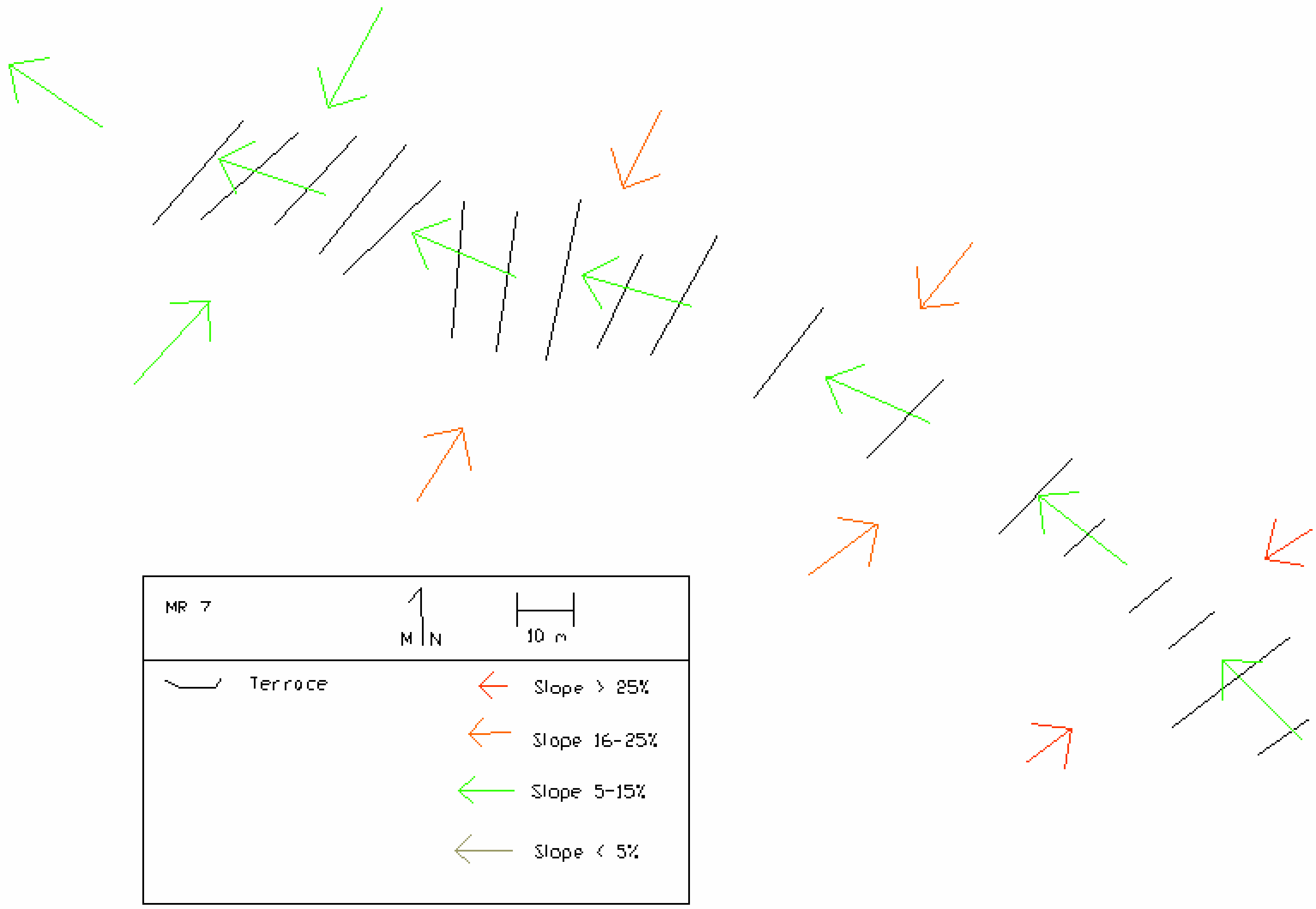

R
MR 3
M N
10 m
R Range Structure
Elite Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

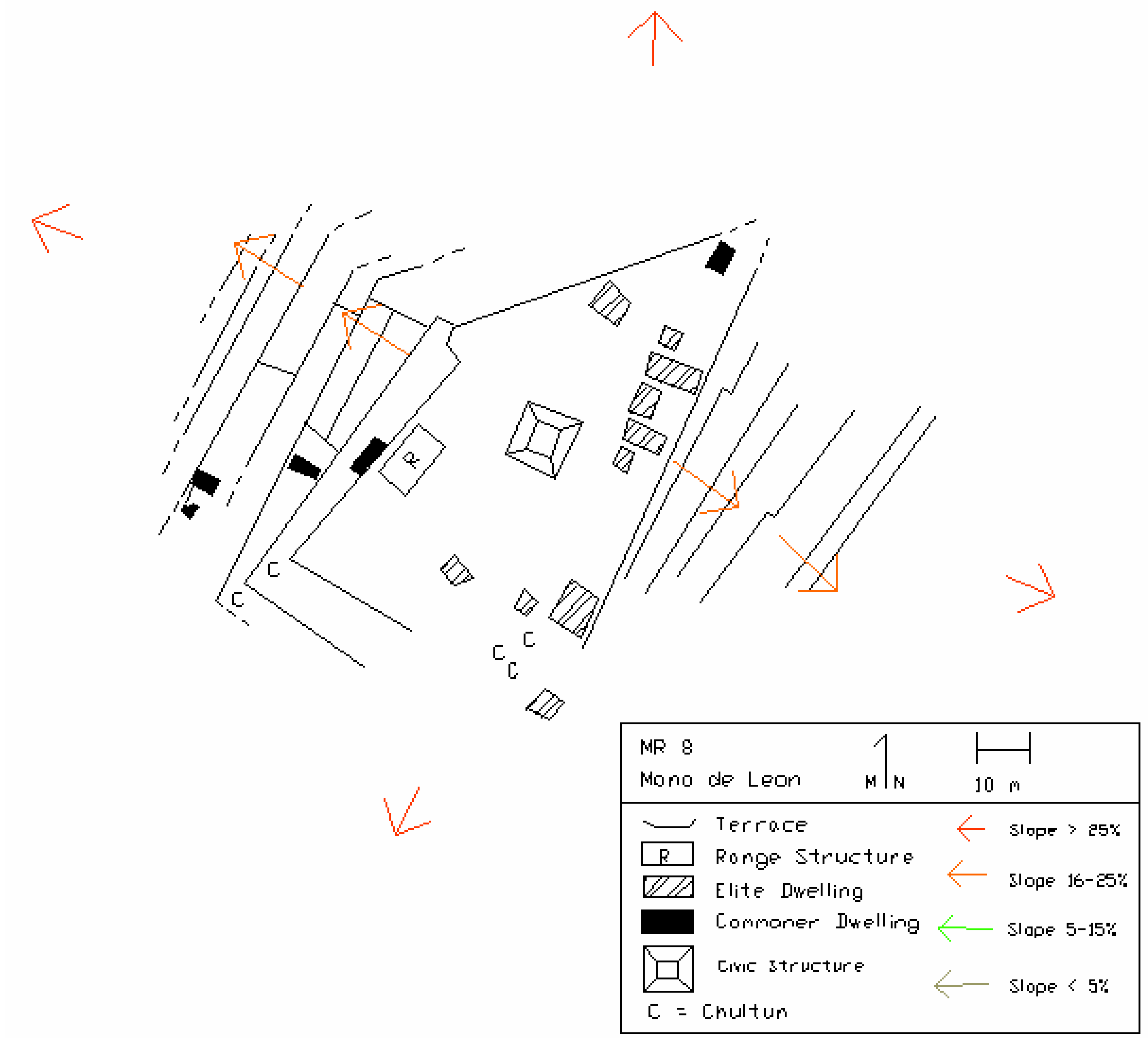


MR4
Espinol
M N
10 m
Terroce
Ronge Structure
Elite Dwelling
Conmoner Dwelling
Civic Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

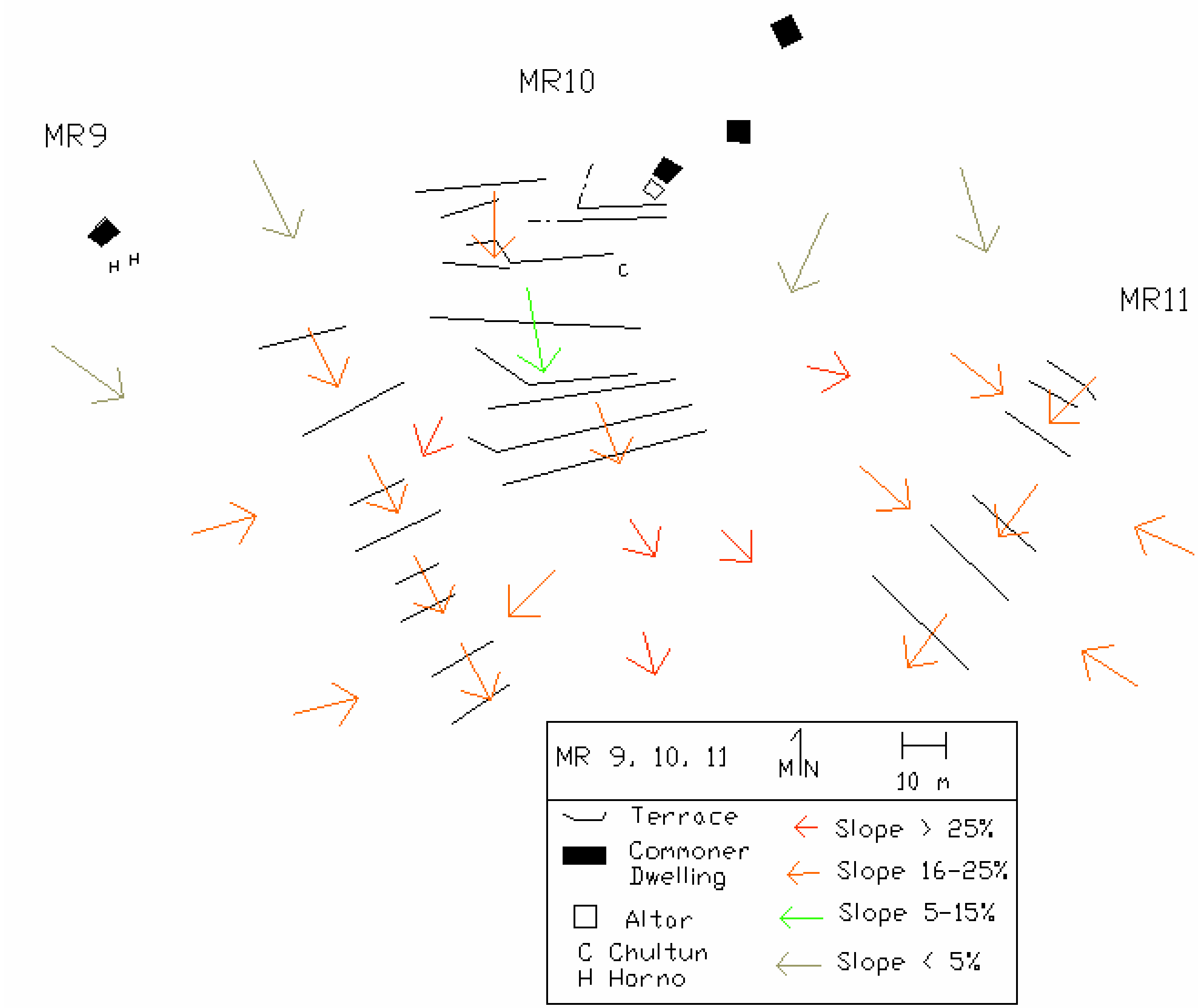
MR 5
El Vecino
MN
10 m
Terrace
Range Structure
Elite Dwelling
Commoner Dwelling
Civic Structure
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Field Wall

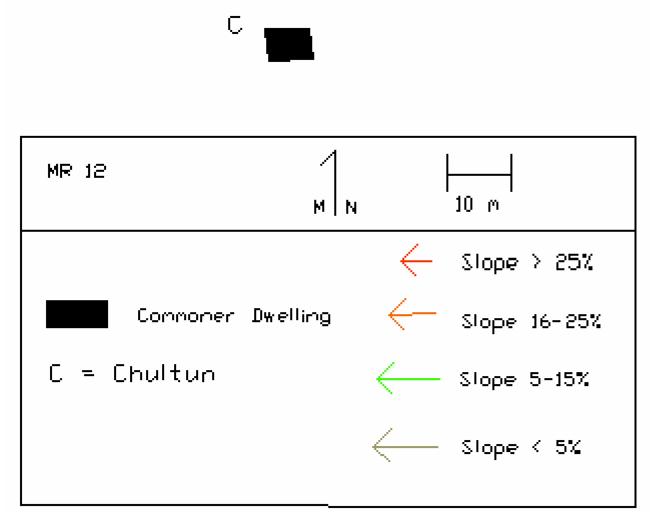

RS
MR 6
M N
10 m
Terroce
Elite Dwelling
Commoner Dwelling
Bedrock
RS = Rockshelter
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

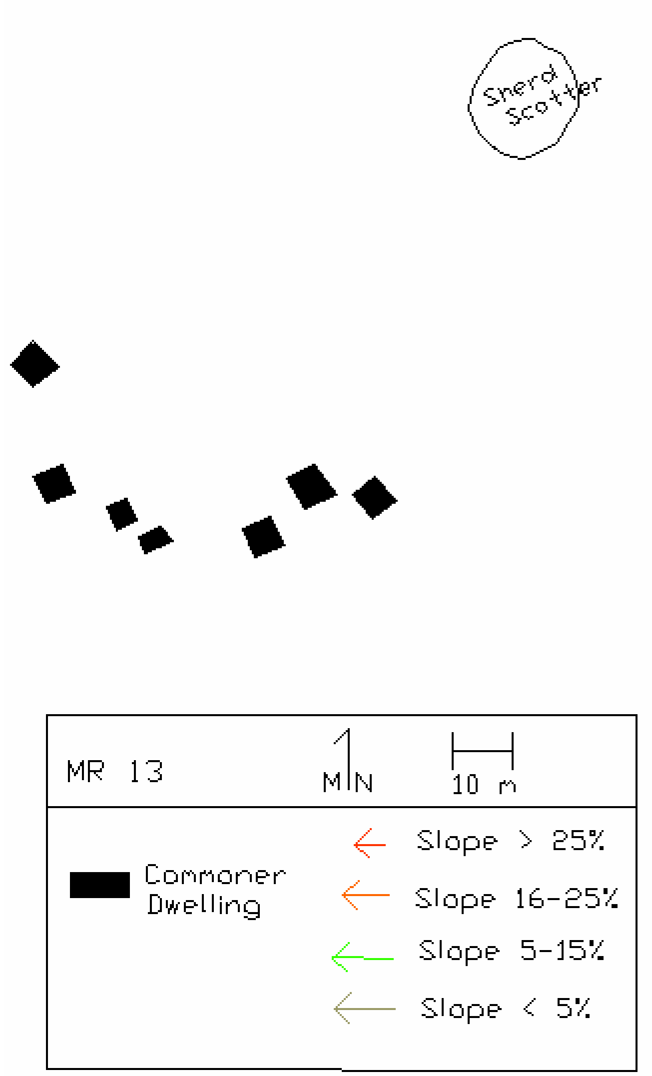

MR 7
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

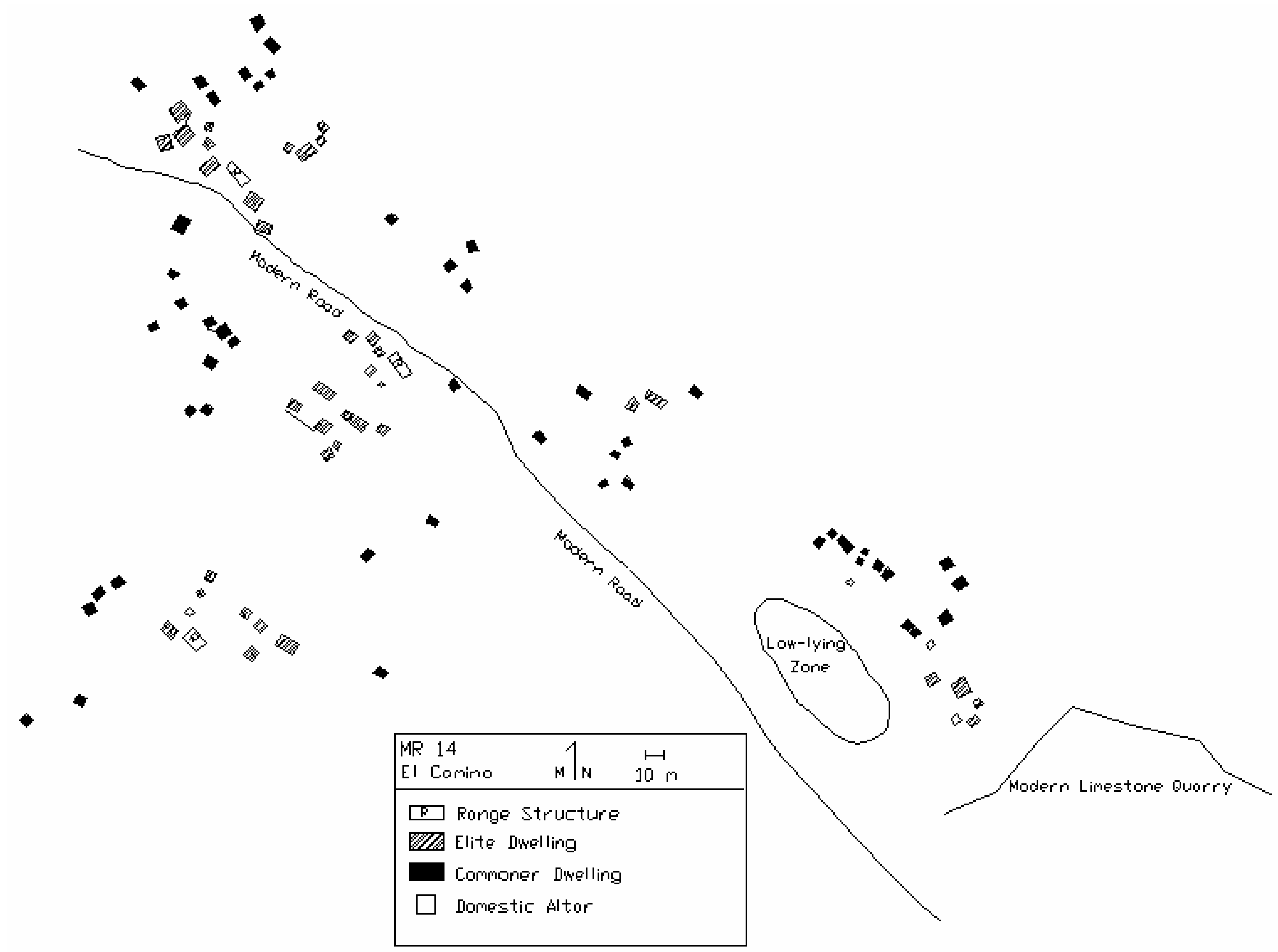


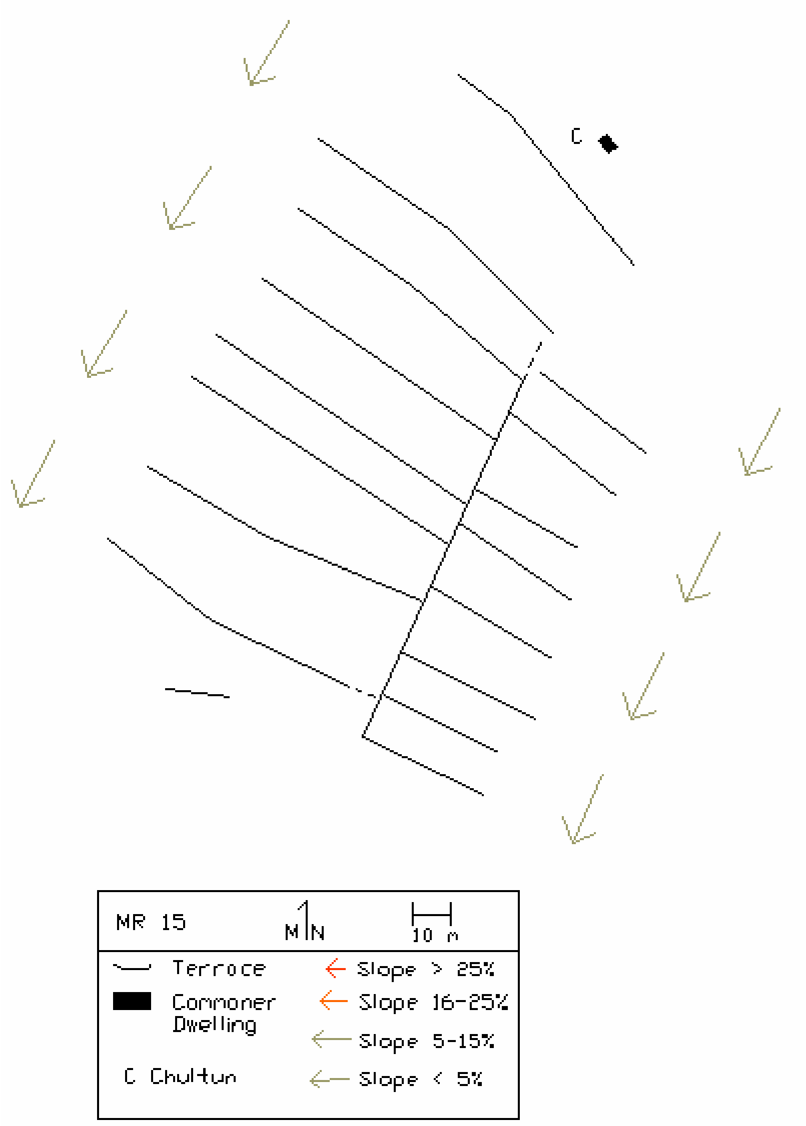
R
C
C
C
C
C
MR 8
Morro de Leon
M N
10 m
Terrace
Range Structure
Elite Dwelling
Commoner Dwelling
Civic Structure
C = Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

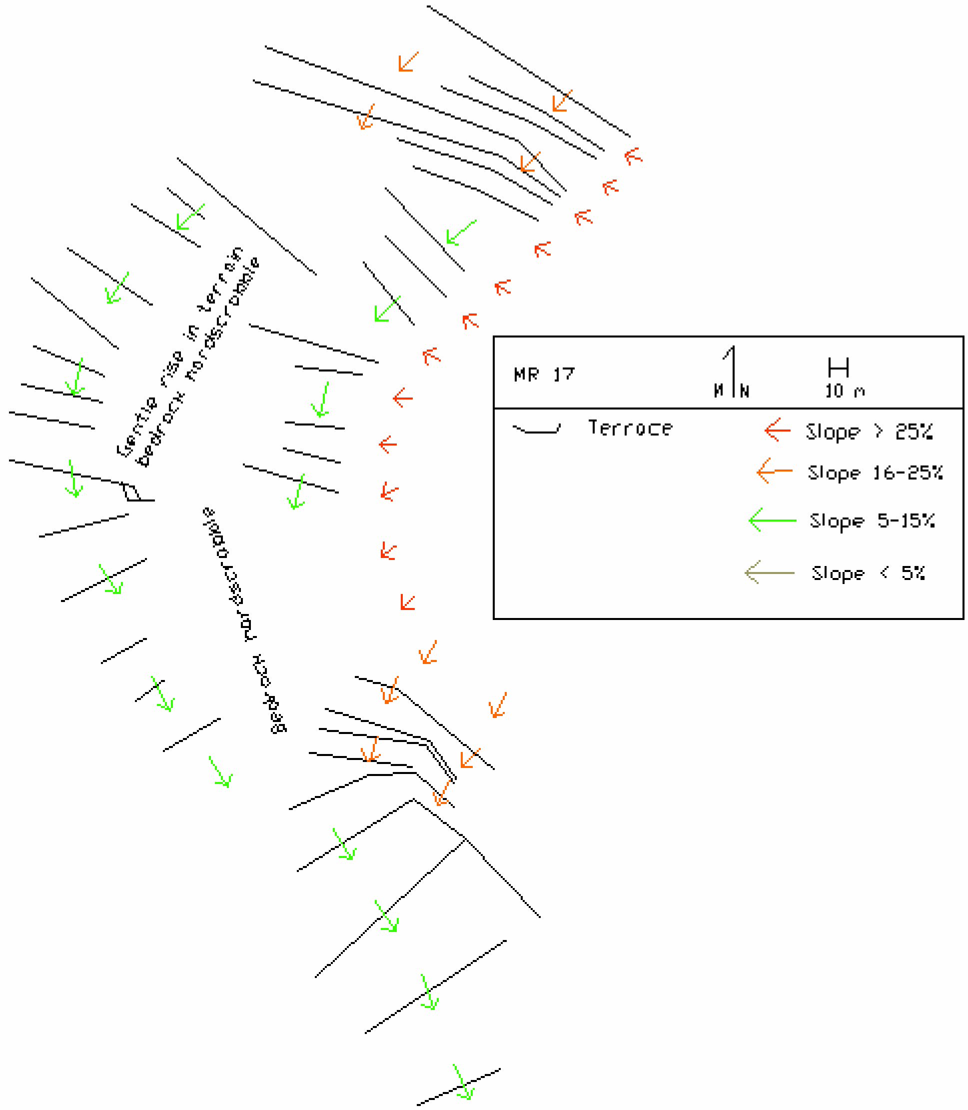

MR10
MR9
H H
C
MR11
MR 9, 10, 11
M N
10 m
Terrace
Commoner Dwelling
Altar
C Chultun
H Horno
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


C
MR 12
M N
10 m
Slope > 25%
Commoner Dwelling
Slope 16-25%
C = Chultun
Slope 5-15%
Slope < 5%

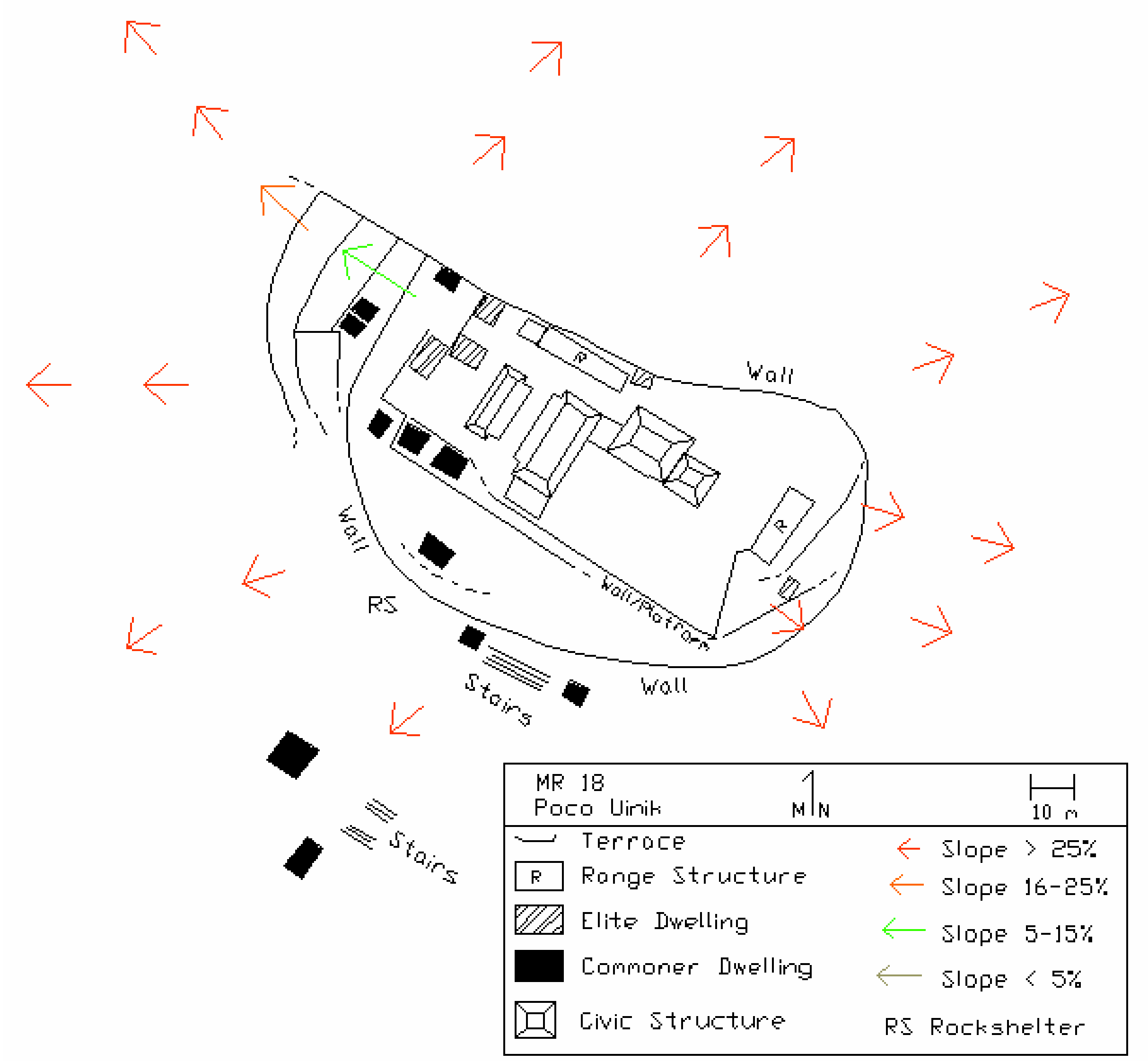

Sherd Scatter
MR 13
MN
10 m
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


Modern Road
Modern Road
Low-lying Zone
Modern Limestone Quarry
MR 14
El Camino
M N
10 m
R
Range Structure
Elite Dwelling
Commoner Dwelling
Domestic Altar

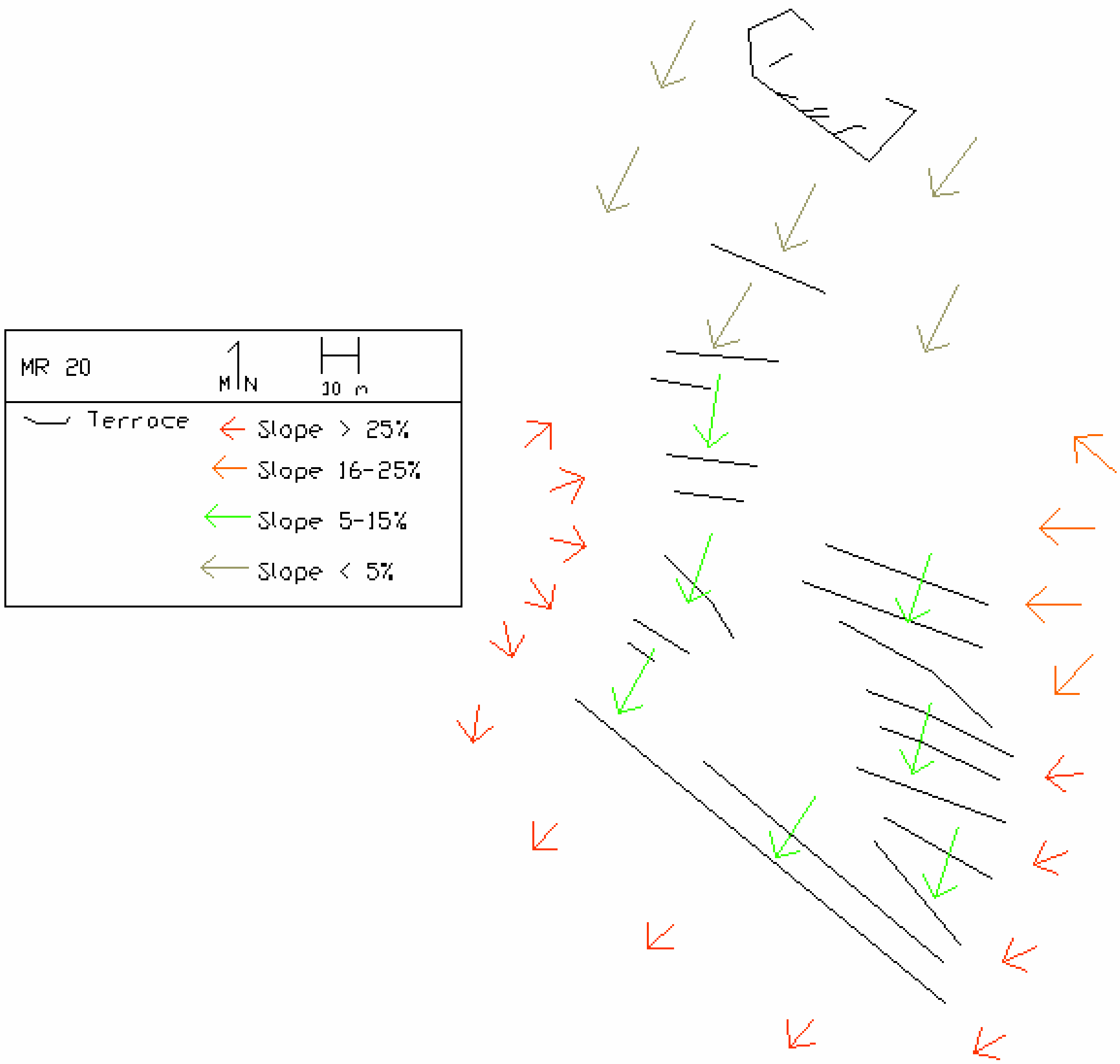

C
MR 15
M N
10 m
Terrace
Commoner Dwelling
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

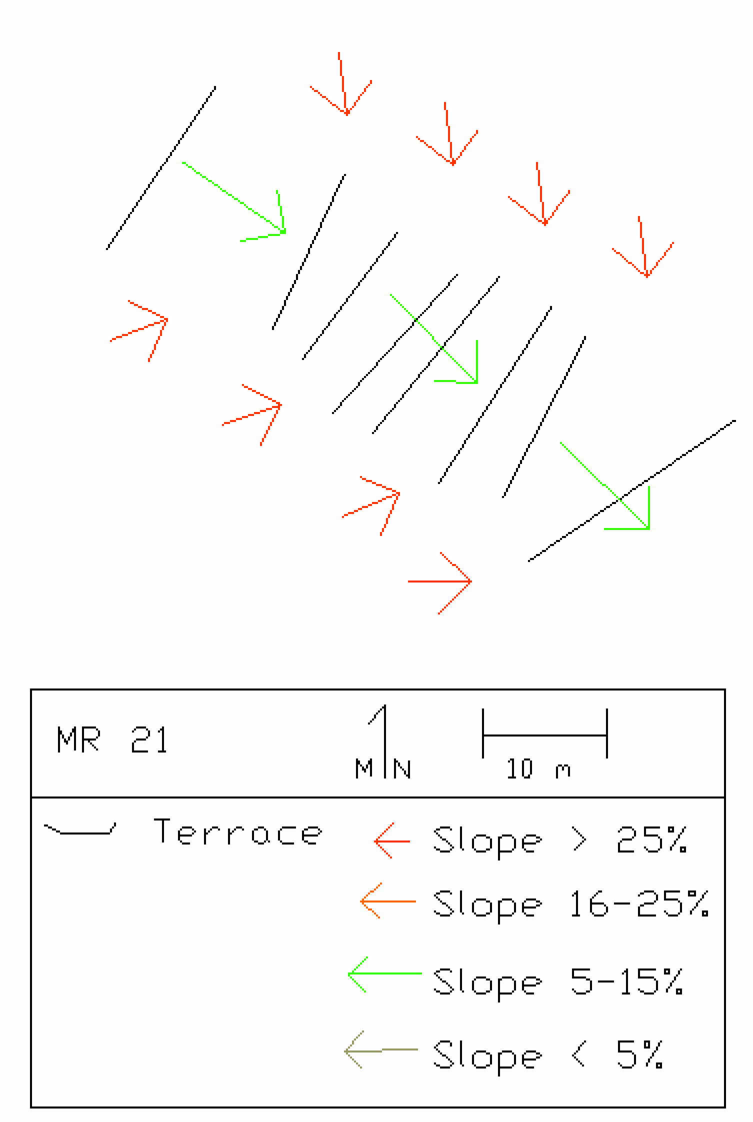


Gentle rise in terrain
Bedrock hardscrabble
Bedrock hardscrabble
MR 17
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

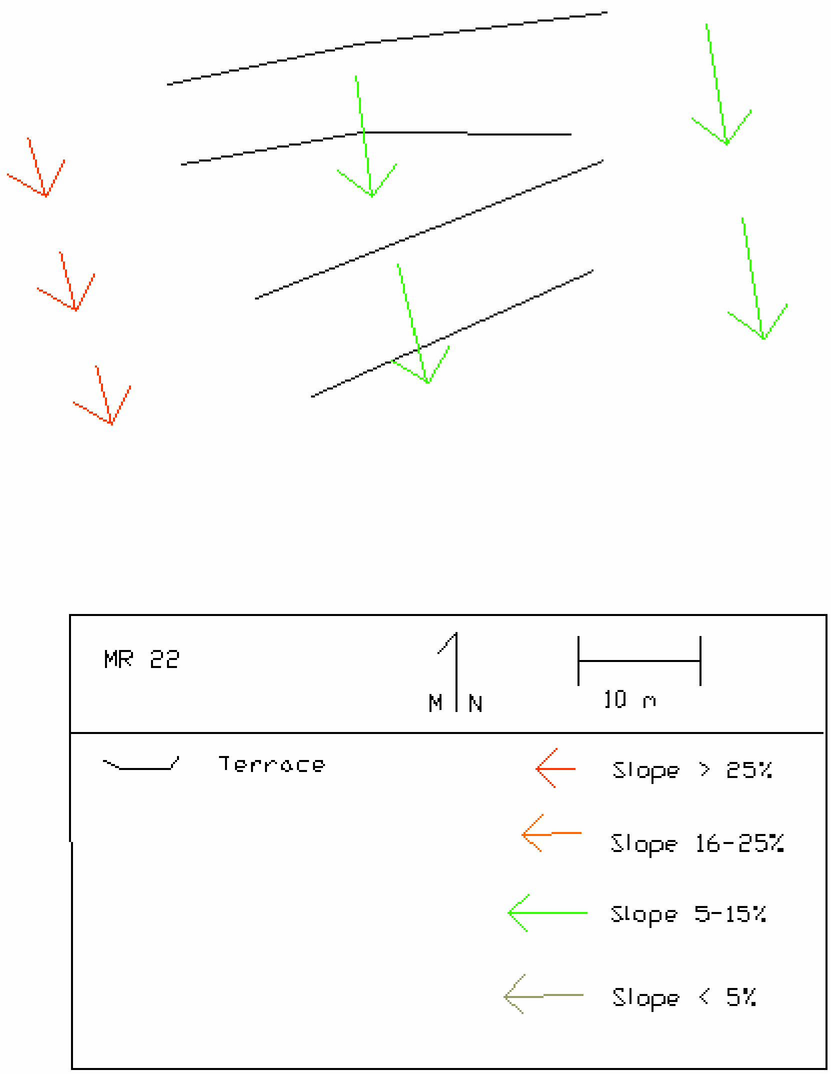


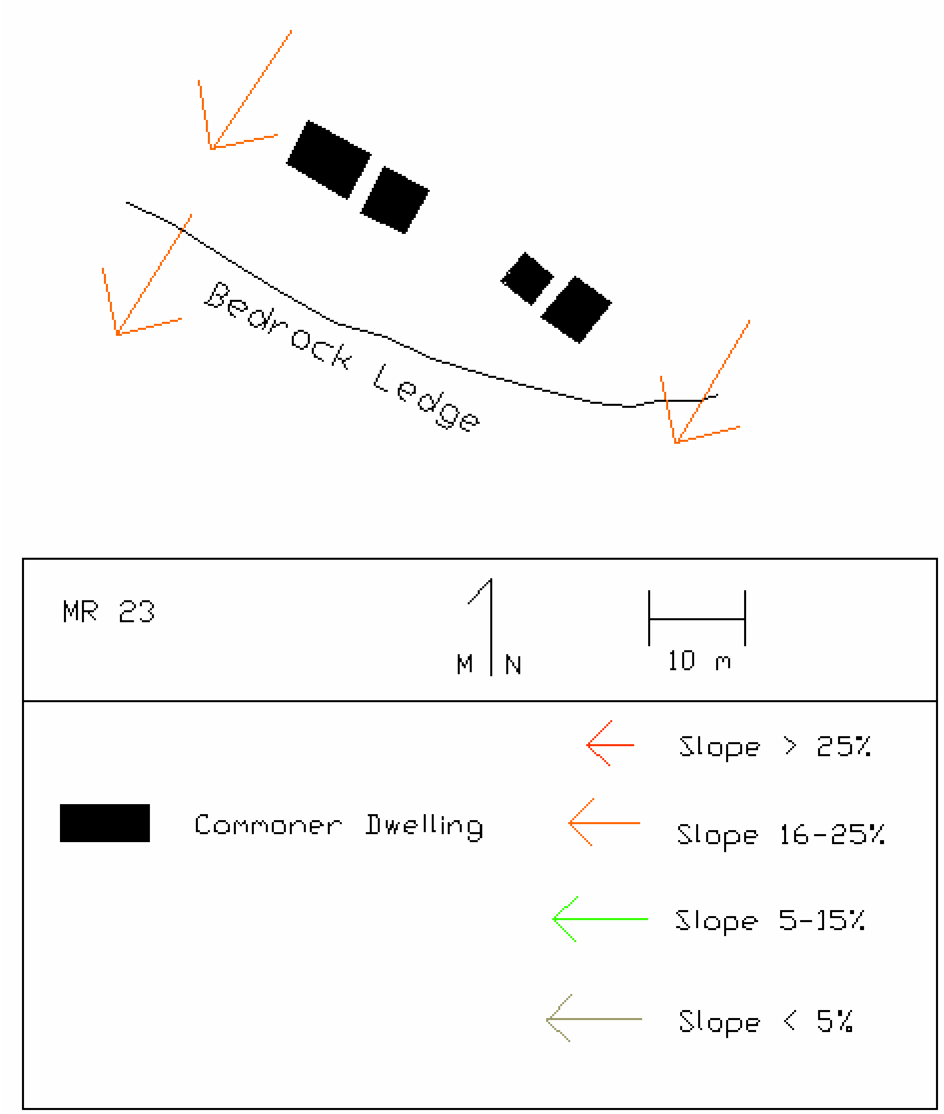
Wall
Wall
Wall/Platform
Wall
RS
Stairs
Stairs
MR 18
Poco Uinik
M N
10 m
Terrace
Range Structure
Elite Dwelling
Commoner Dwelling
Civic Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
RS Rockshelter

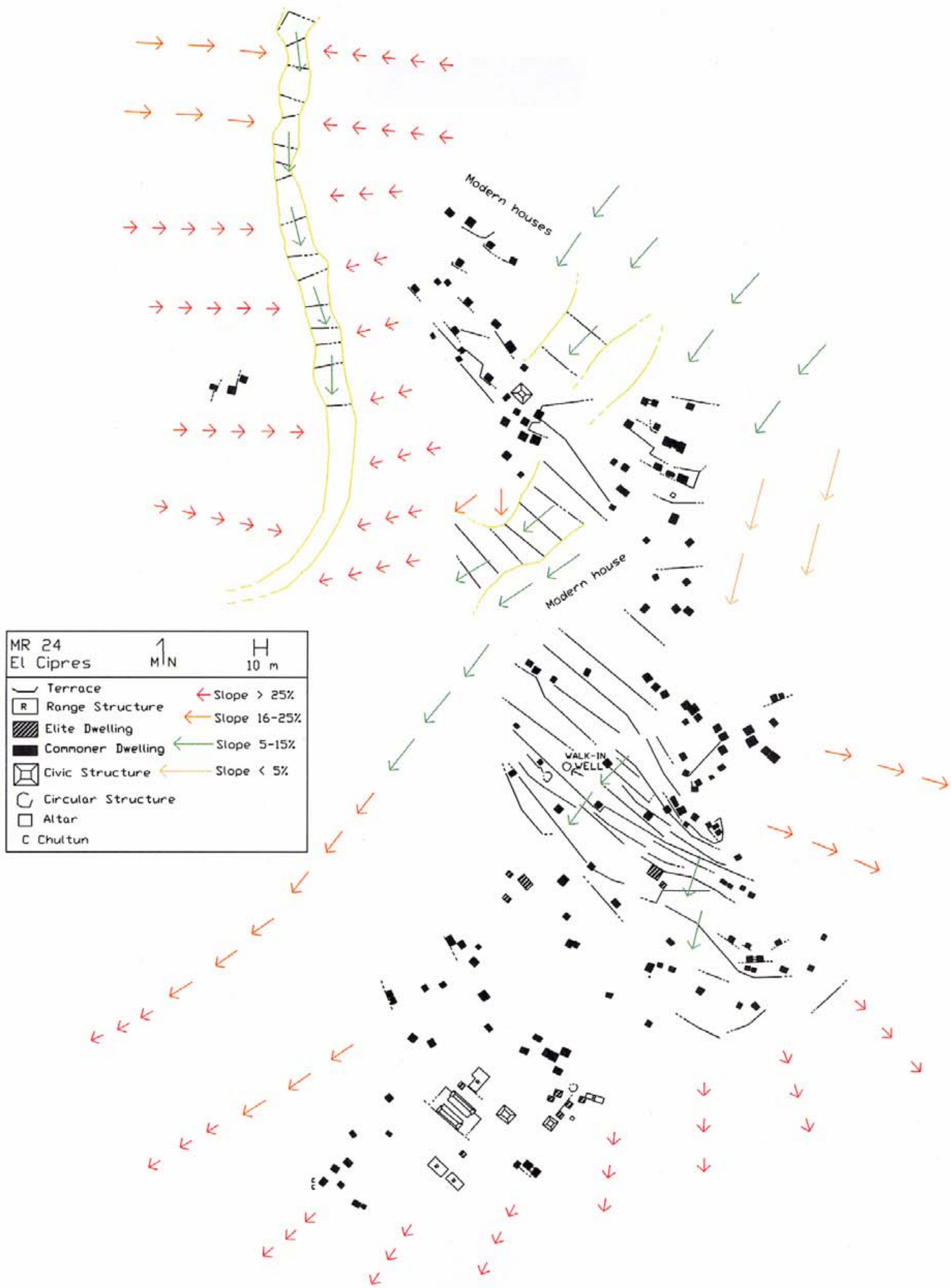

MR 20
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%



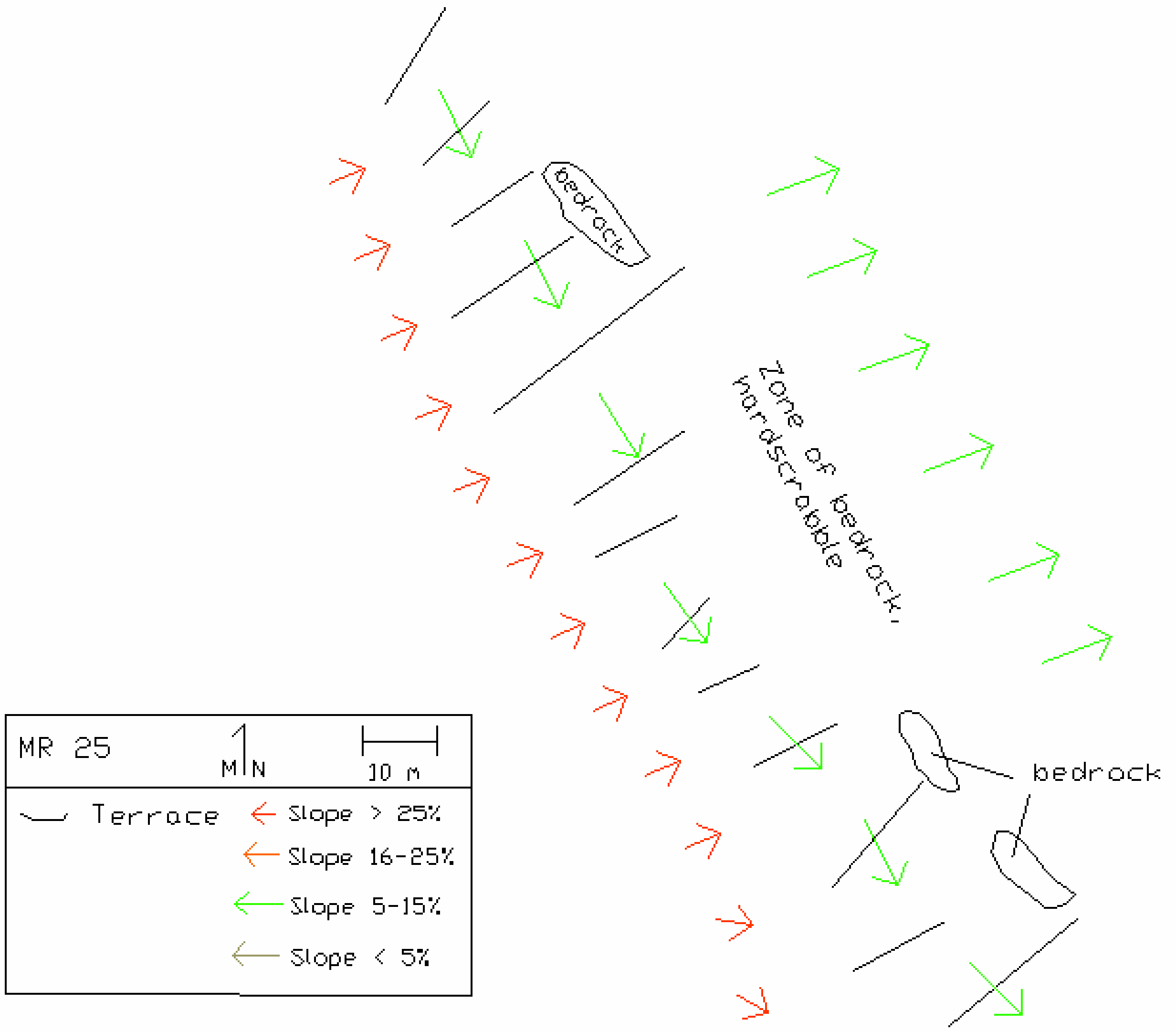
MR 21
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

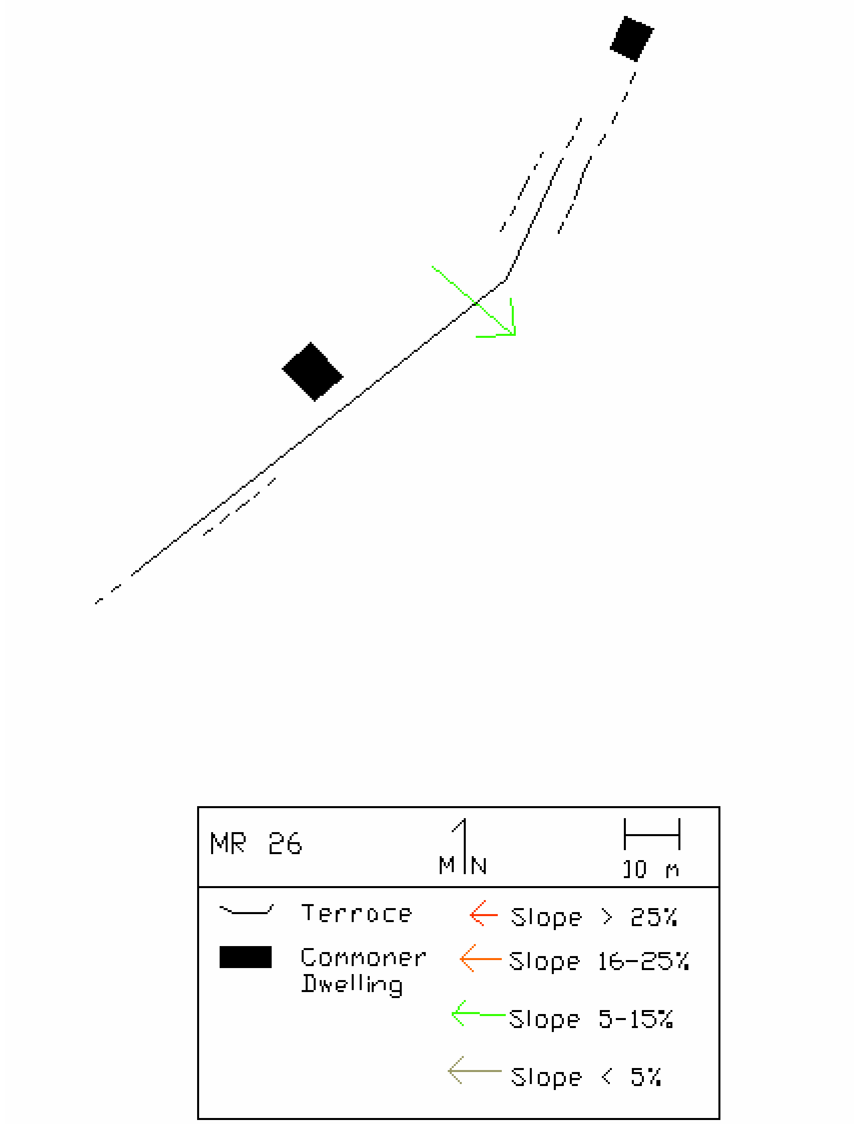

MR 22
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

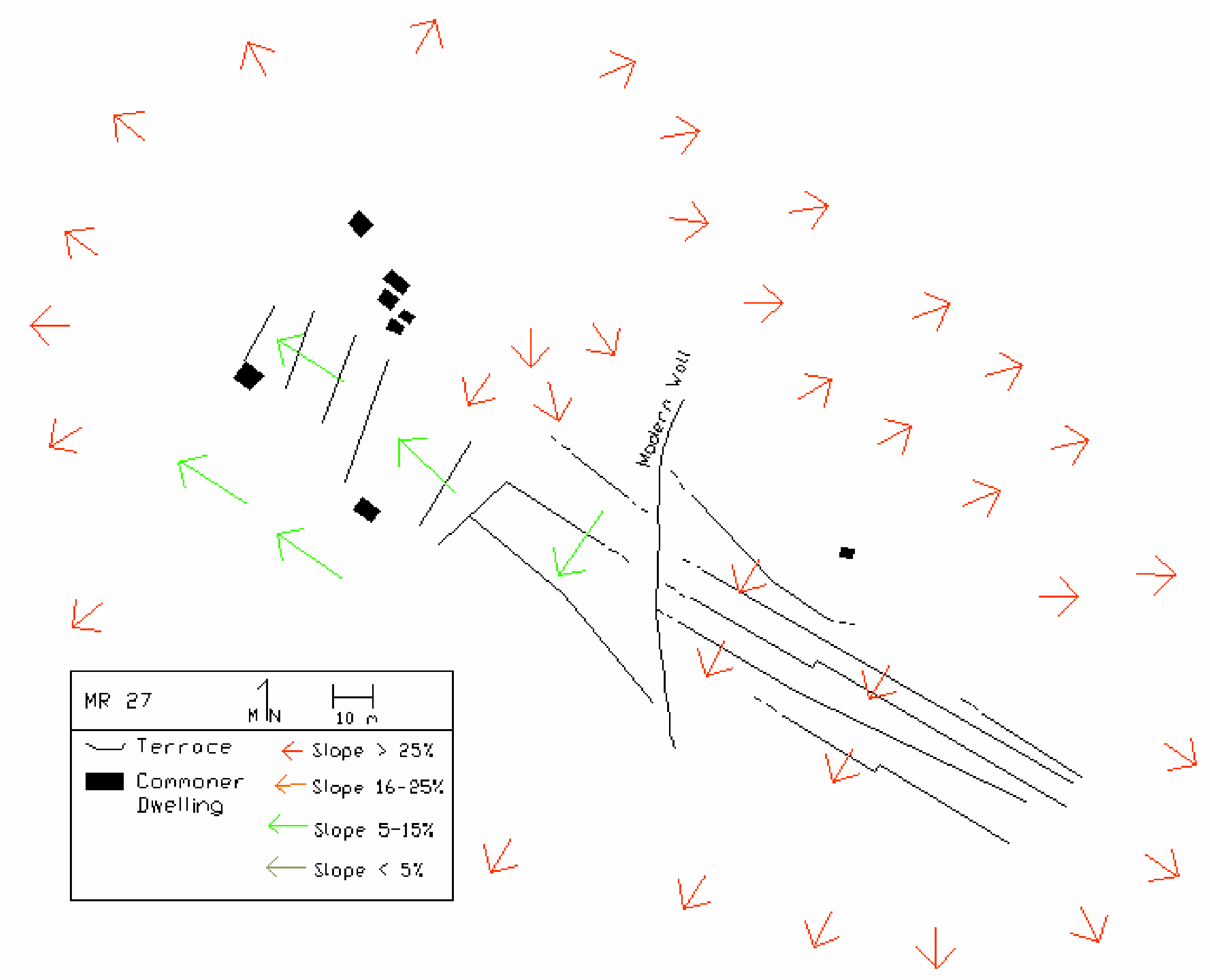

Bedrock Ledge
MR 23
M N
10 m
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

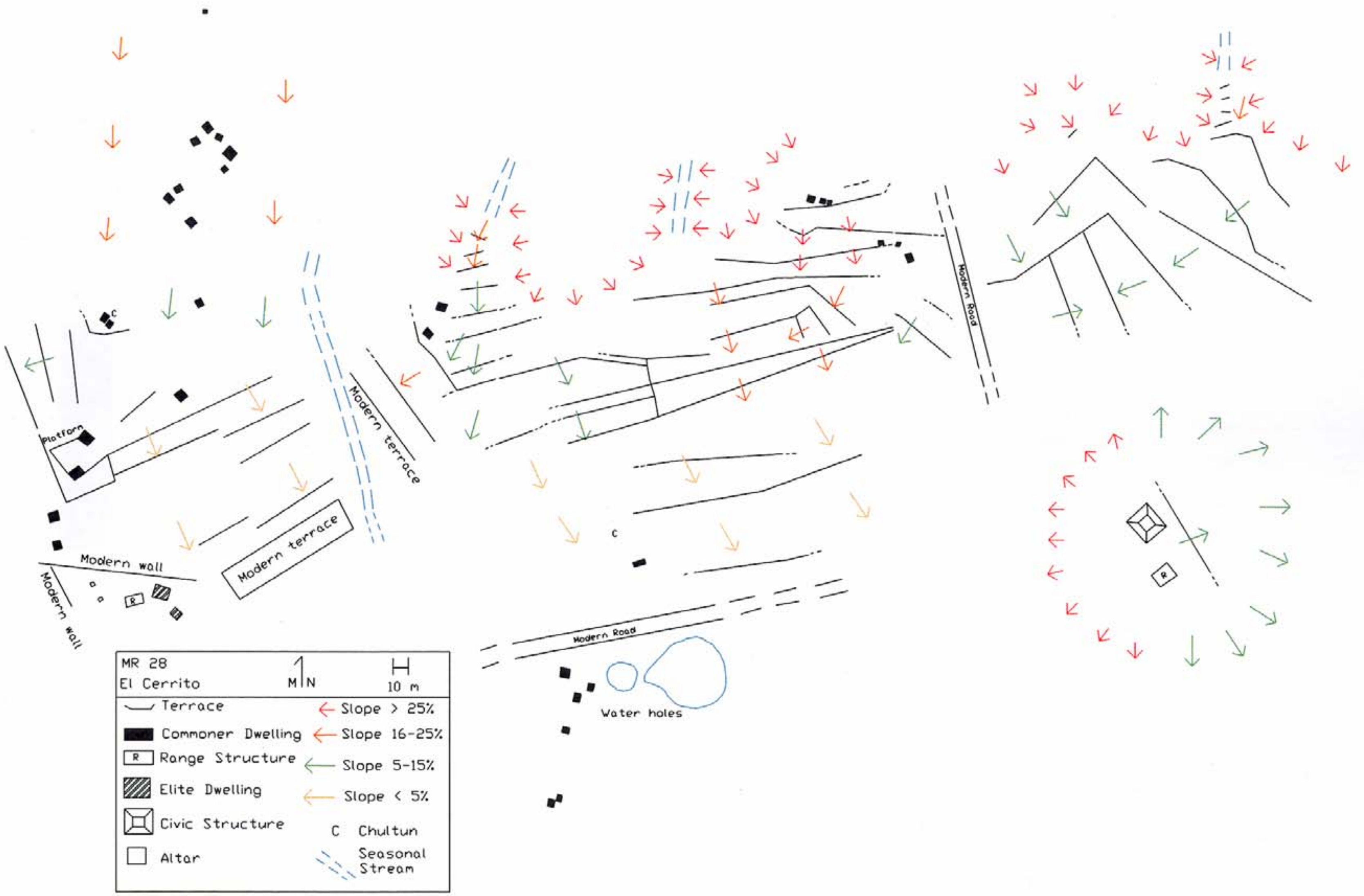


Modern houses
Modern house
WALK-IN WELL
MR 24
El Cipres
N
10 m
Terrace
Range Structure
Elite Dwelling
Commoner Dwelling
Civic Structure
Circular Structure
Altar
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

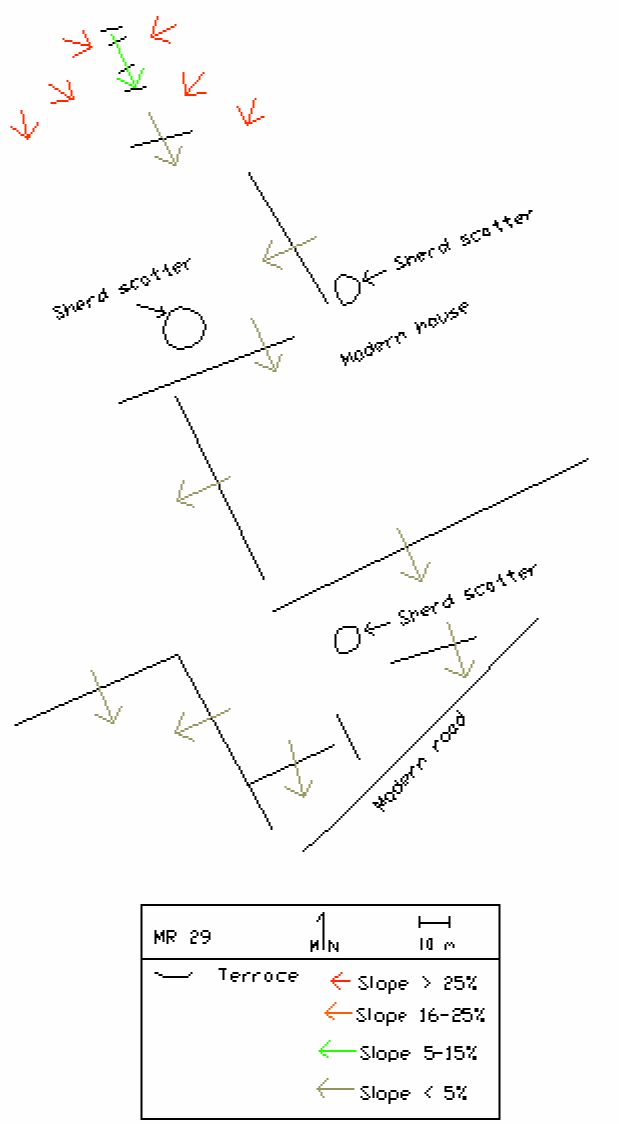

bedrock
Zone of bedrock, hardscrabble
bedrock
MR 25
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

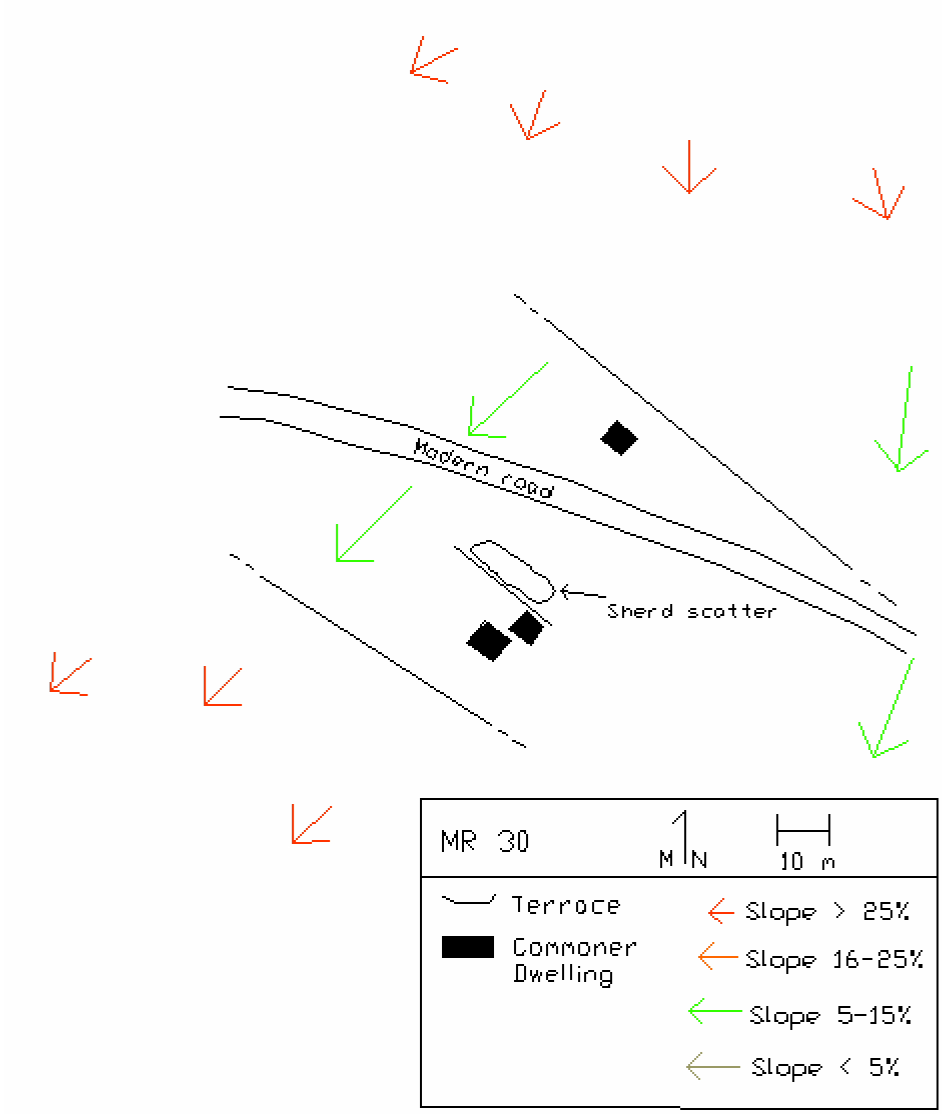

MR 26
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

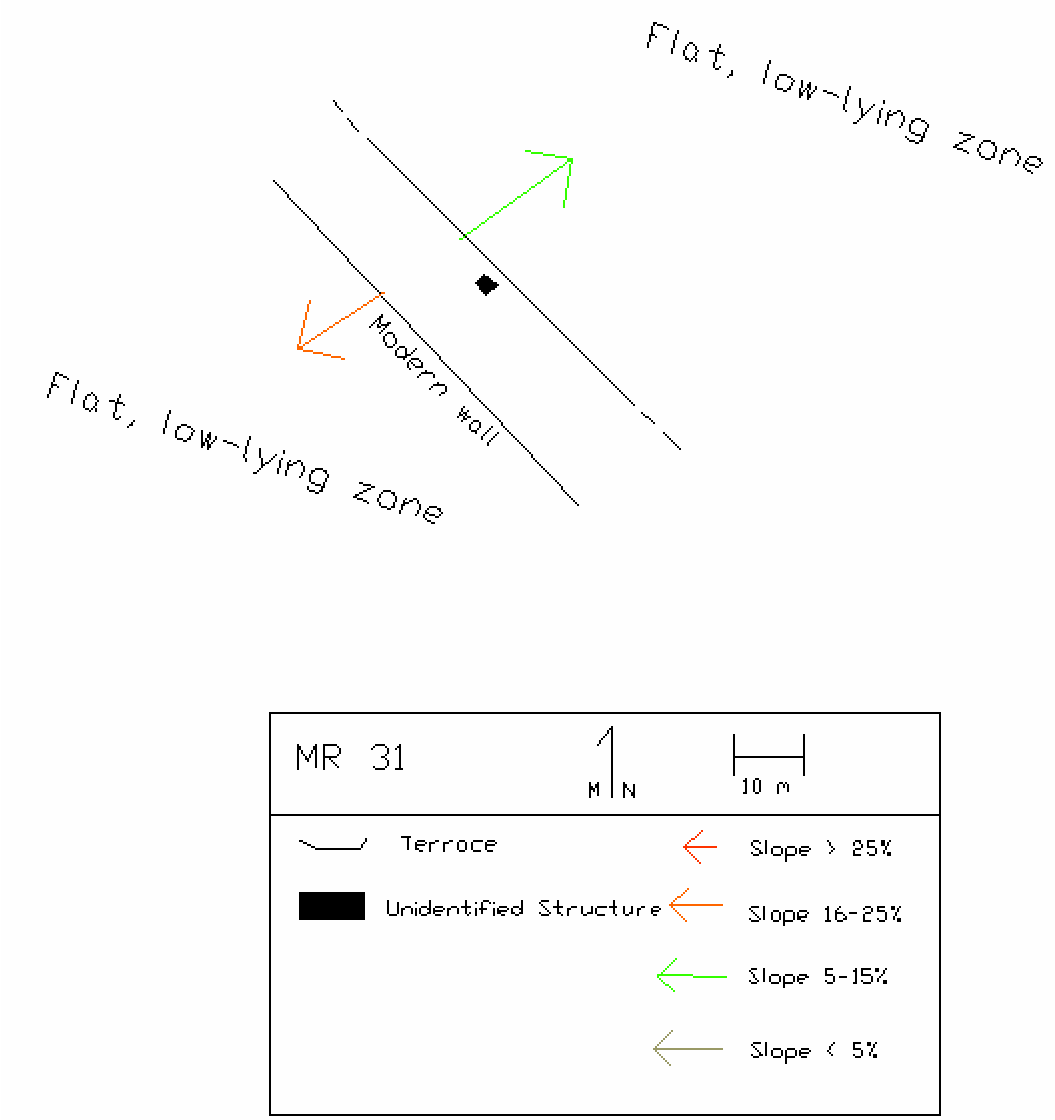

Modern Wall
MR 27
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

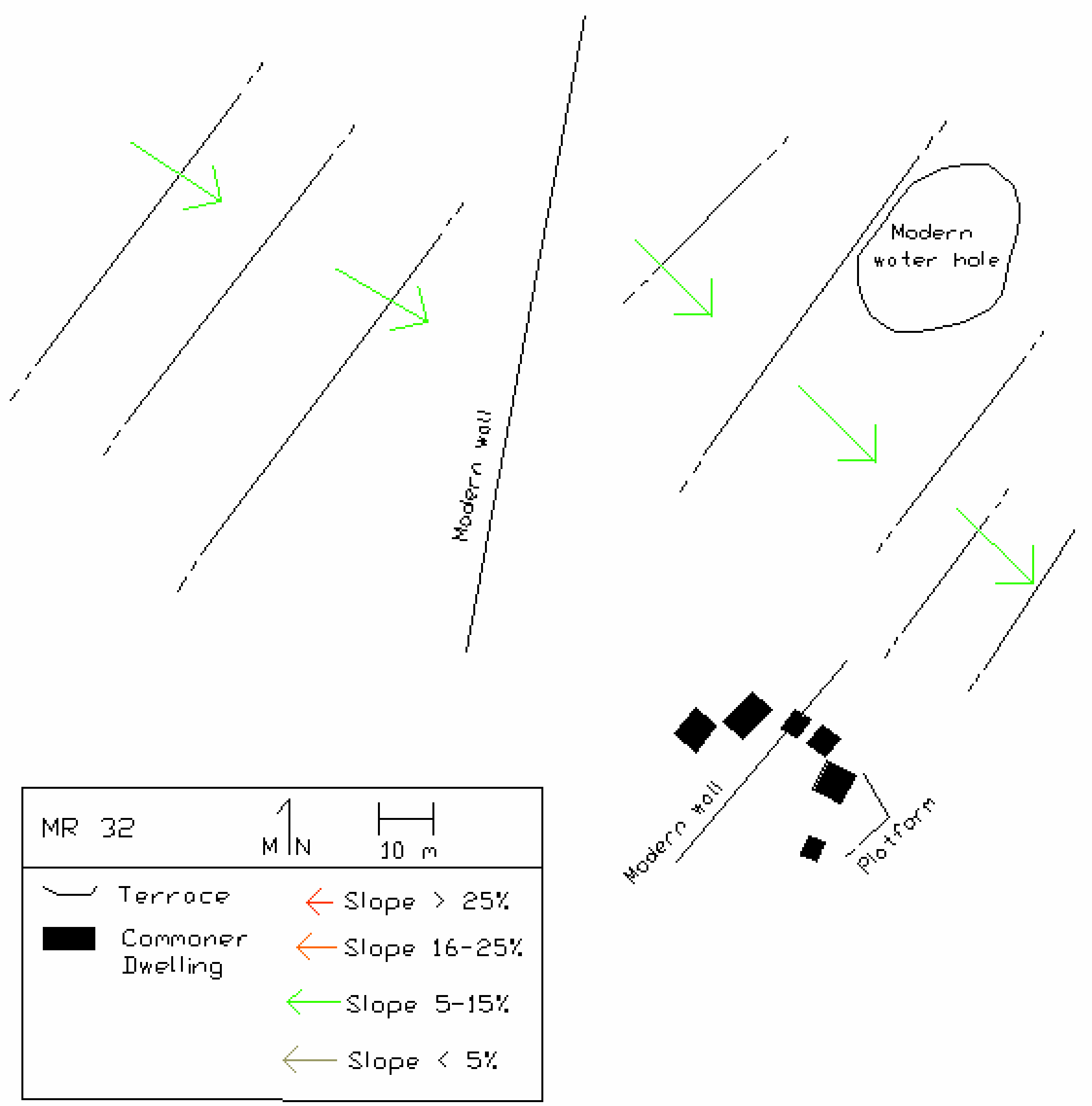


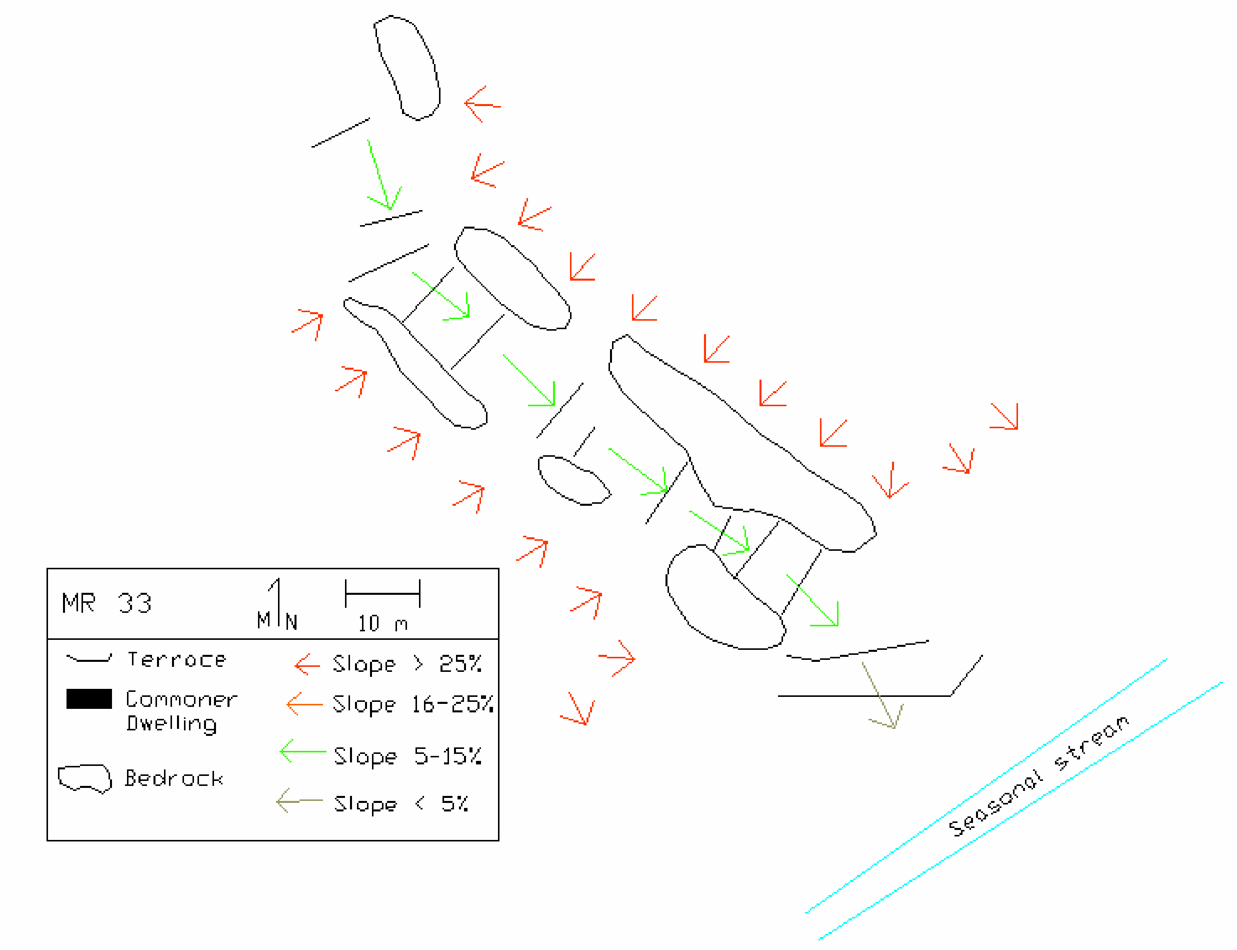
MR 28
El Cerrito
M N
10 m
Terrace
Commoner Dwelling
Range Structure
Elite Dwelling
Civic Structure
Altar
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
C Chultun
Seasonal Stream
Platform
Modern wall
Modern wall
Modern terrace
Modern terrace
Modern Road
Modern Road
Water holes


Sherd scatter
Sherd scatter
Modern house
Sherd scatter
Modern road
MR 29
MN
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

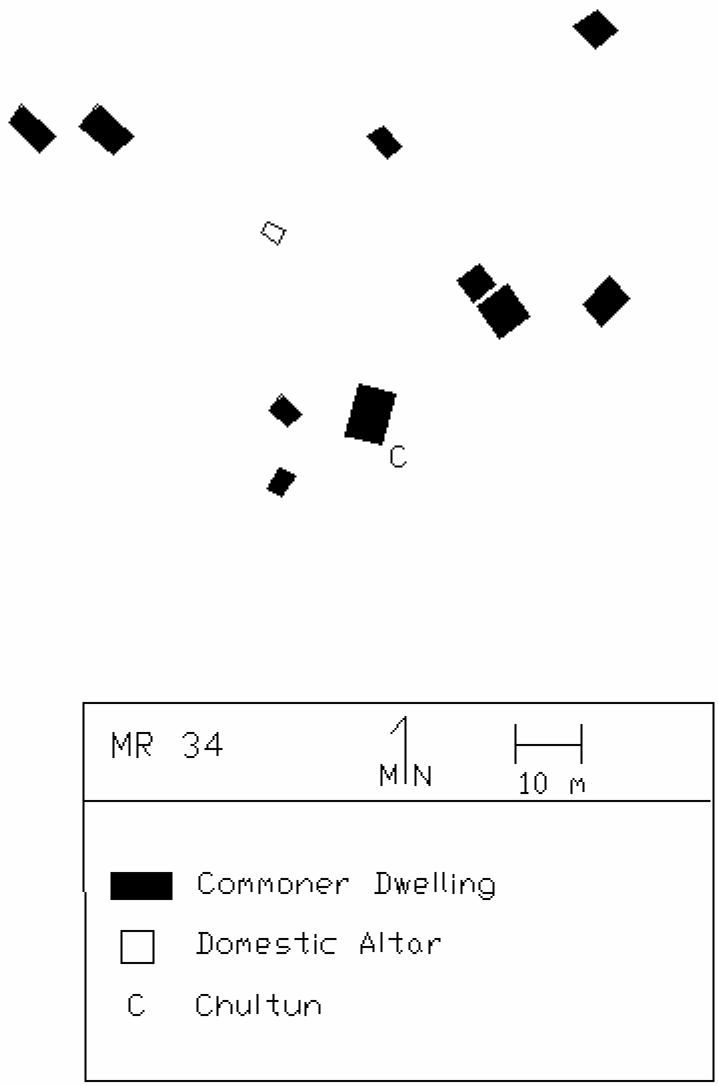

Modern road
Sherd scatter
MR 30
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

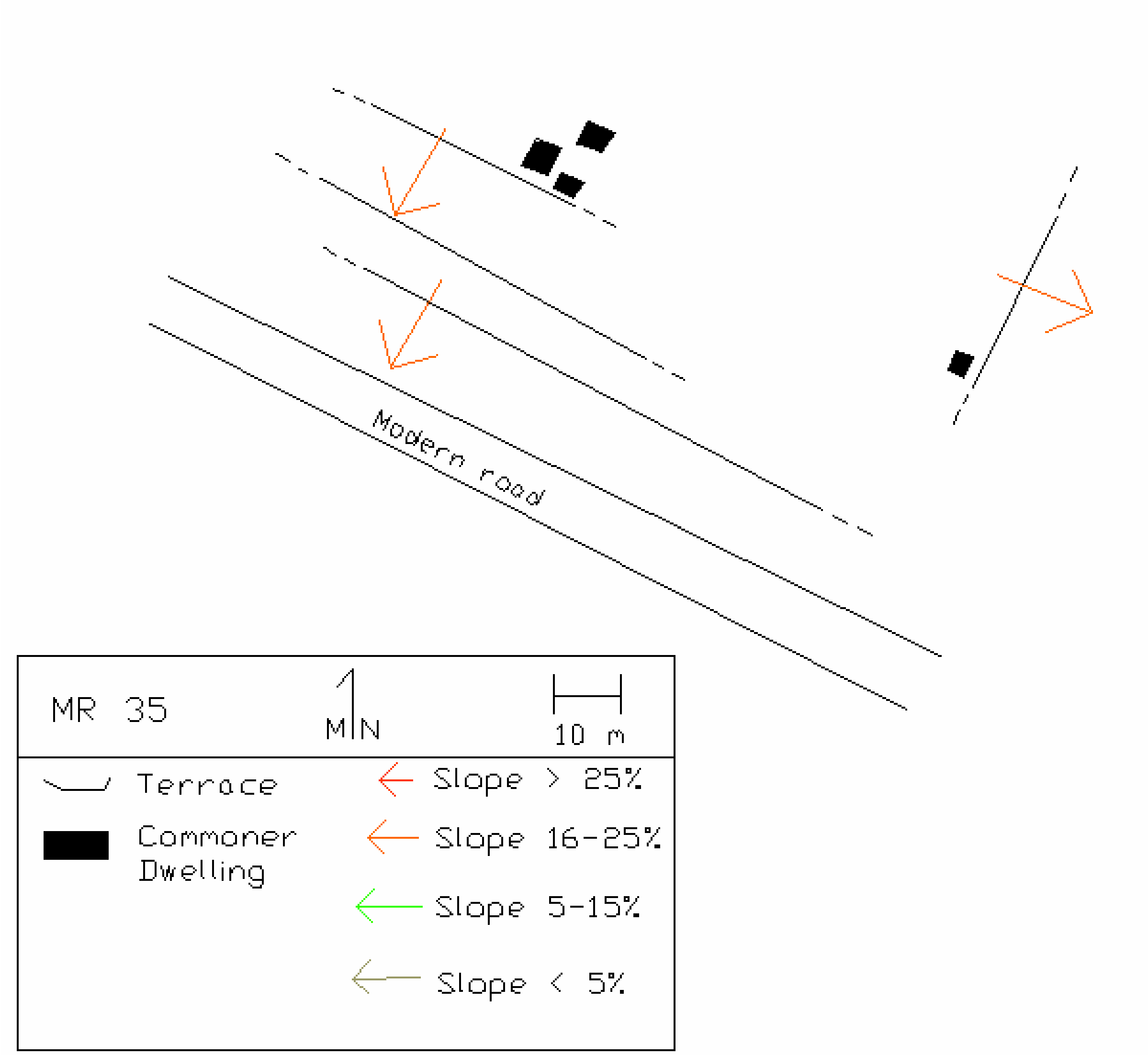

Flat, low-lying zone
Modern wall
Flat, low-lying zone
MR 31
M N
10 m
Terrace
Unidentified Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

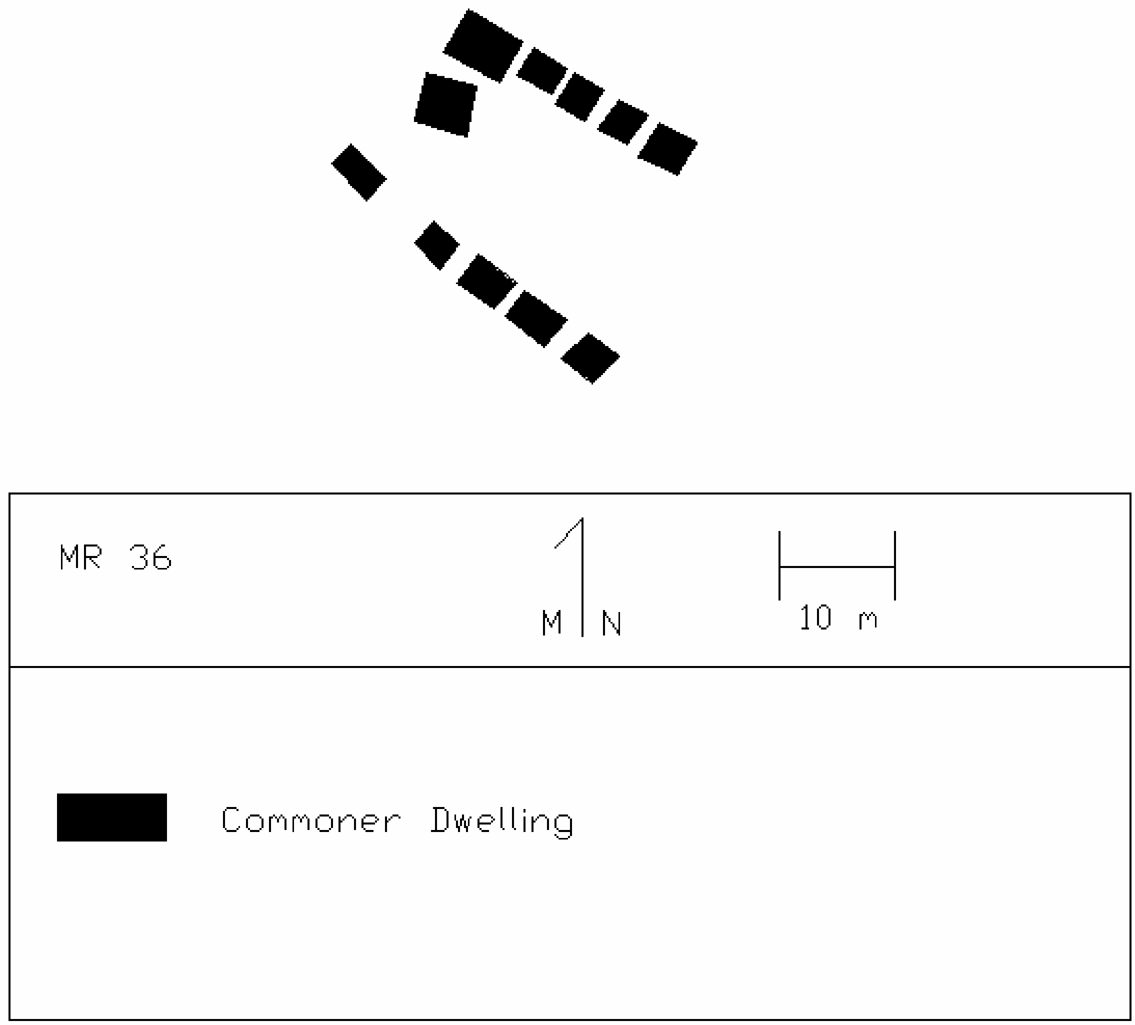

Modern wall
Modern water hole
Modern wall
Platform
MR 32
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

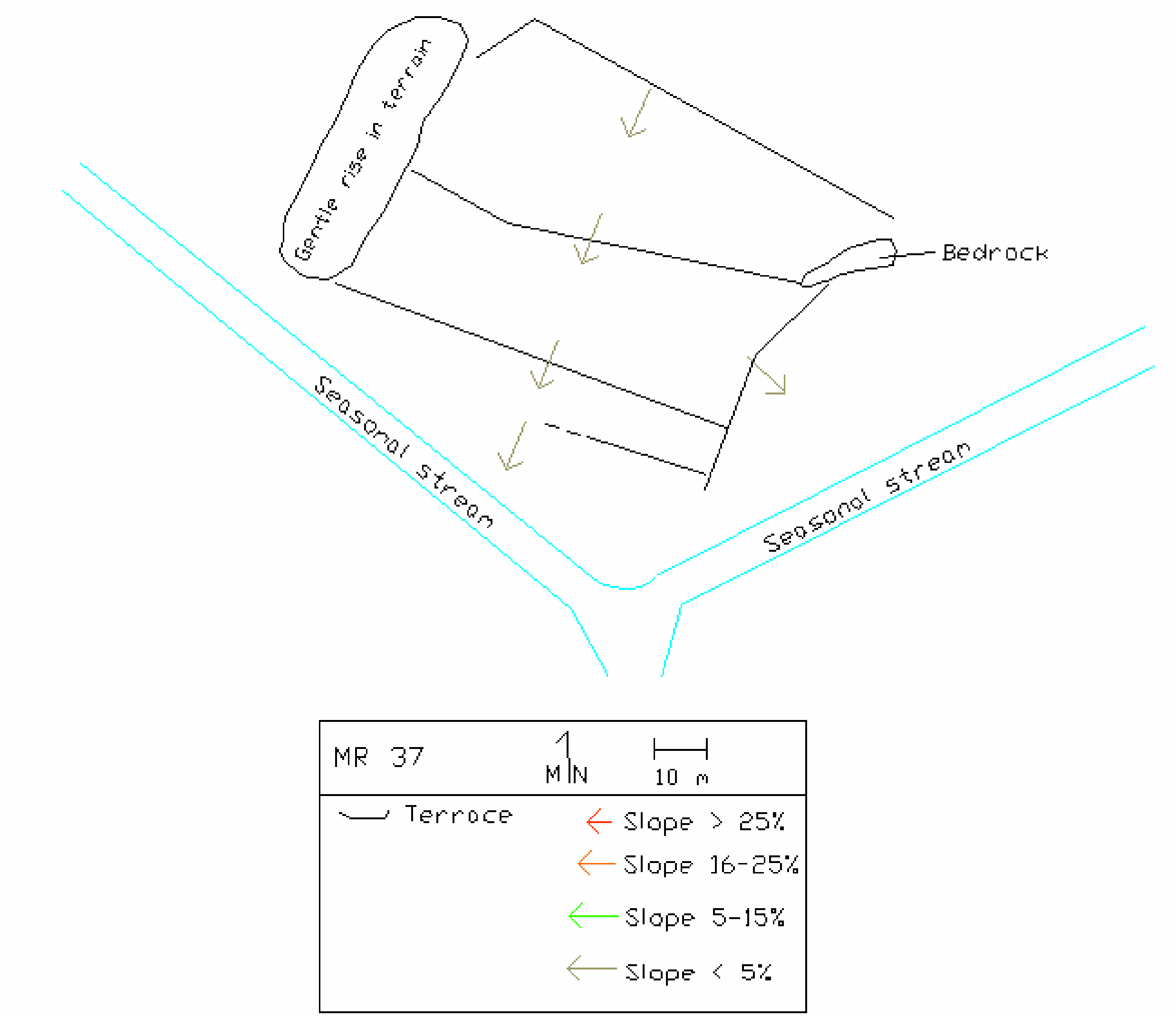


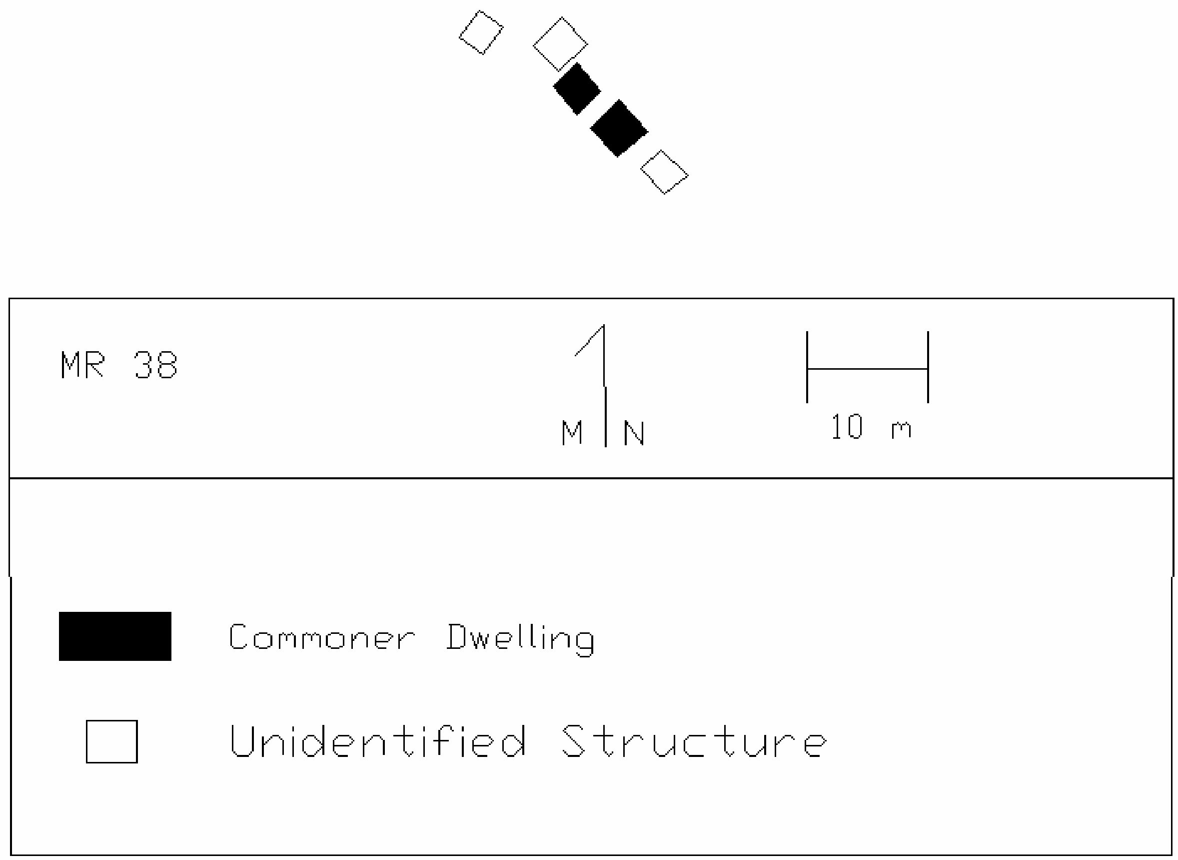
MR 33
M
N
10 m
Terrace
Commoner Dwelling
Bedrock
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Seasonal stream

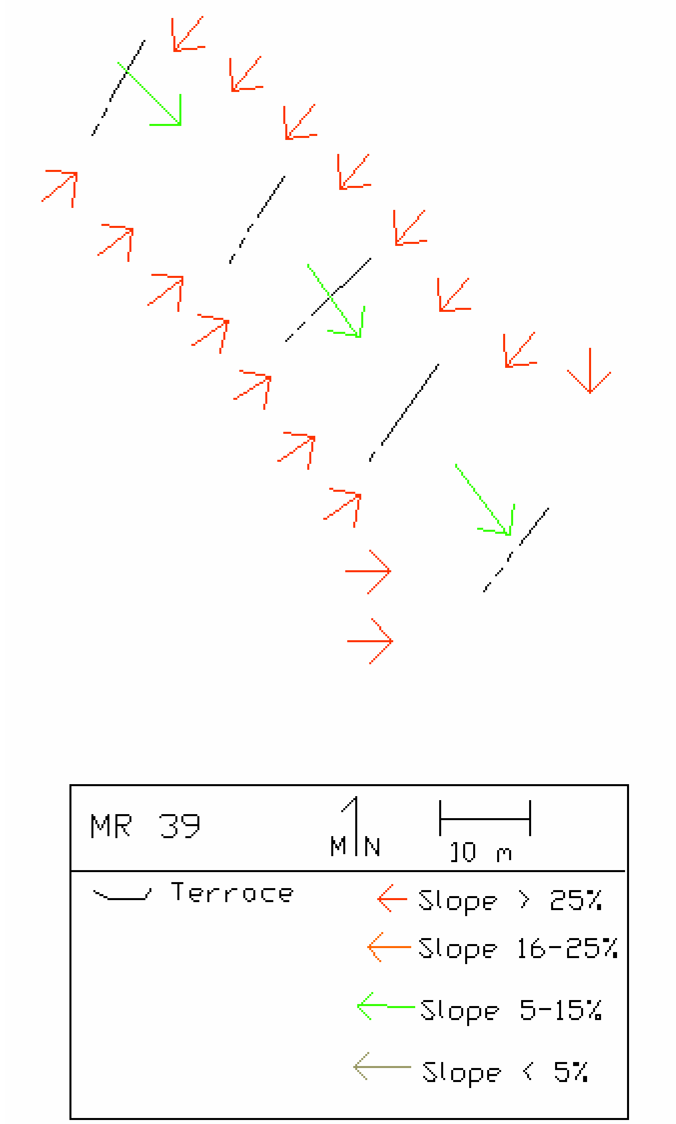

C
MR 34
M N
10 m
Commoner Dwelling
Domestic Altar
C Chultun

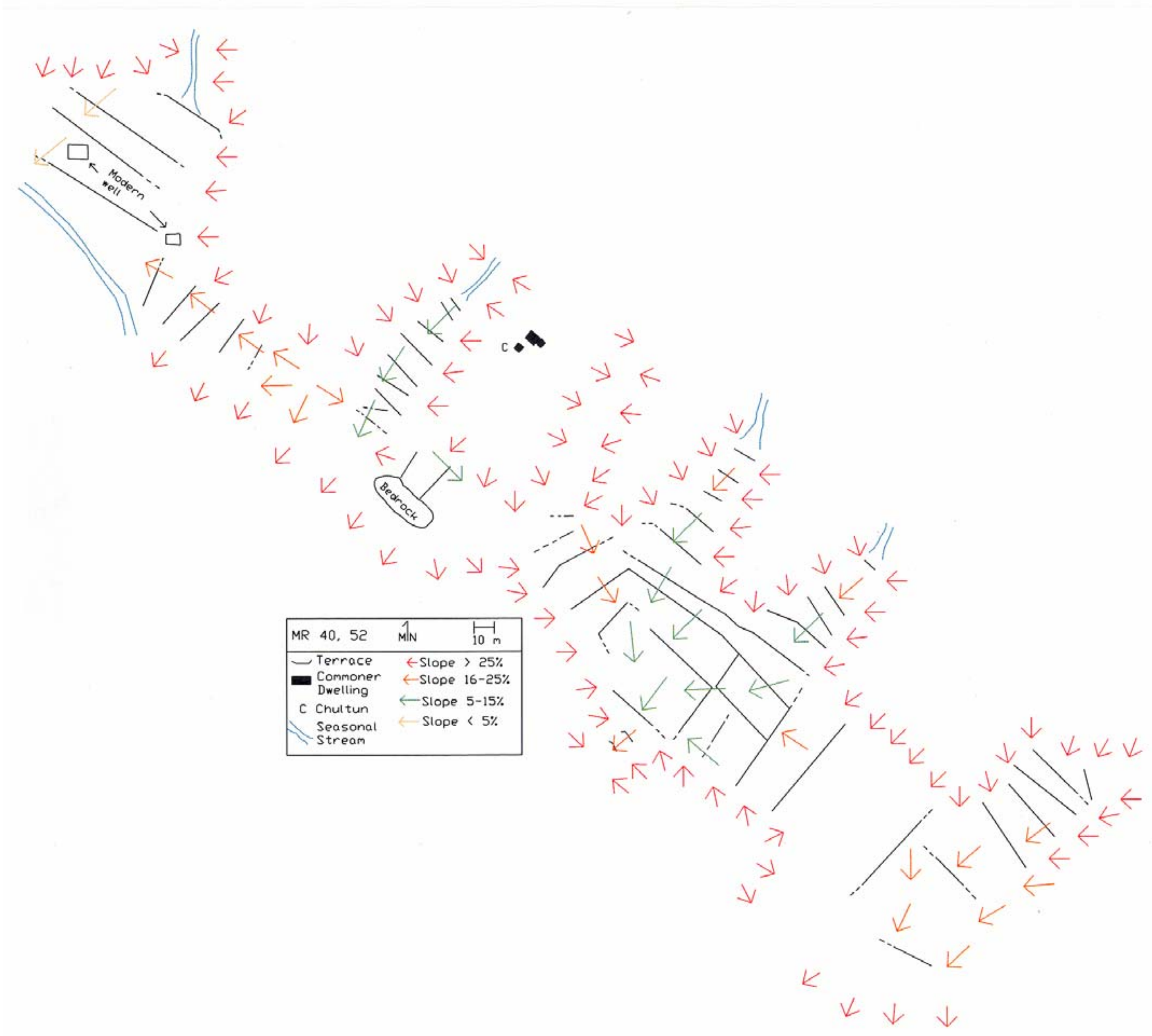

Modern road
MR 35
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

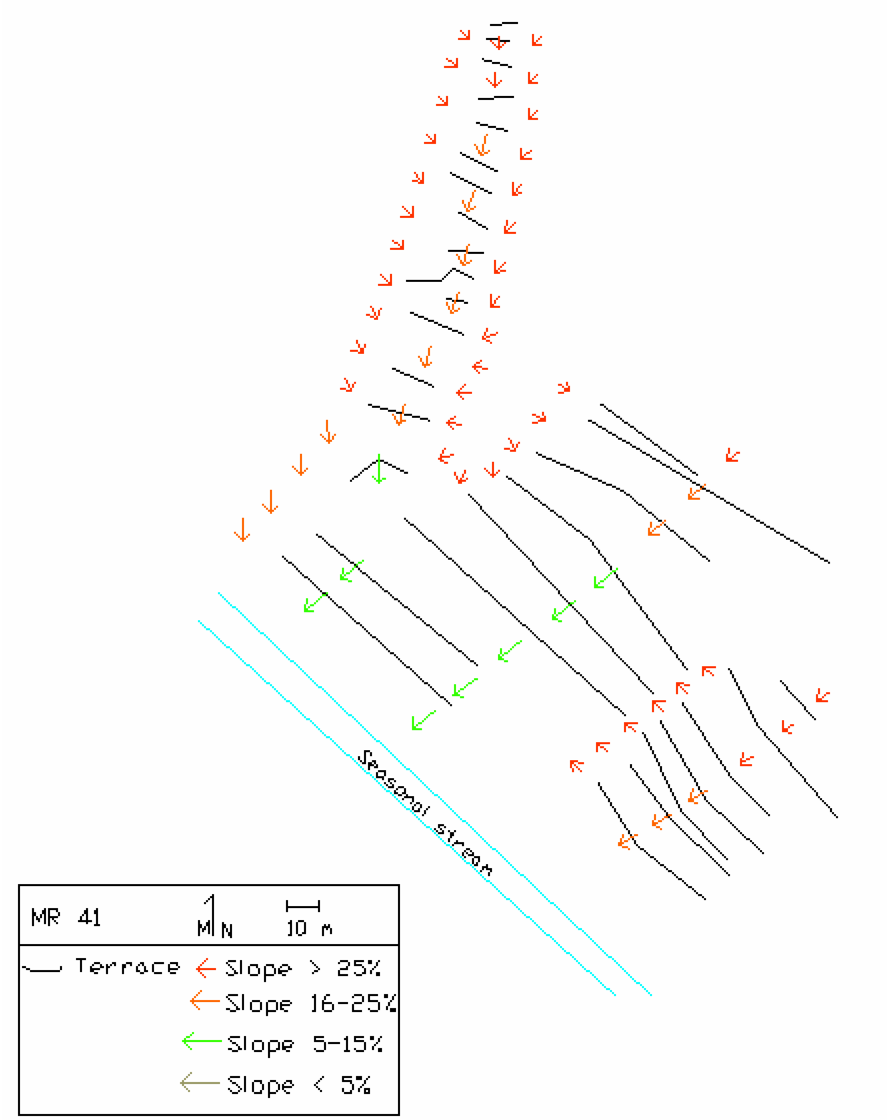

MR 36
M N
10 m
Commoner Dwelling

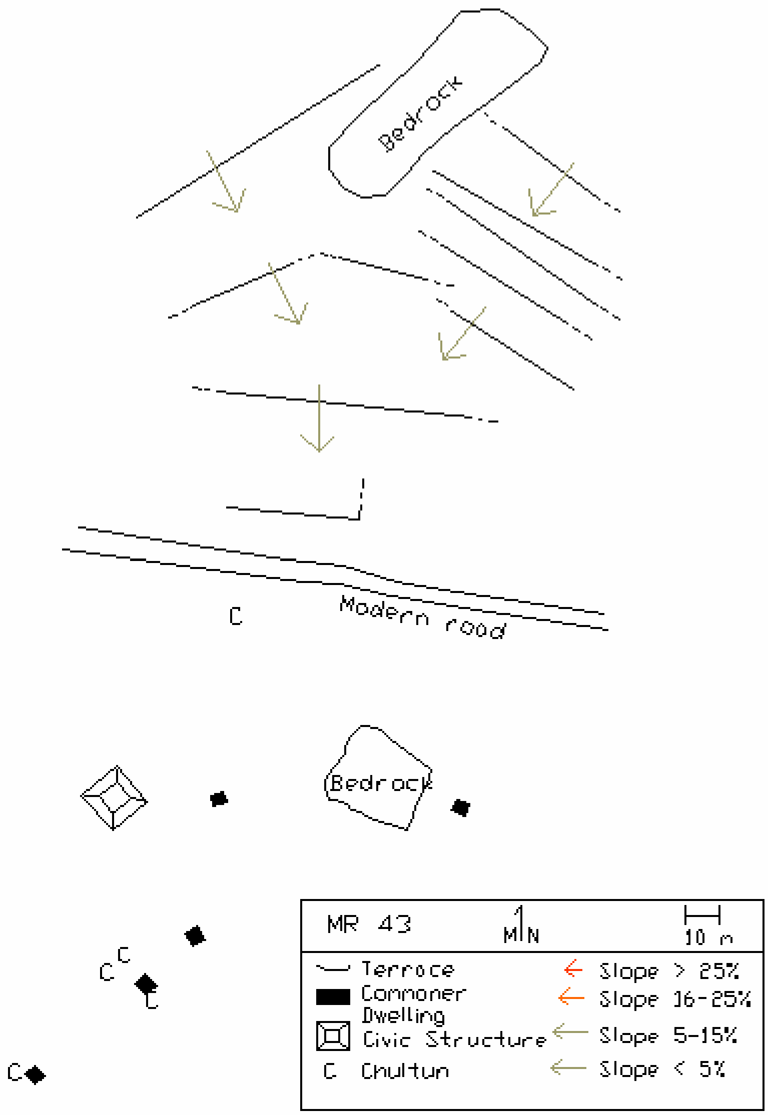

Gentle rise in terrain
Bedrock
Seasonal stream
Seasonal stream
MR 37
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

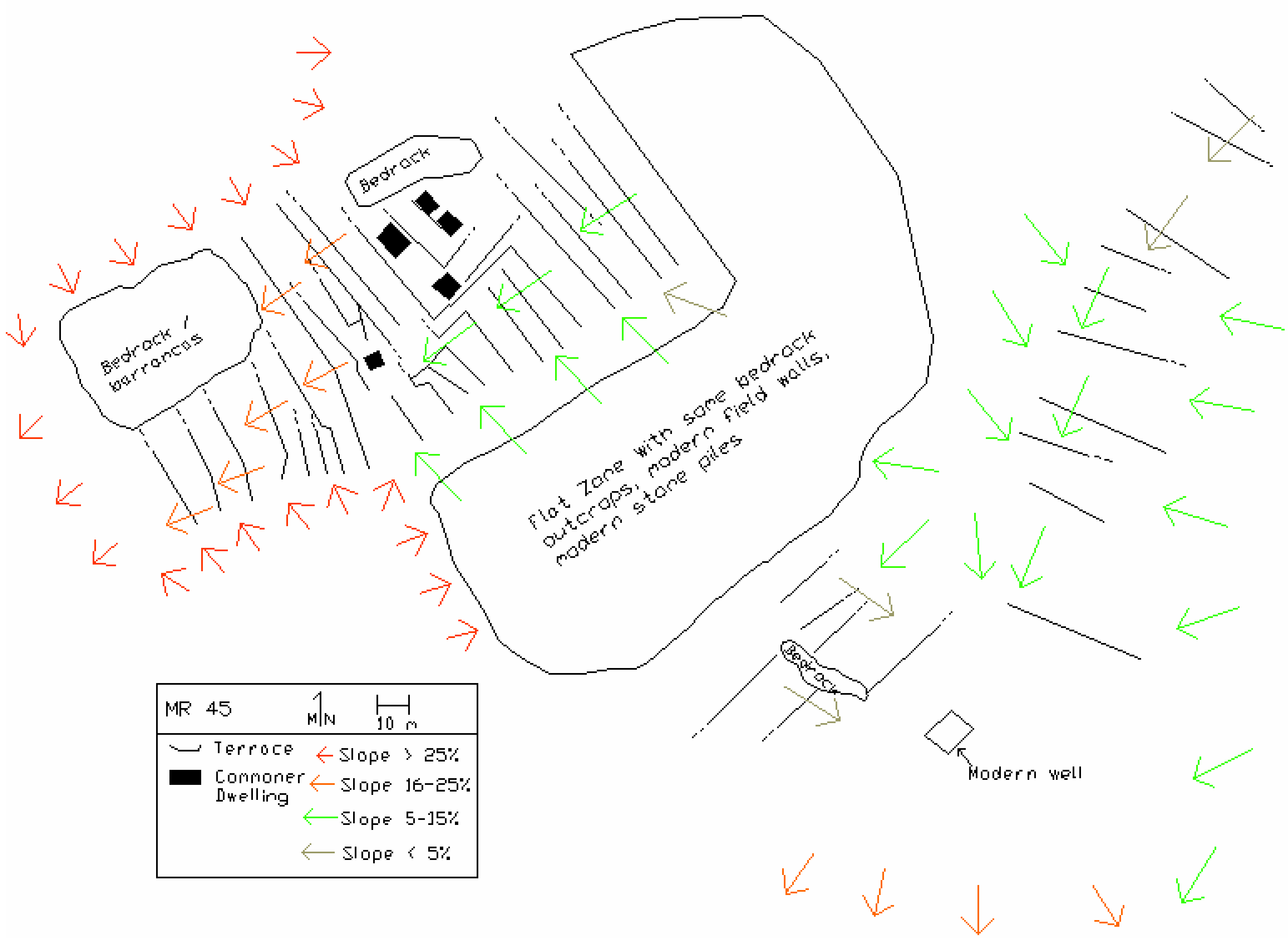

MR 38
M N
10 m
Commoner Dwelling
Unidentified Structure

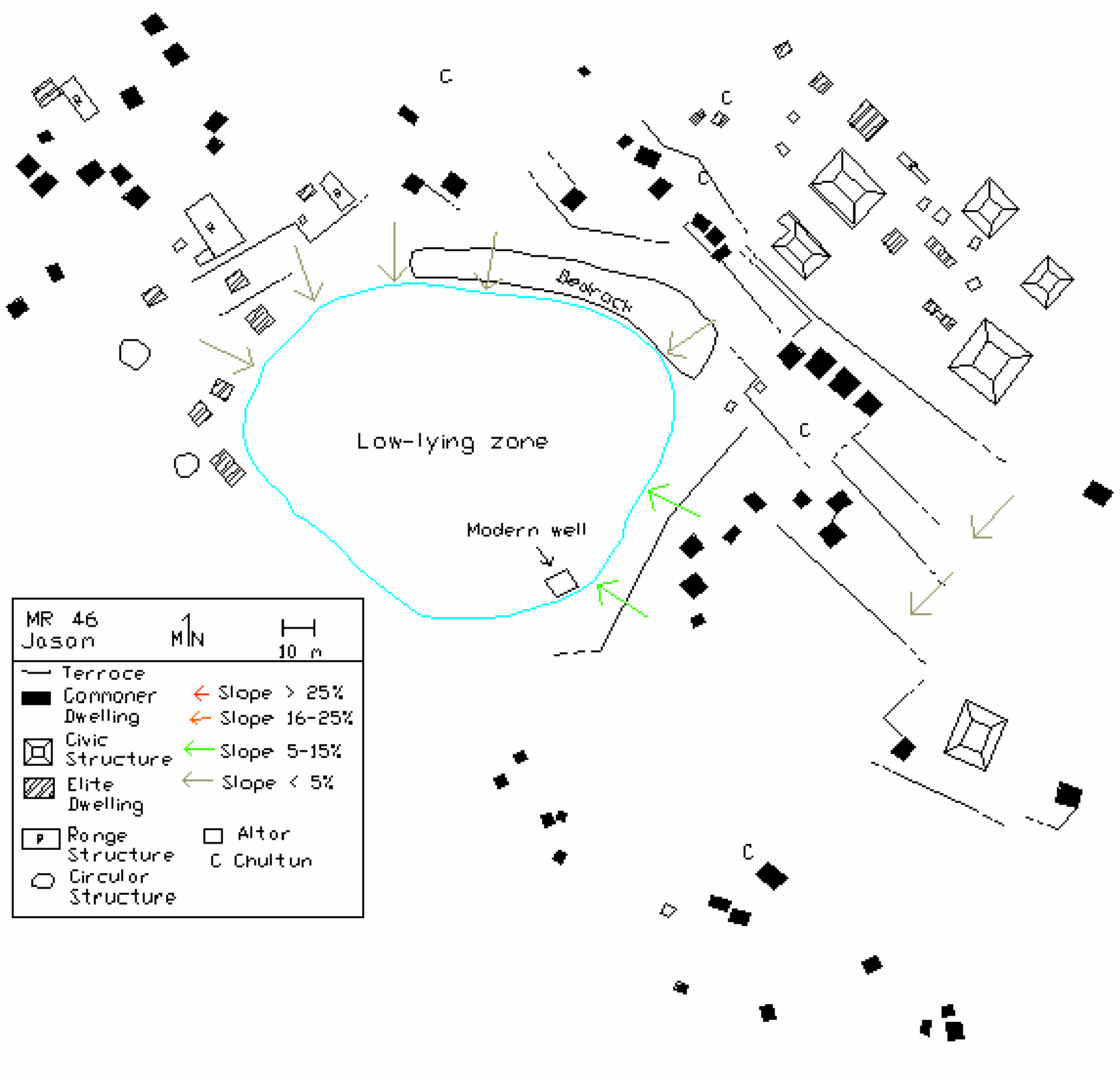

MR 39
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


Modern well
C
Bedrock
MR 40, 52
MN
10 m
Terrace
Commoner Dwelling
C Chultun
Seasonal Stream
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

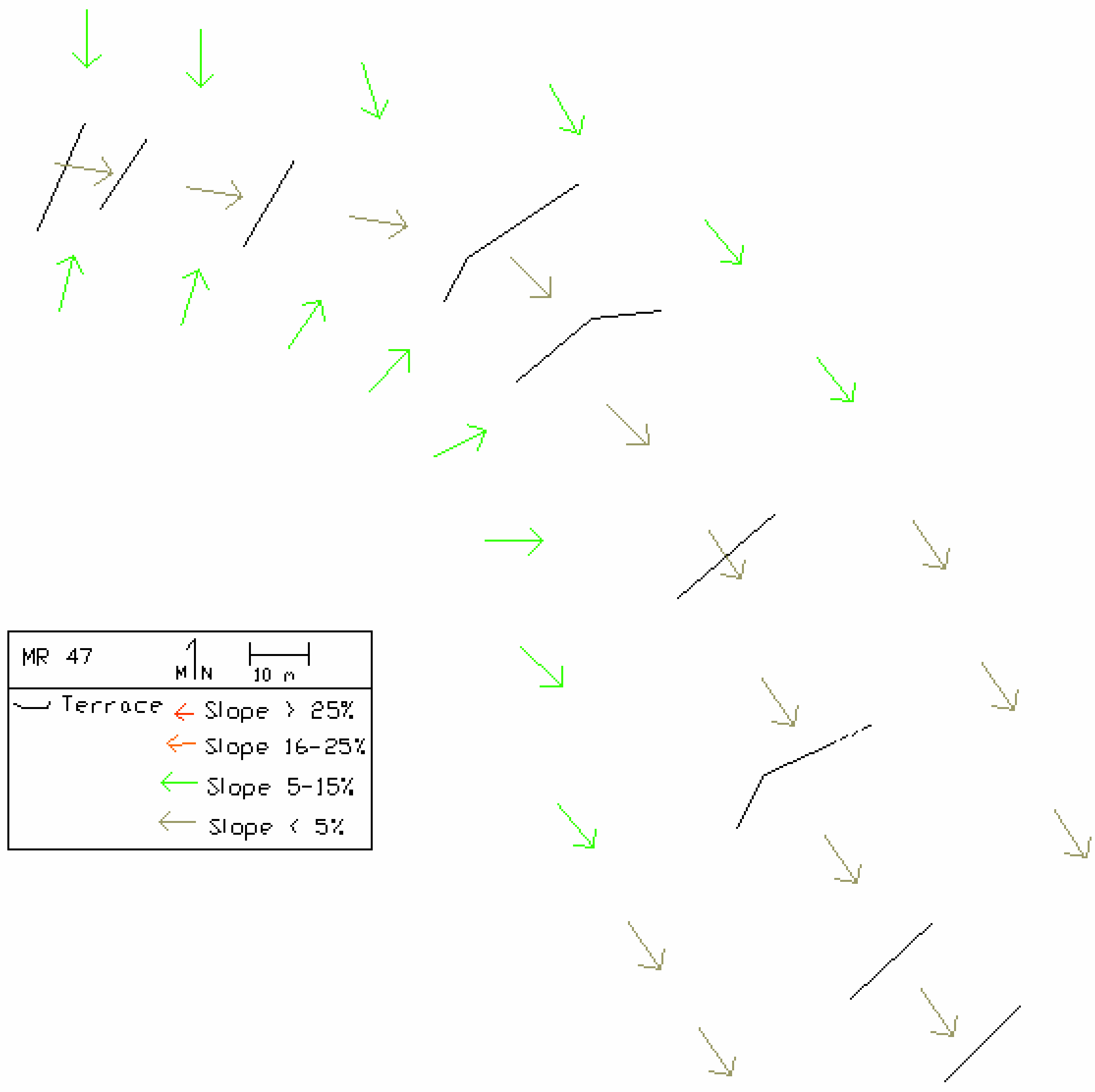

Seasonal stream
MR 41
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

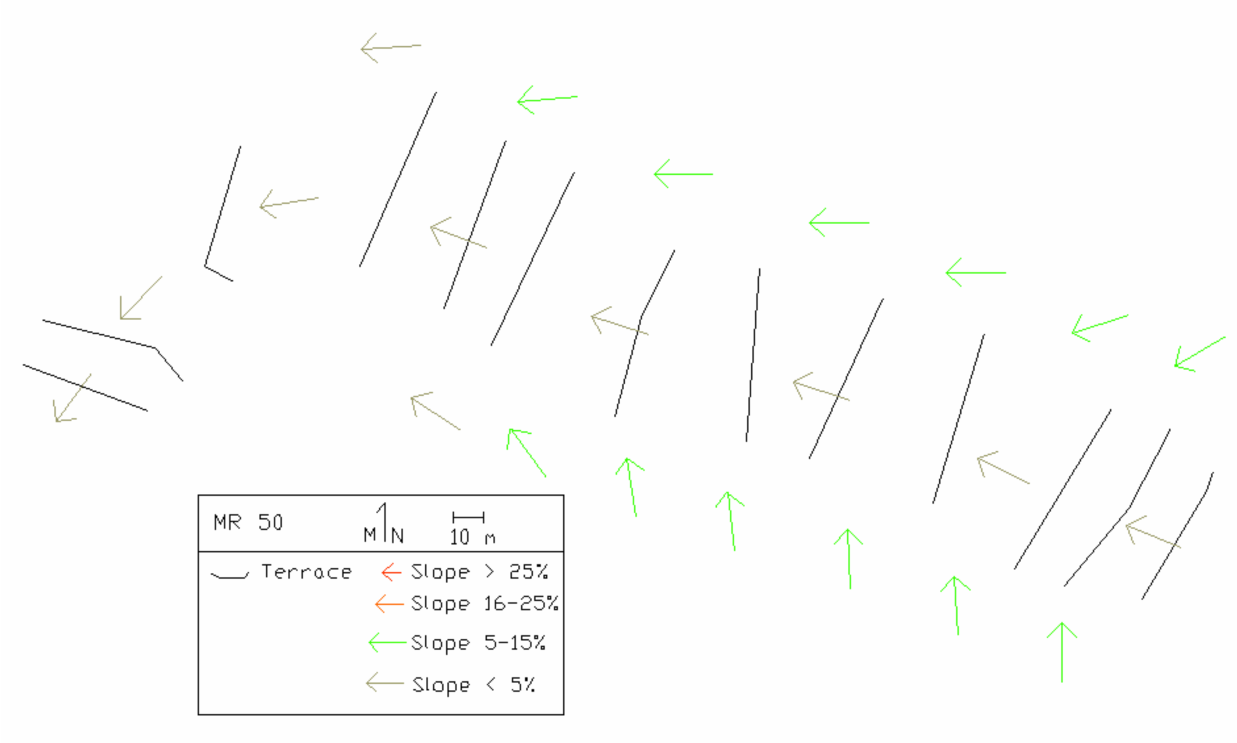

Bedrock
Modern road
C
Bedrock
C
C
C
C
MR 43
MN
10 m
Terrace
Commoner Dwelling
Civic Structure
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

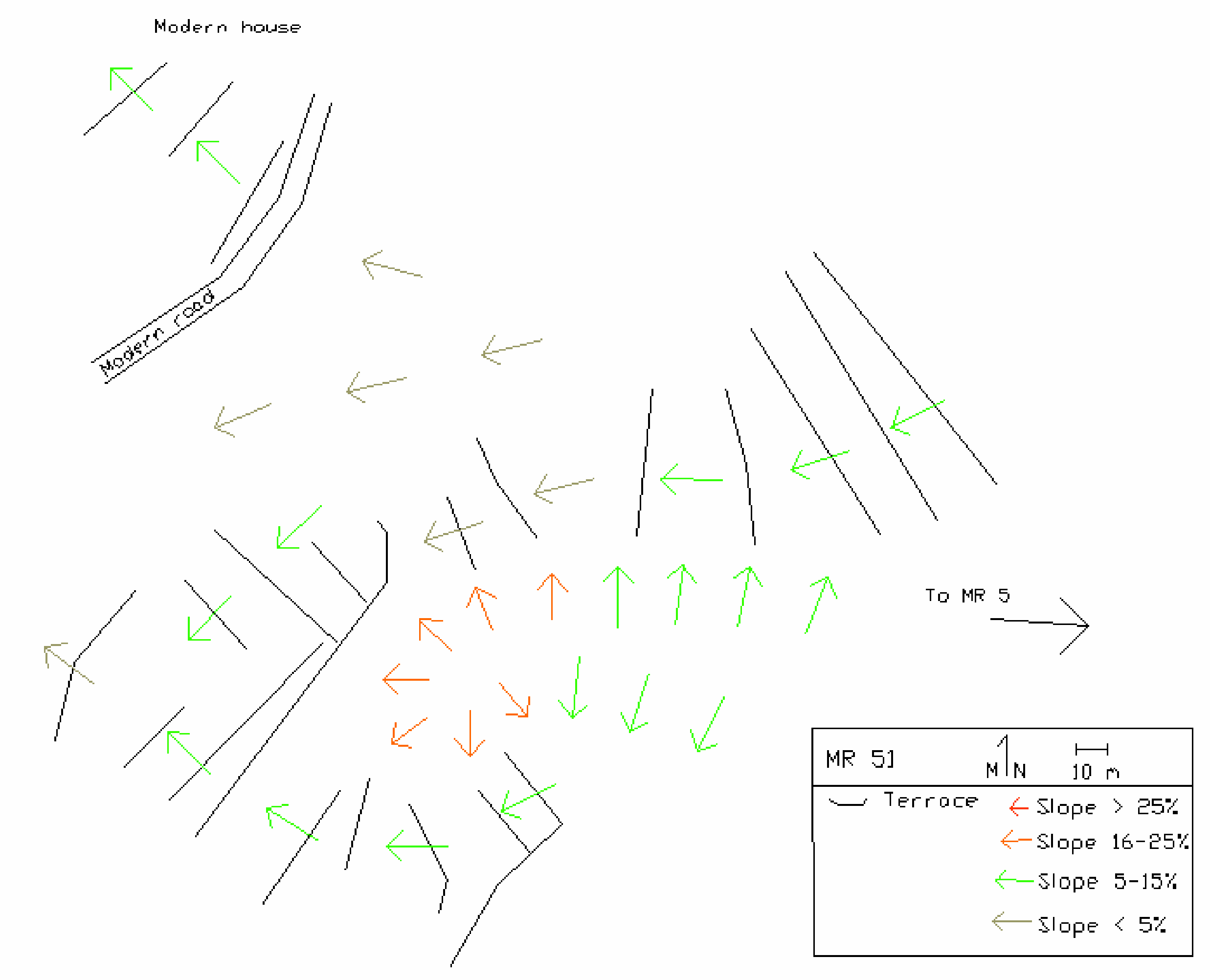

Bedrock
Bedrock / barrancas
Flat Zone with some bedrock outcrops, modern field walls, modern stone piles
Bedrock
Modern well
MR 45
M N
10 m
Terrace
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

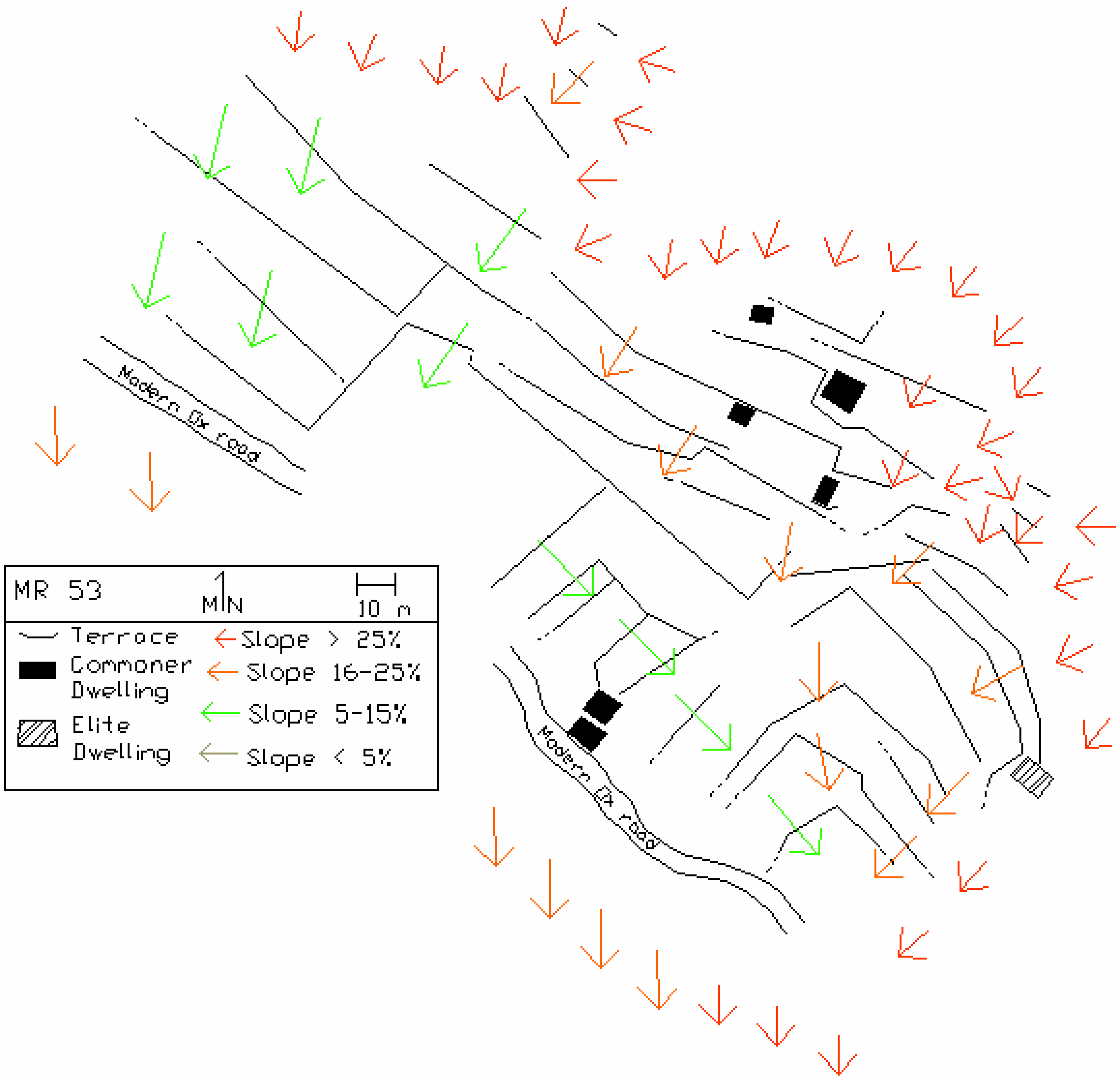


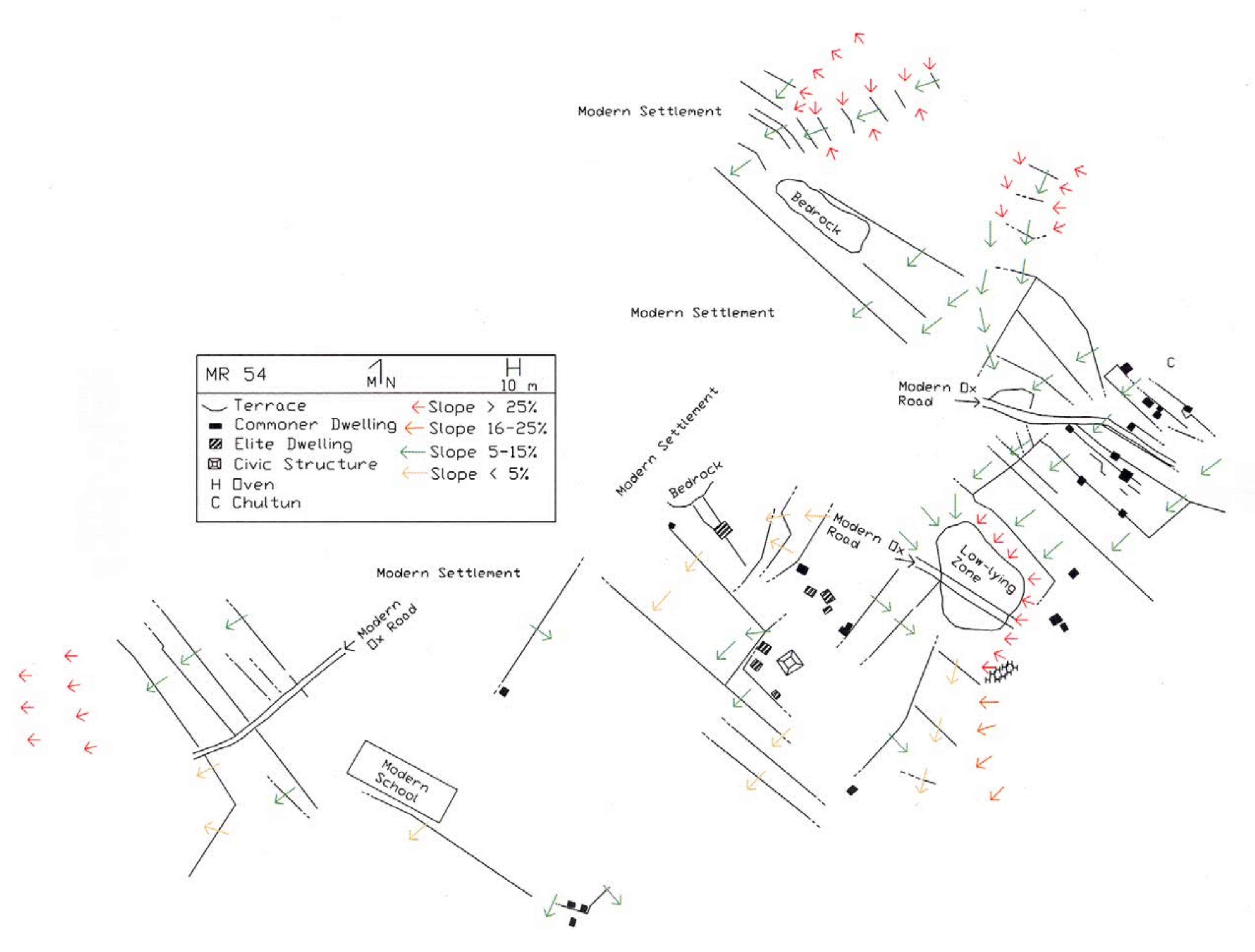
MR 46
Jason
MN
10 m
Terrace
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Circular Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Altar
C Chultun
Low-lying zone
Modern well
Bedrock

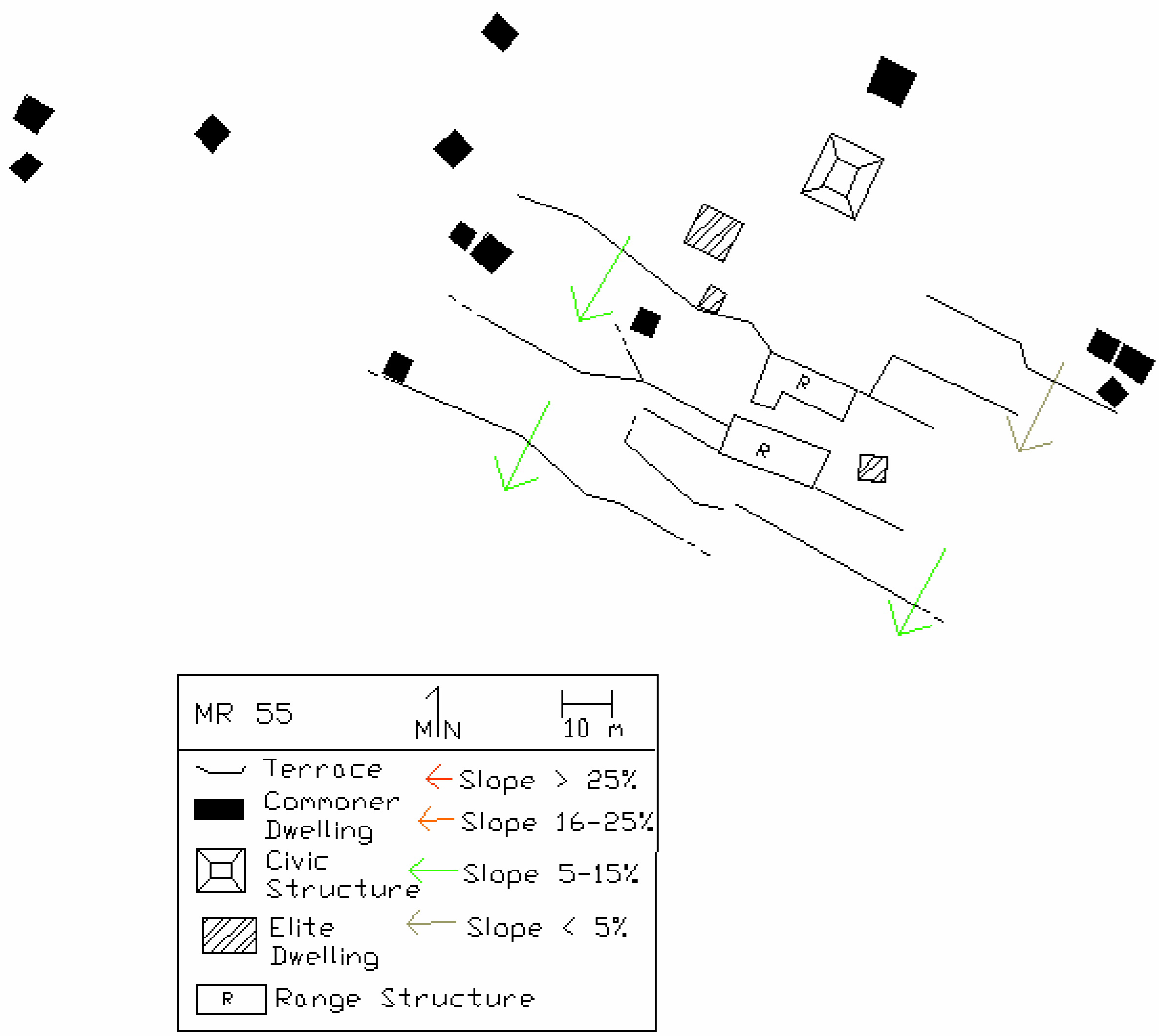

MR 47
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

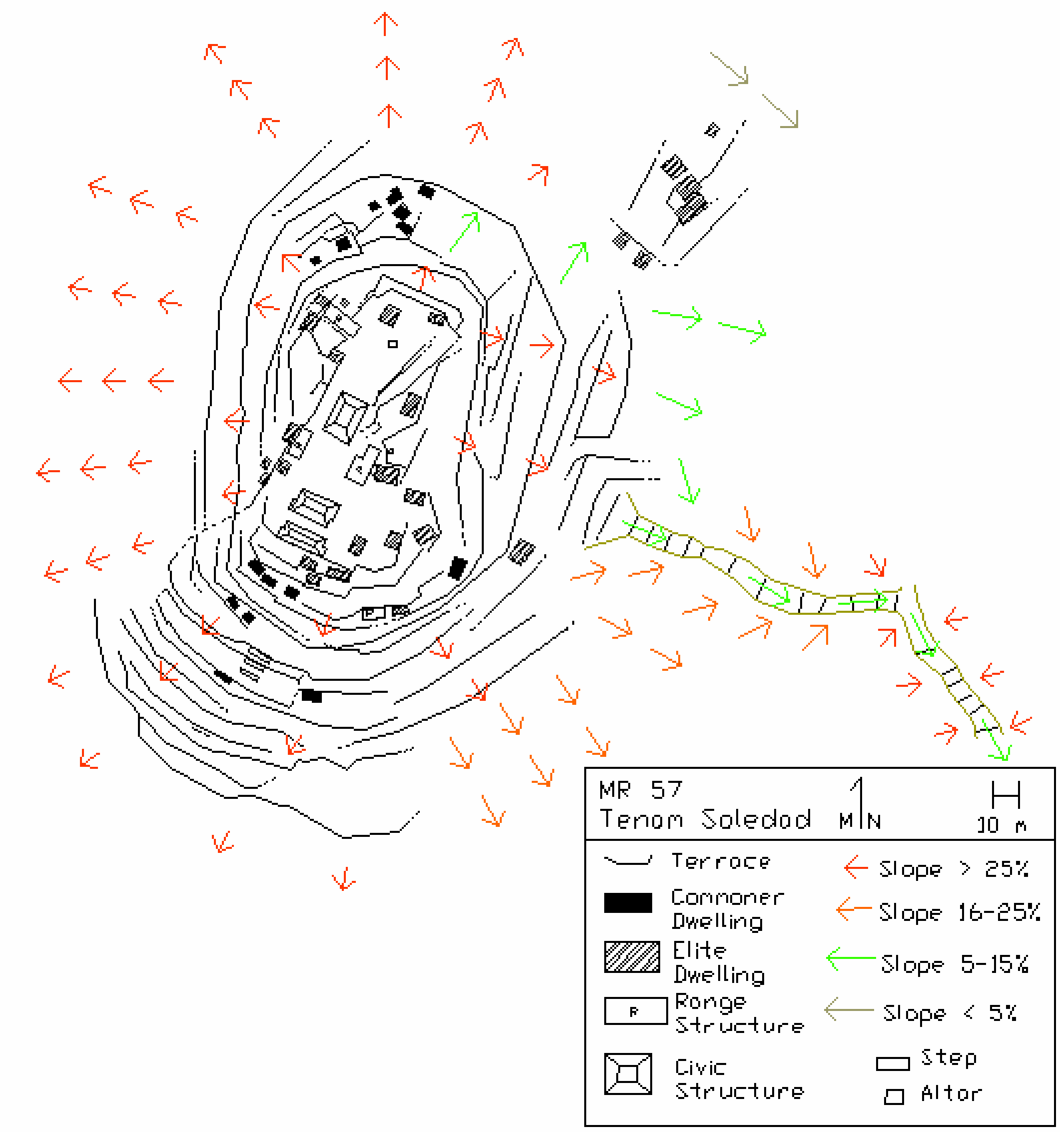

MR 50
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

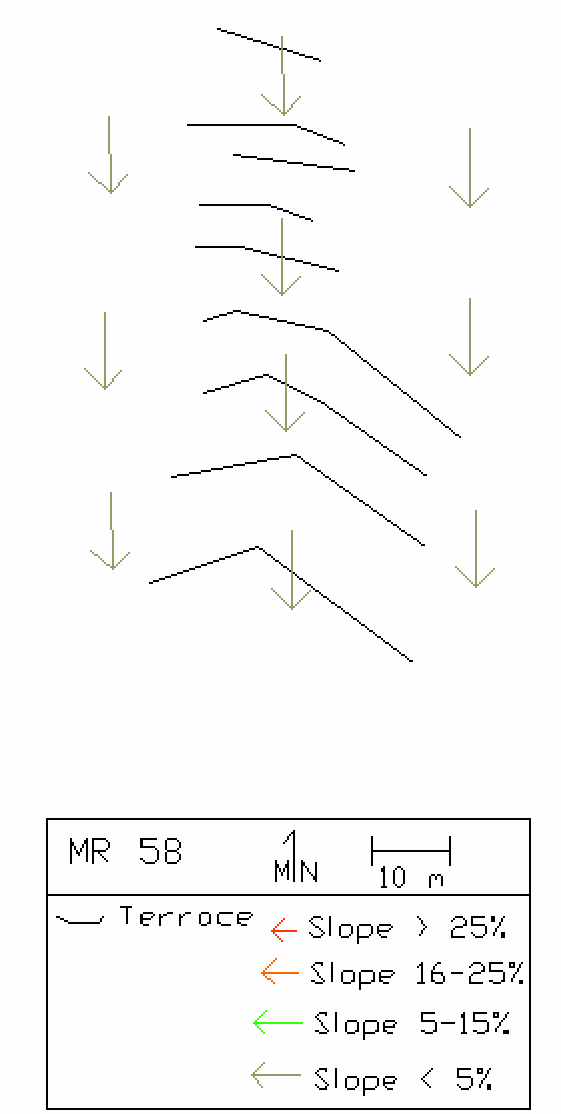

Modern house
Modern road
To MR 5
MR 51
M N
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

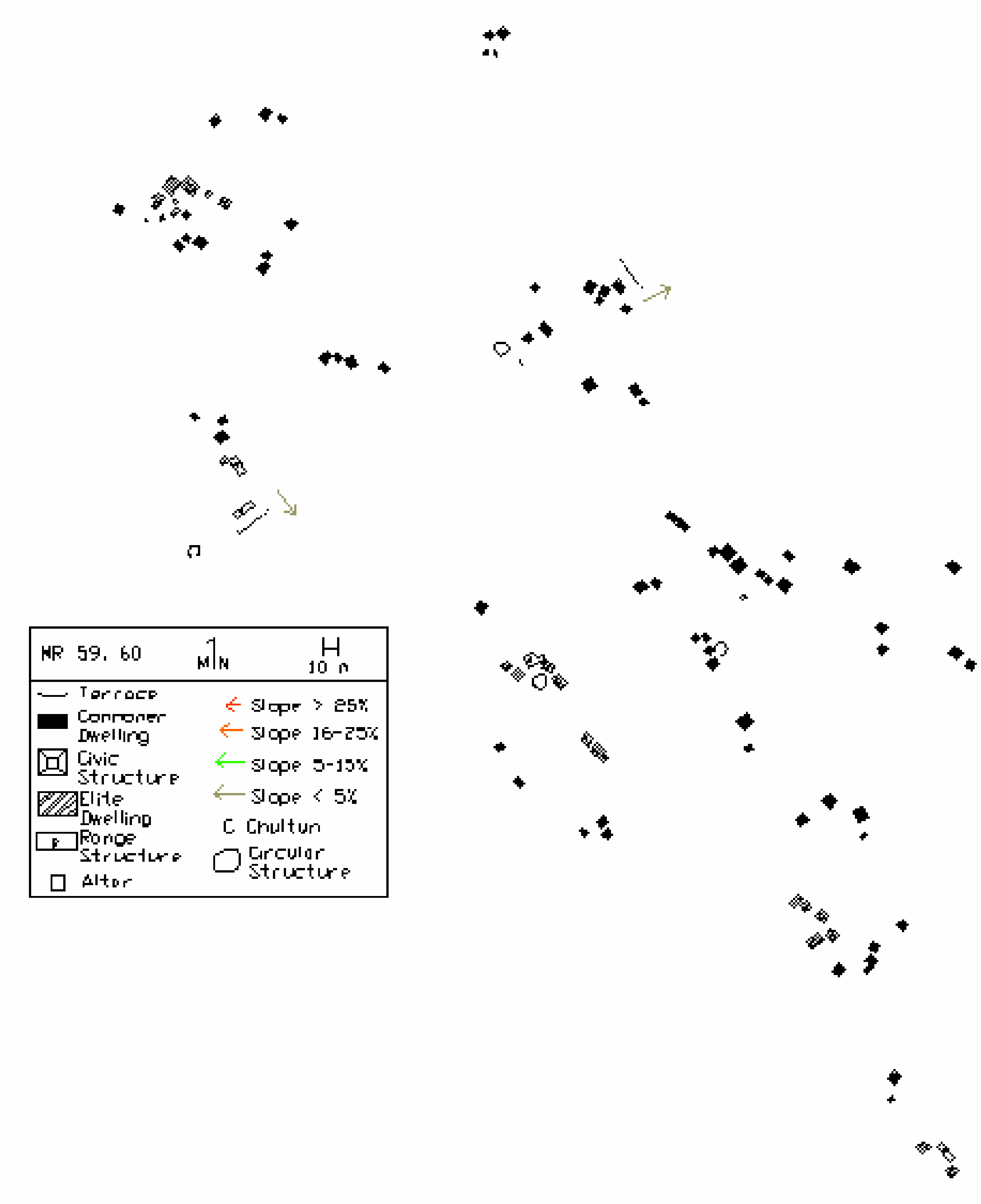

MR 53
MN
10 m
Terrace
Slope > 25%
Commoner Dwelling
Slope 16-25%
Slope 5-15%
Elite Dwelling
Slope < 5%
Modern Ox road
Modern Ox road


MR 54
M N
10 m
Terrace
Commoner Dwelling
Elite Dwelling
Civic Structure
H Oven
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Modern Settlement
Modern Settlement
Modern Settlement
Modern Settlement
Bedrock
Bedrock
Modern Ox Road
Modern Ox Road
Modern Ox Road
Low-lying Zone
Modern School
C

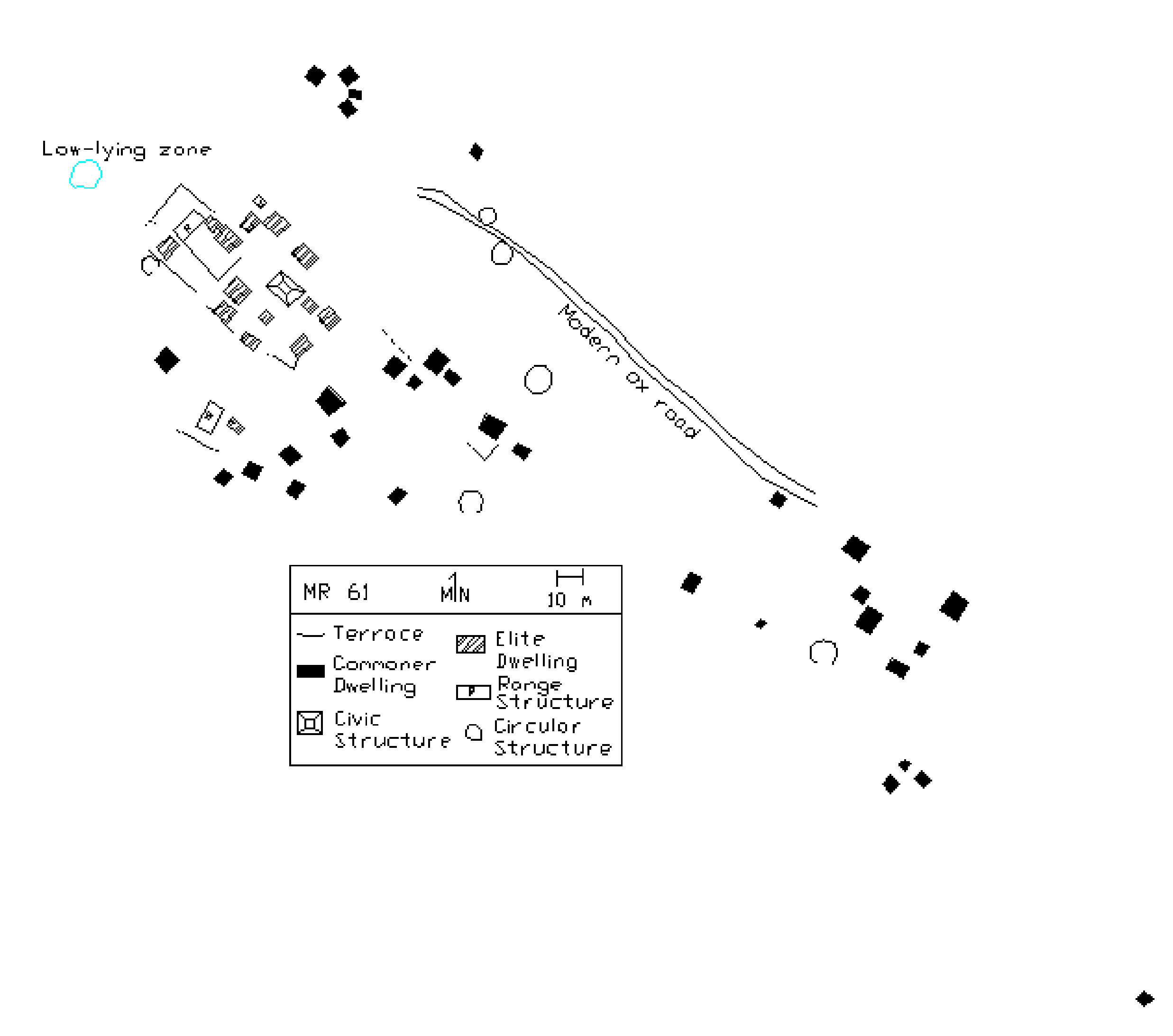

R
R
MR 55
M N
10 m
Terrace
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

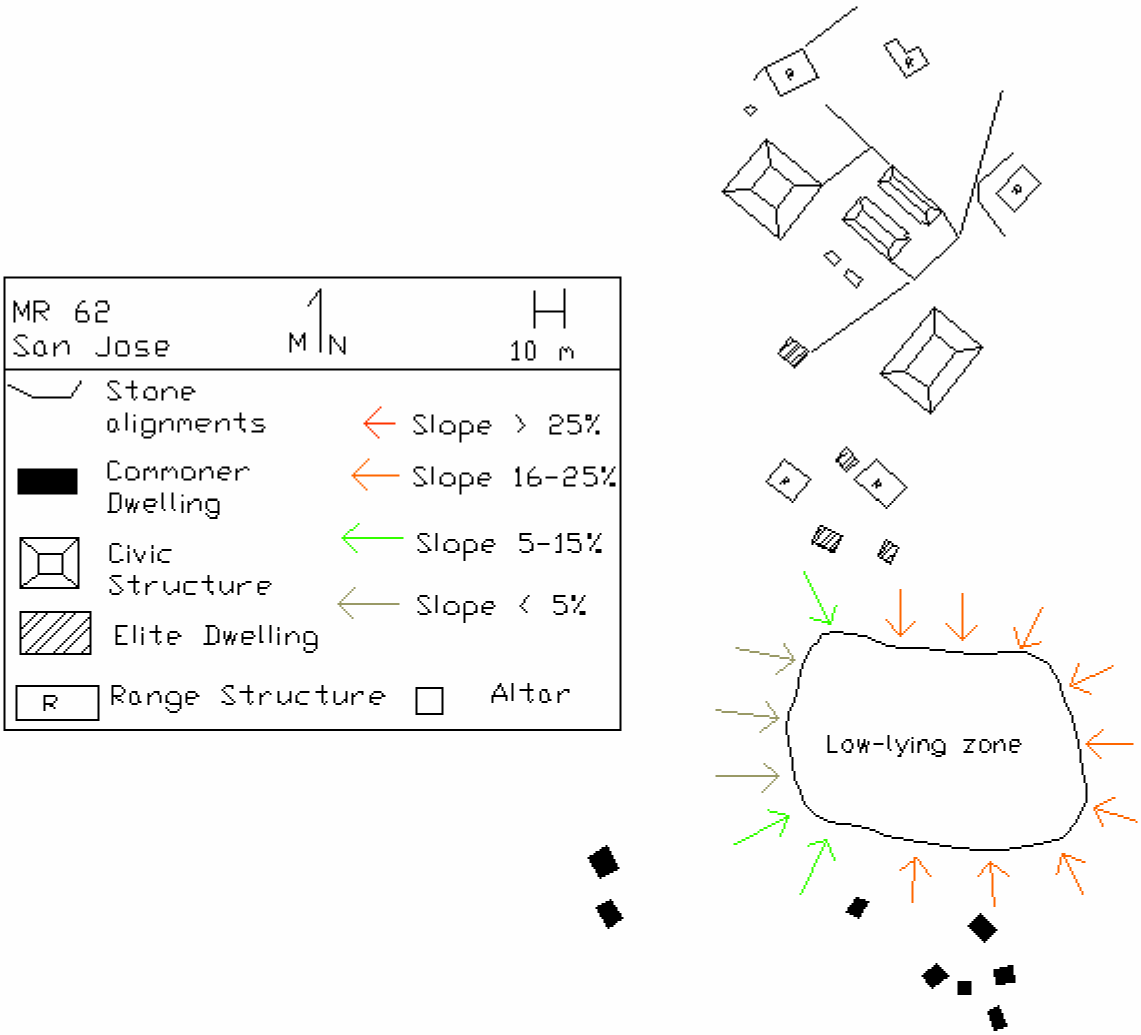

MR 57
Tenam Soledad
N
10 m
Terrace
Commoner Dwelling
Elite Dwelling
Range Structure
Civic Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Step
Altar

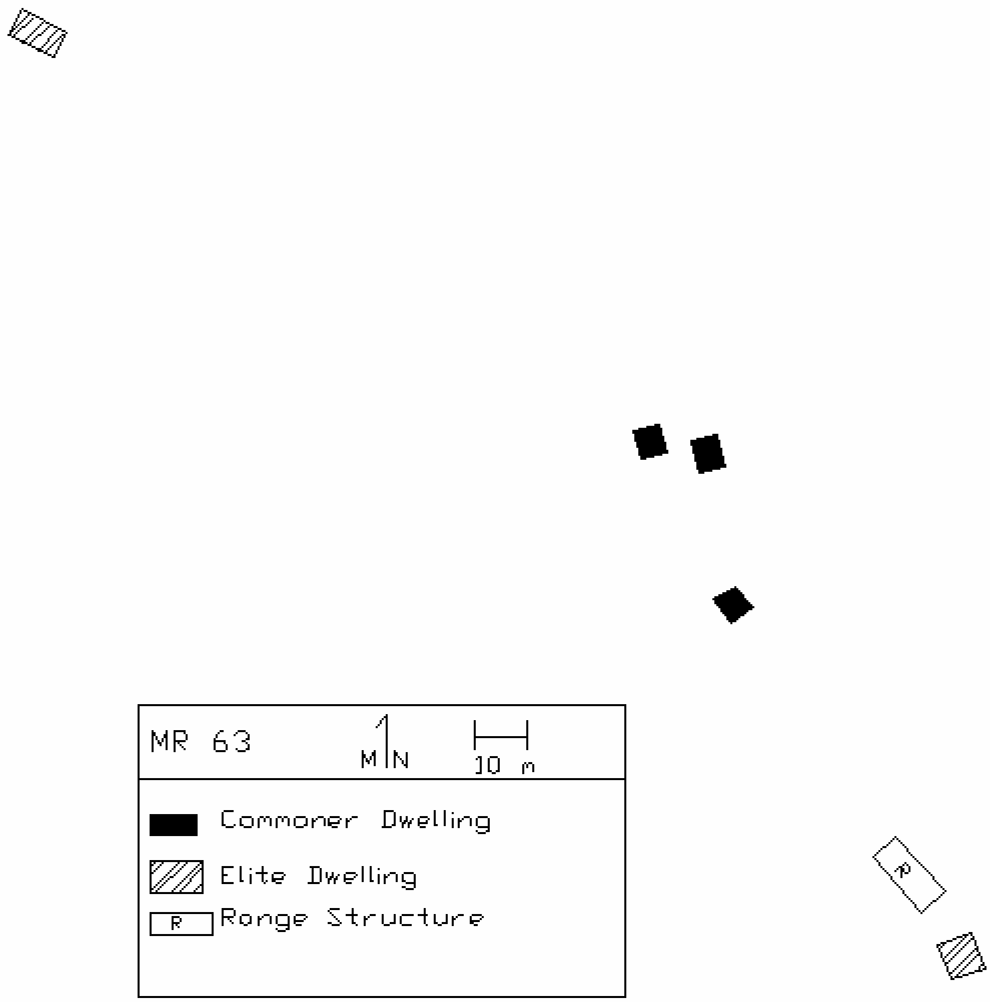

MR 58
N
M
10 m
Terrace
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

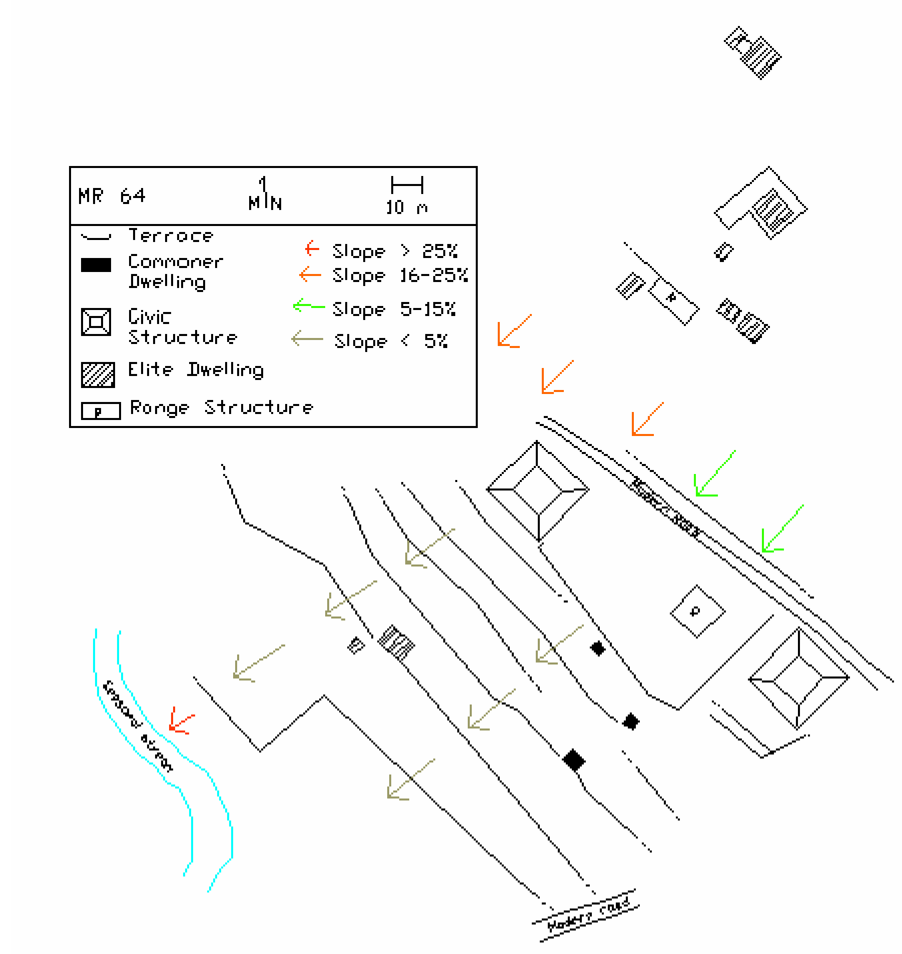


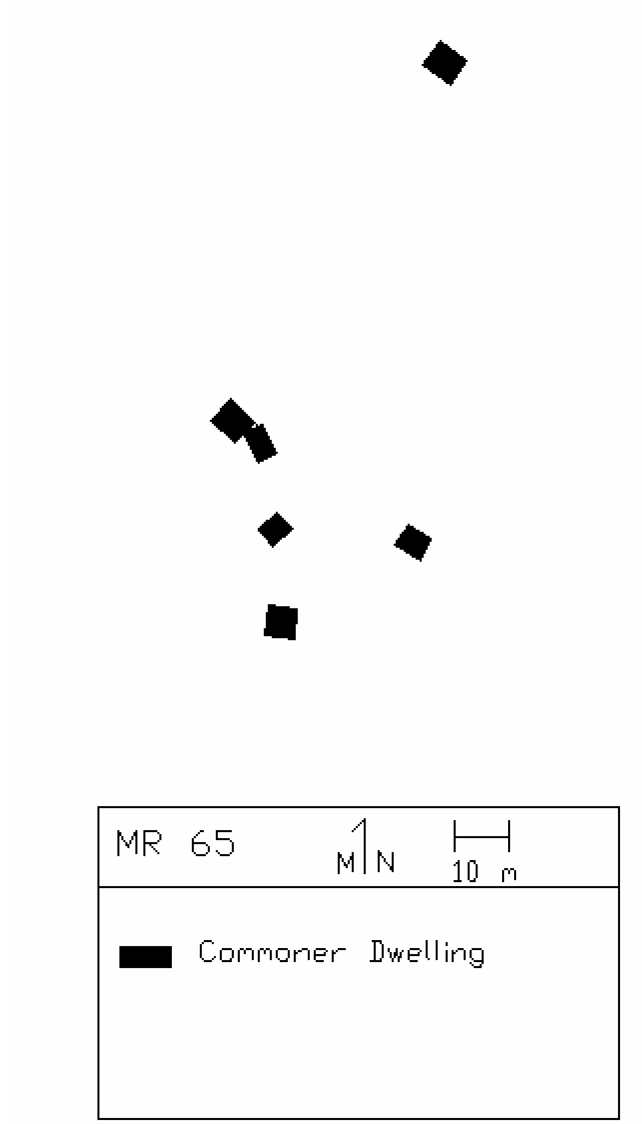
NR 59, 60
M N
10 m
Terrace
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Altar
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
C Chultun
Circular Structure

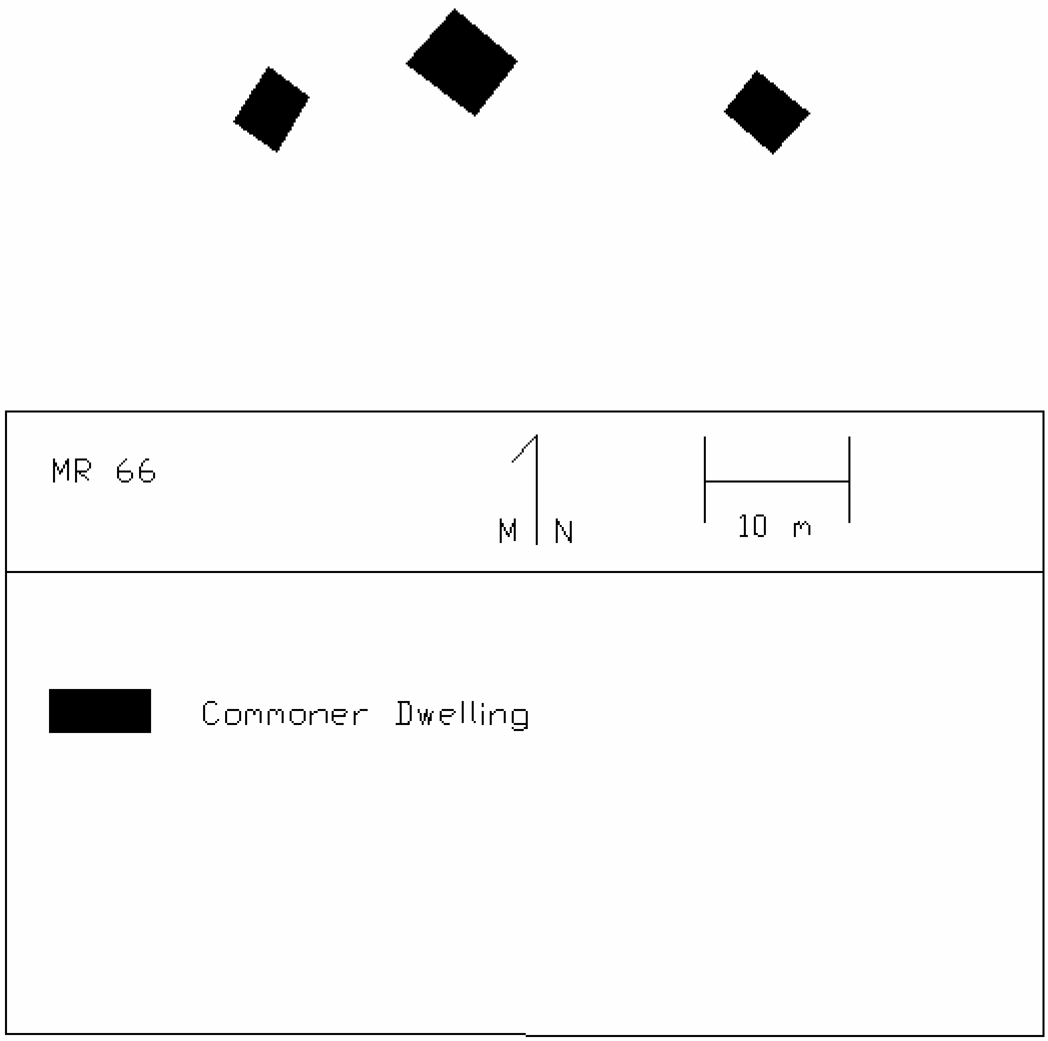

Low-lying zone
Modern ox road
MR 61
N
10 m
Terrace
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Circular Structure

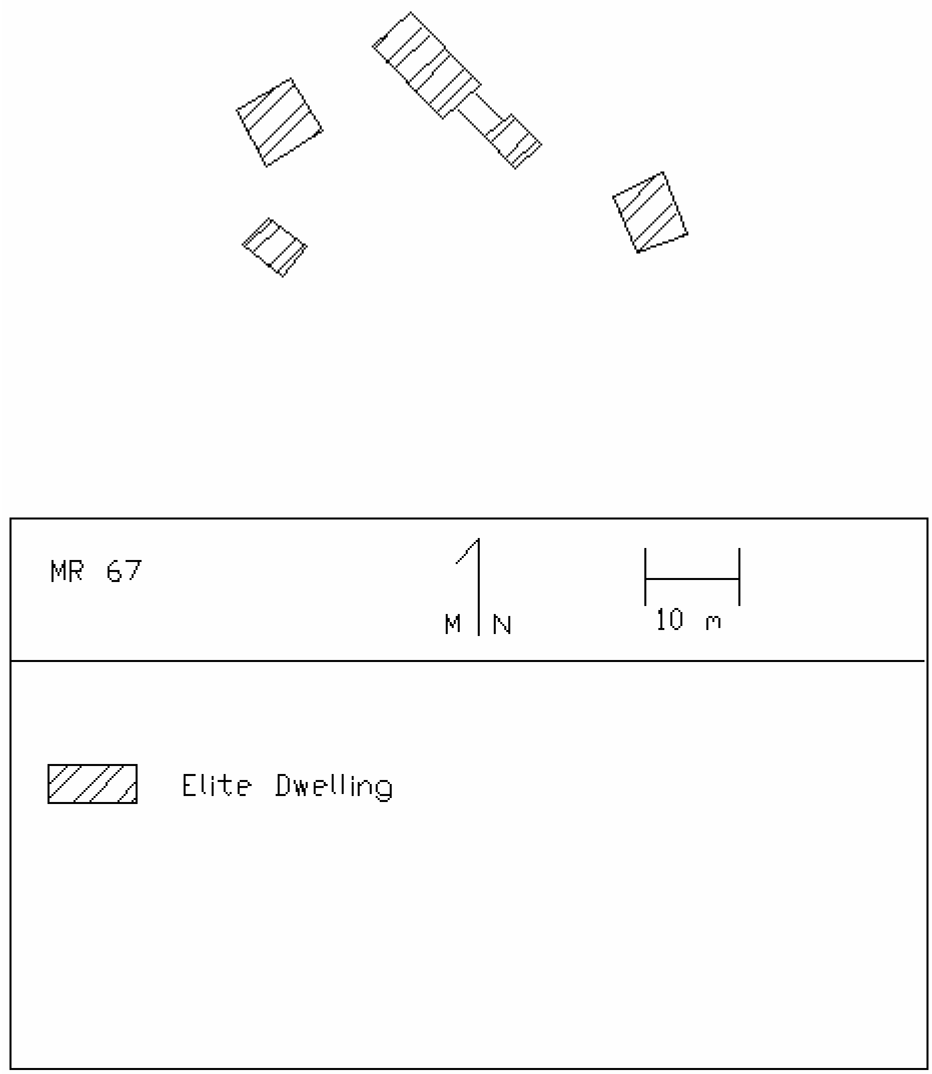

MR 62
San Jose
M N
10 m
Stone alignments
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Altar
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Low-lying zone

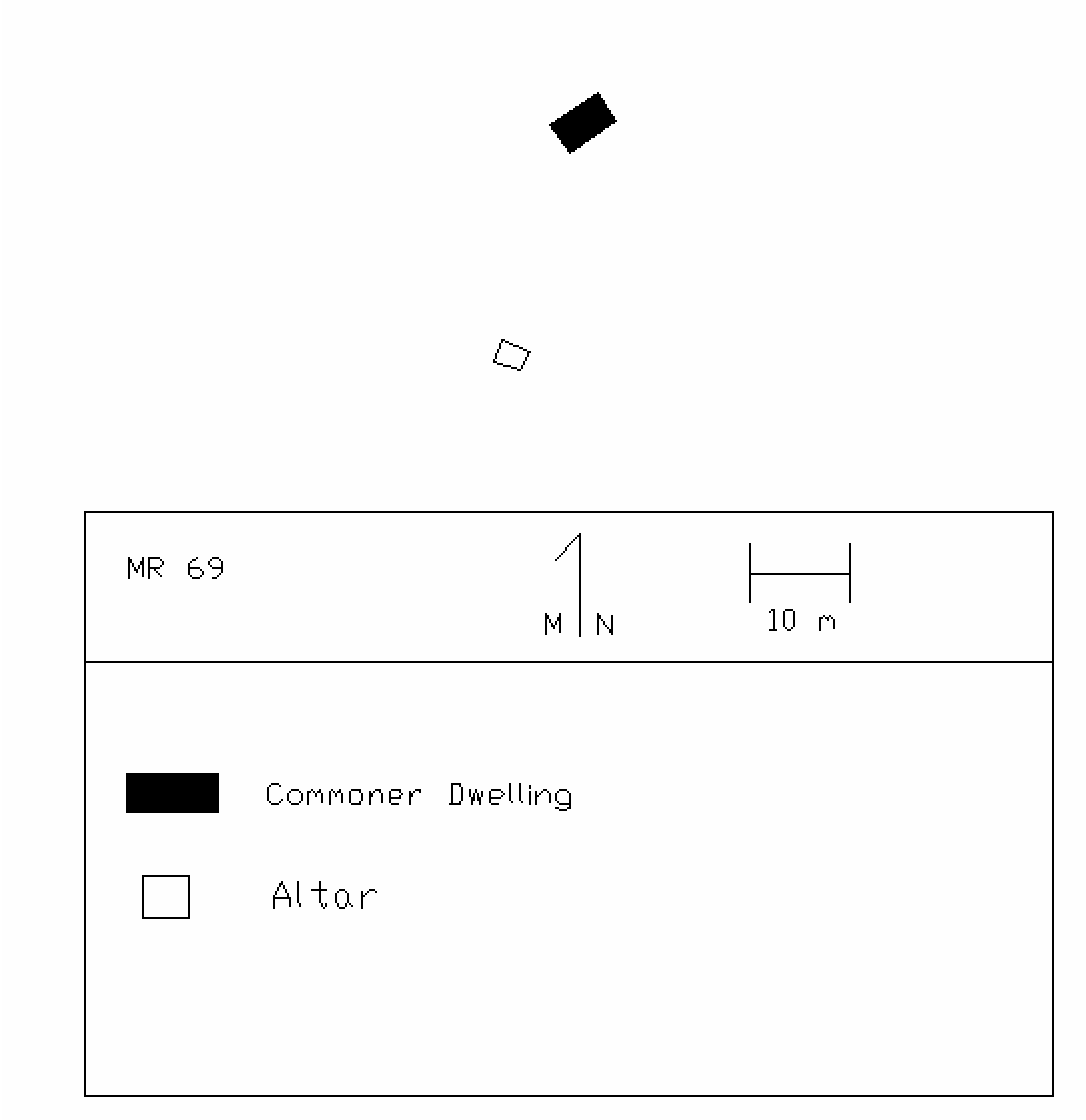

MR 63
M N
10 m
Commoner Dwelling
Elite Dwelling
R Range Structure
R

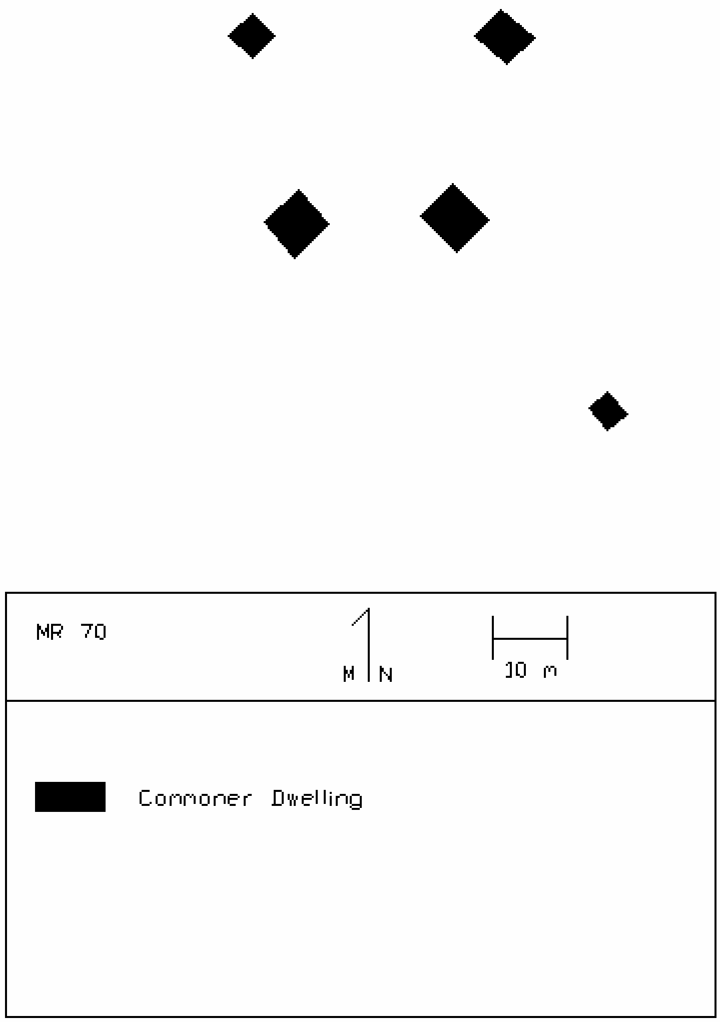

MR 64
N
10 m
Terrace
Commoner Dwelling
Civic Structure
Elite Dwelling
Range Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%
Modern road

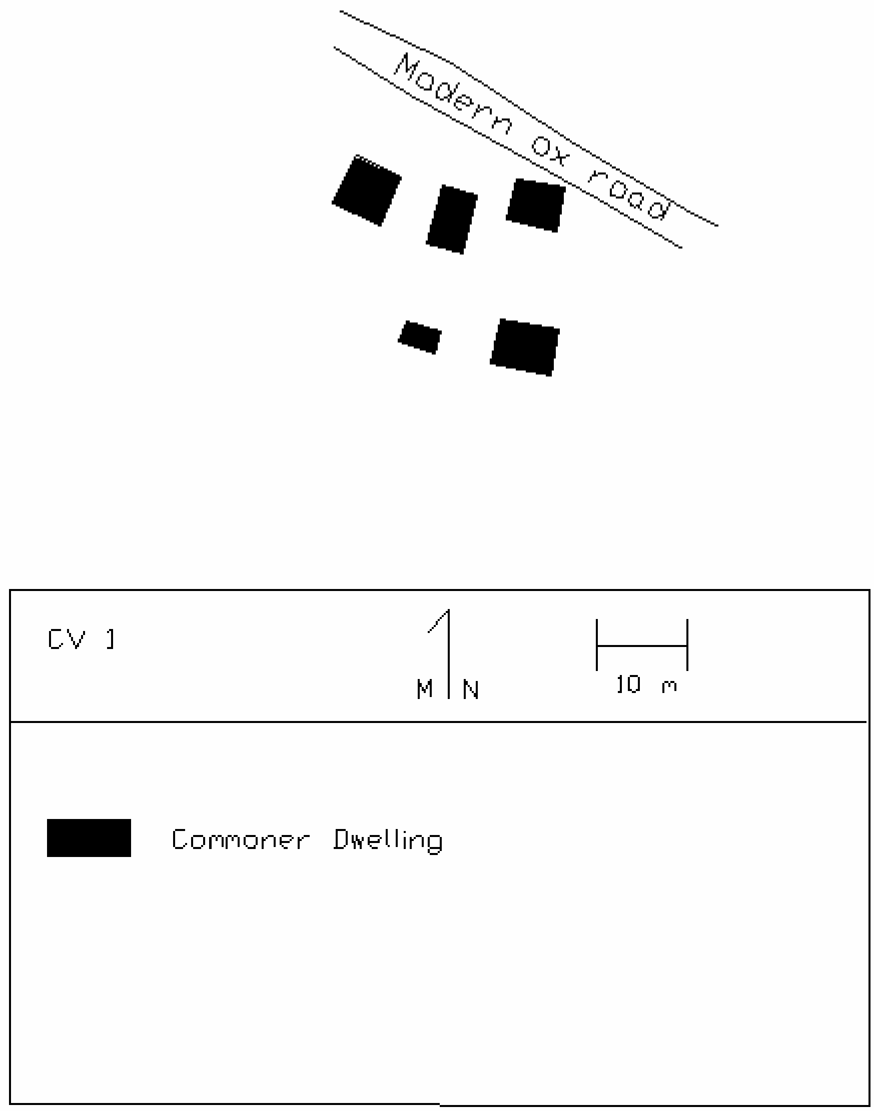

MR 65
M N
10 m
Commoner Dwelling

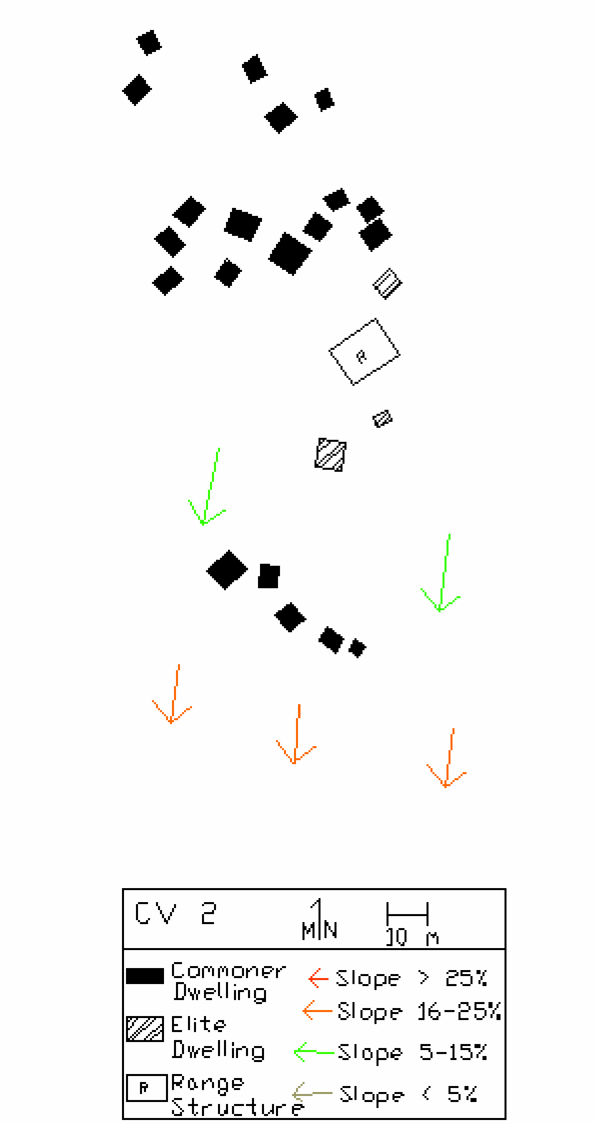

MR 66
M N
10 m
Commoner Dwelling

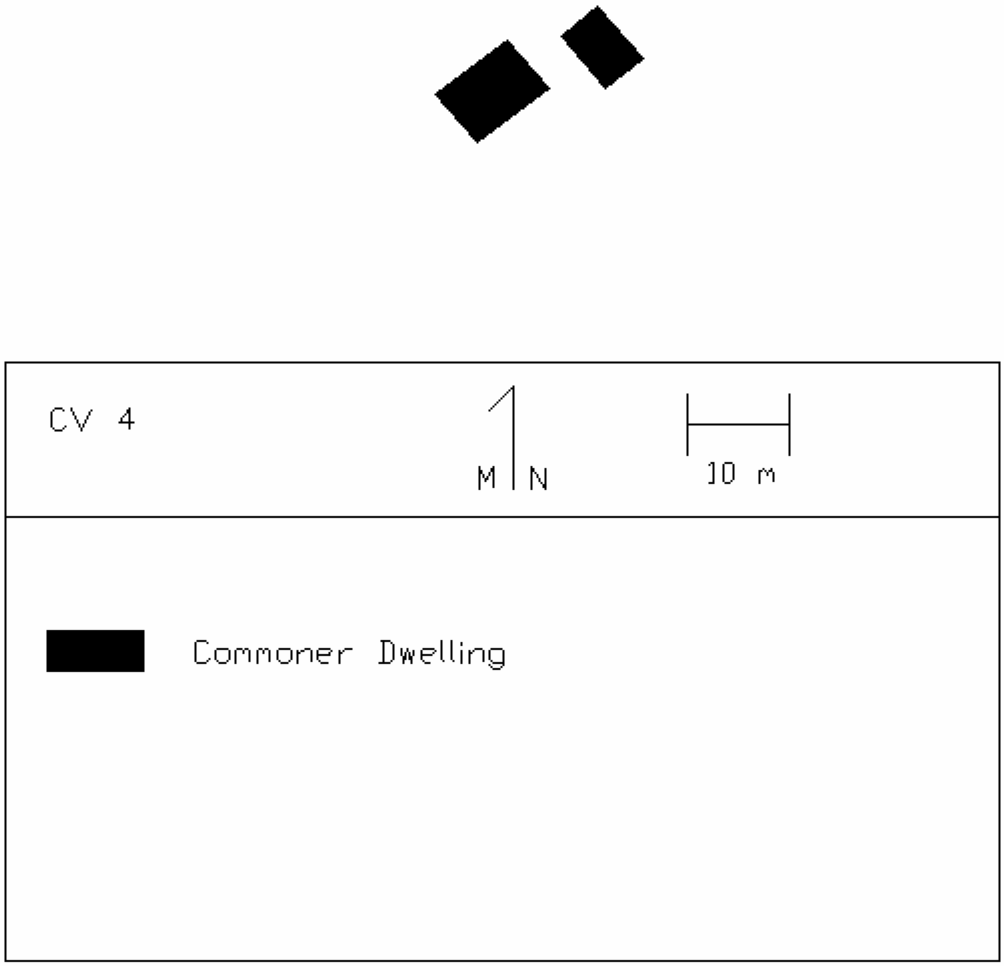

MR 67
M N
10 m
Elite Dwelling

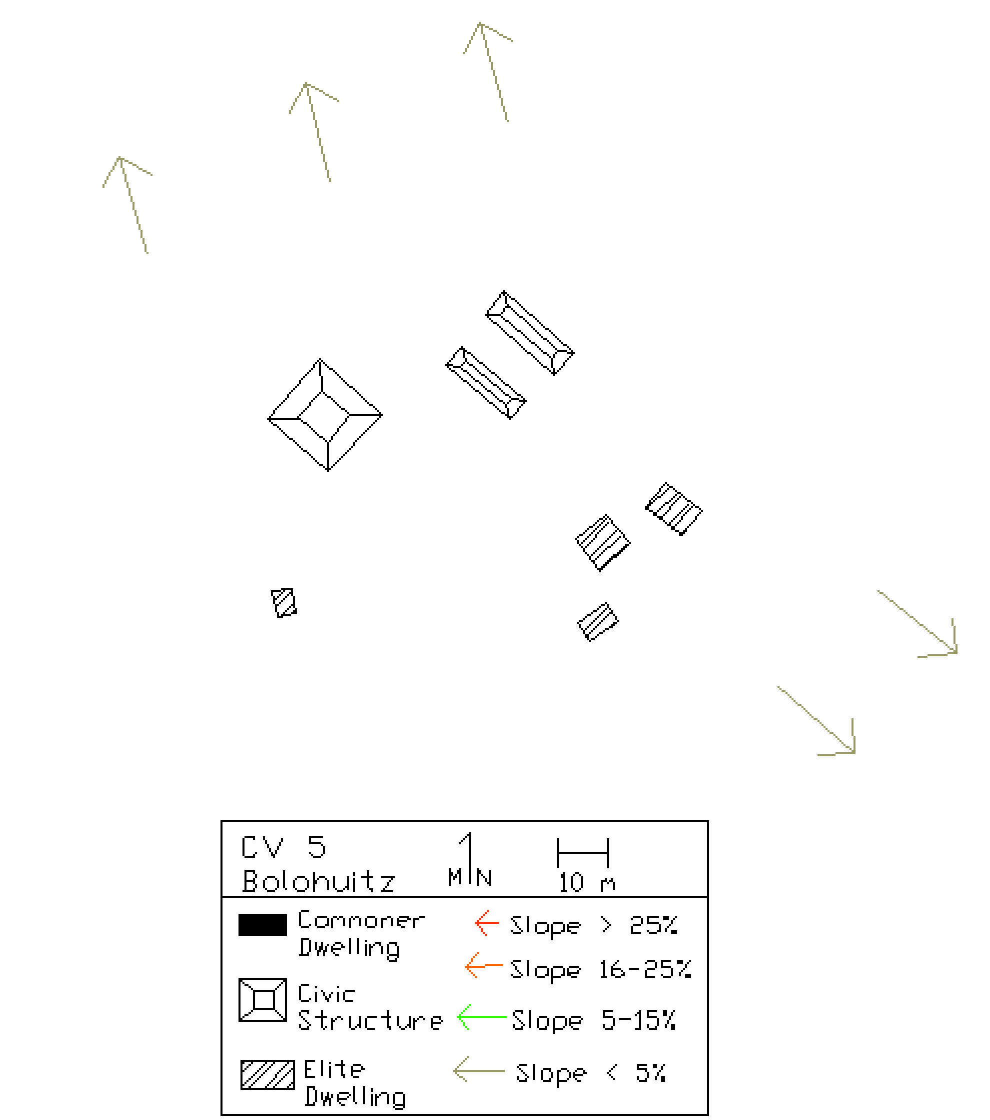

MR 69
M N
10 m
Commoner Dwelling
Altar


MR 70
M N
10 m
Commoner Dwelling

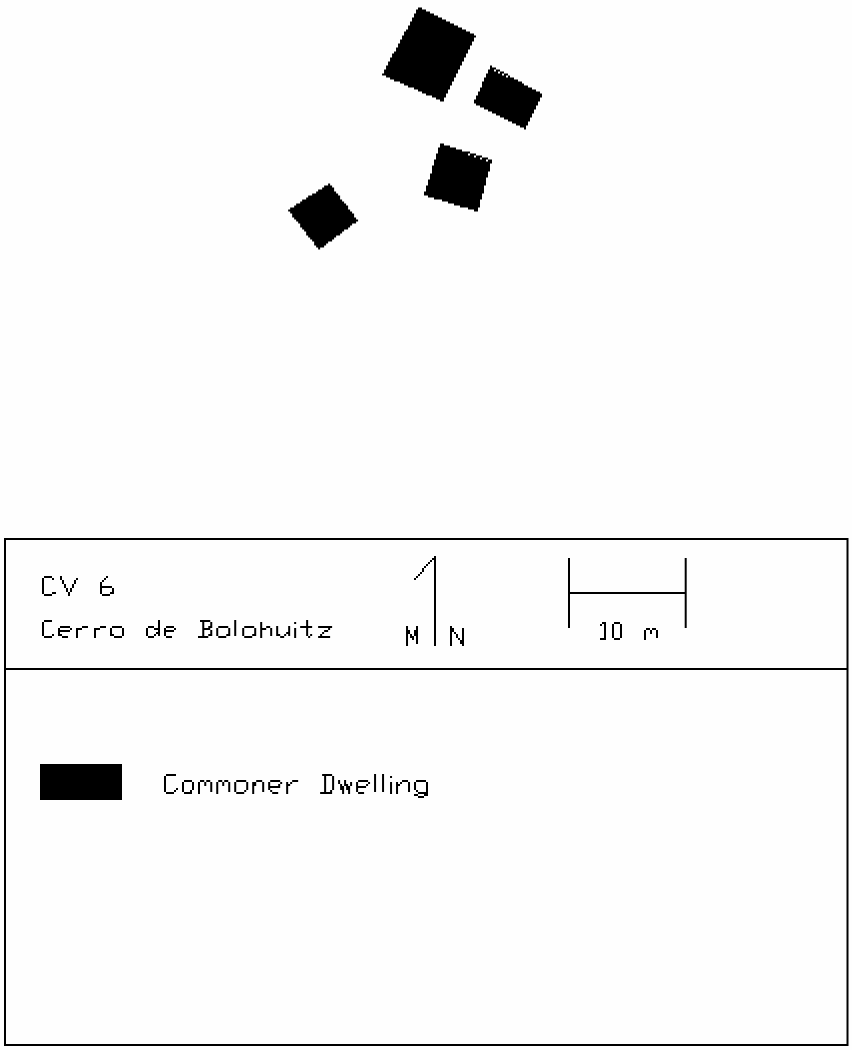

Modern ox road
CV 1
M N
10 m
Commoner Dwelling

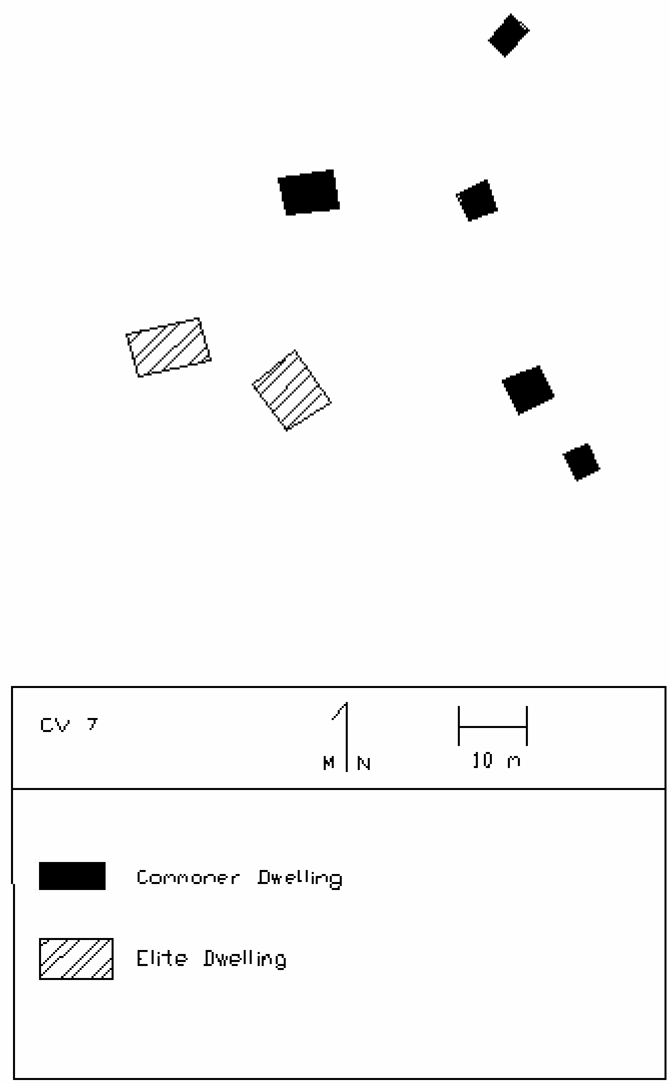

CV 2
MN
10 m
Commoner Dwelling
Elite Dwelling
Range Structure
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

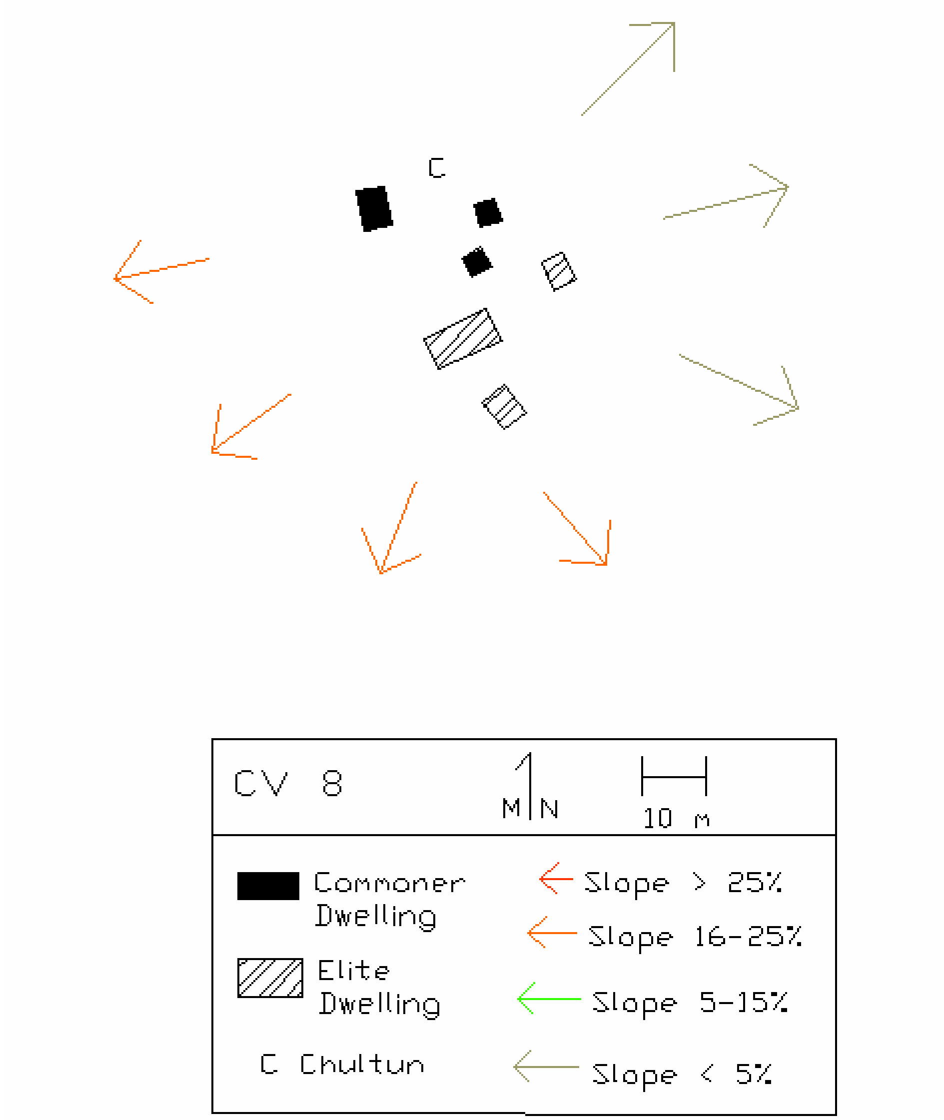

CV 4
M N
10 m
Commoner Dwelling

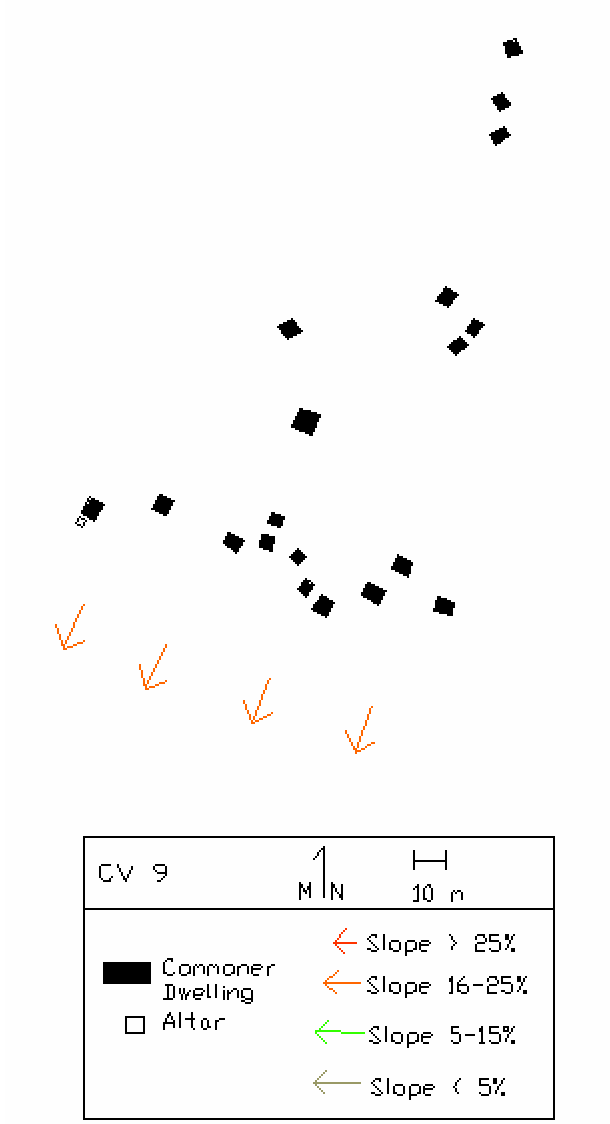


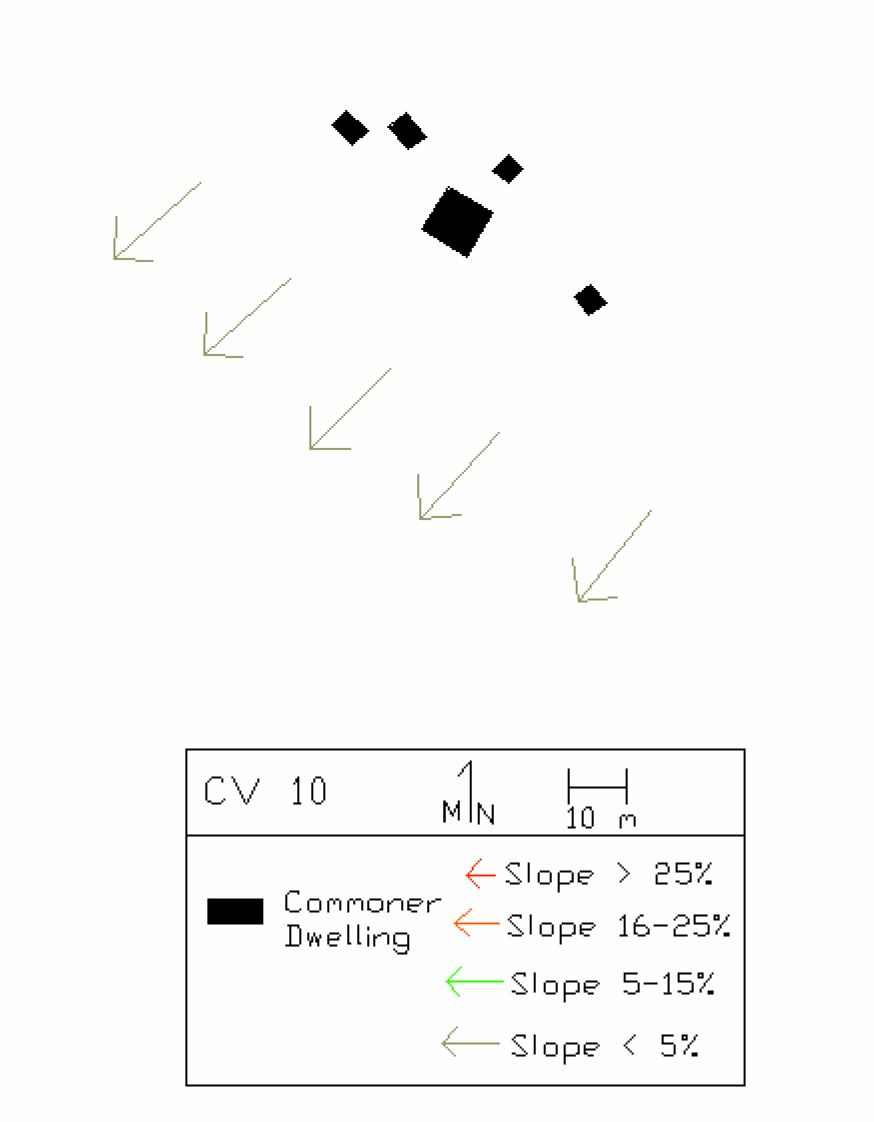
CV 5
Bolohuitz
M N
10 m
Commoner Dwelling
Civic Structure
Elite Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%

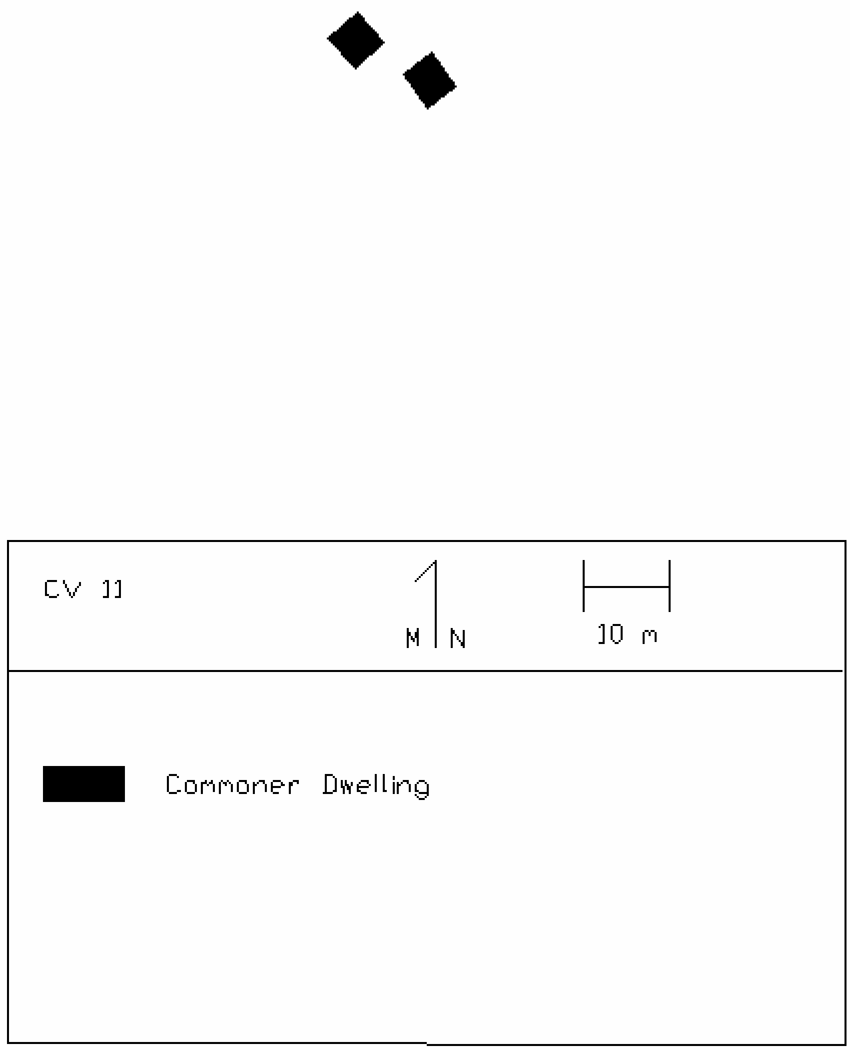

CV 6
Cerro de Bolohuitz
M N
10 m
Commoner Dwelling


CV 7
M N
10 m
Commoner Dwelling
Elite Dwelling


C
CV 8
M N
10 m
Commoner Dwelling
Elite Dwelling
C Chultun
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


CV 9
M
N
10 m
Commoner Dwelling
Altar
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


CV 10
M N
10 m
Commoner Dwelling
Slope > 25%
Slope 16-25%
Slope 5-15%
Slope < 5%


CV 11
M N
10 m
Commoner Dwelling

APPENDIX B

DESCRIPTIONS OF HOUSE GROUP CLUSTERS, CIVIC CENTERS, AND TERRACE SYSTEMS

KEY

MR: Morelos polity; CV: Clavo Verde polity
UTM: Universal Transverse Mercator coordinates obtained from hand-held GPS unit and checked against INEGI topographic map (1:50,000).
Altitude: obtained from hand-held GPS unit.
Slope: 1 = < 5%; 2 = 5% to 15%; 3 = 16% to 25%; 4 = > 25%
Drainage: 1 = well-drained; 2 = moderately well-drained; 3 = imperfectly to poorly drained; 4 = poorly to very poorly drained
Soil/Bedrock: 1 = no visible bedrock exposure; 2 = moderate bedrock exposure (% of soil / % of bedrock); 3 = mostly bedrock exposure (% of soil / % of bedrock); 4 = completely bedrock
Nearest Water Source: R = river; ST = stream; SP = spring; L = low-lying zone; M = marsh; H = water hole; W = well; P = perennial; S = seasonal
Vegetation: TD = tropical deciduous; ST = short-tree savanna; PO = pine-oak forest; ES = evergreen forest; P = palm forest; R = riparian; G = grassland; H = herbaceous marsh; C = cleared
Current Land Use: M = milpa; P = pasture; F = fallow; W = wood reserve; S = current settlement
Date: LTC = Late-Terminal Classic; PC = Proto-Classic; F = Formative
Type: H = habitational; T = agricultural terraces; C = civic
Civic Rank: 1 through 5 in accordance with criteria described in Chapter 3
Preservation: E = excellent; G = good; F = fair; P = poor; T = terrible; L = looting
Dwellings: CD = Commoner dwellings; ED = Elite dwellings (includes junior relatives/retainers); RS = Range Structures
House Groups: R = range structure elite; E = non-range structure elite; C = commoner
Civic Structures: P = pyramid; B = ballcourt

MR 1

UTM: 625.1 E, 1772.6 N; *Altitude:* 1238 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S (Poza Honda); *Vegetation:* ST, C; *Current Land Use:* F, P, M; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 3 (CD = 3); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 20

Notes: To the immediate east of MR 1 is a steep hill upon which the polity capital, Tenam Soledad (MR 57), is situated. From the top of the hill all of MR 1 is clearly in view.

MR 2

UTM: 624.8 E, 1771.1 N; *Altitude:* 1166 masl; *Slope:* 1, 2; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S (Poza Honda); *Vegetation:* ST, C; *Current Land Use:* P; *Date:* LTC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* (CD = 1); *House Groups:* (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 9

MR 3

UTM: 624.4 E, 1771.5 N; *Altitude:* 1125 masl; *Slope:* 1; *Drainage:* 2; *Soil/Bedrock:* 1; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC, PC; *Type:* H; *Civic Rank:* 4; *Structure Preservation:* G, F, P; *Dwellings:* (CD = - ; ED = 3; RS = 1); *House Groups:* (R = 1; E = 1; C = 2); *Domestic Altars:* - ; *Civic Structures:* - (P = ; B =); *Civic Altars:* -

Notes: Situated in the heart of a large milpa that has been plowed using cattle. Only four structures, but it's possible that more existed in the past but since have been destroyed by plowing. But no rubble piles or dense sherd scatters were noted that might indicate that this was the case. Tenam Soledad (MR 57) can be seen clearly from here. Very flat terrain and no bedrock outcrops indicate that this was probably prime farmland in the past as it is today.

MR 4 "Espinal"

UTM: 624 E, 1772.3 N; *Altitude:* 1177 masl; *Slope:* 2, 3; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC, PC; *Type:* H, C, T; *Civic Rank:* 3; *Structure Preservation:* G, F, P, L; *Dwellings:* 13 (CD = 7; ED = 3; RS = 3); *House Groups:* (R = 3; E = 2; C = 5); *Domestic Altars:* - ; *Civic Structures:* 3 (P = 3); *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 19

Notes: MR 4 is set on a low hill overlooking very flat terrain with deep soils to the south, and bordered by rising hillside to the north. On the western side of the site where structures 8, 9, 10, and 11 are found, there is quite a bit of bedrock exposure (soil/bedrock ratio 80/20 whereas the rest of the site is 90/10). Terraces 19, 20, 21, and 22 on the southern end of the site form a long, step-like progression as one approaches from the south.

MR 5 "El Vecino"

UTM: 624.2 E, 1773.4 N; *Altitude:* 1244 masl; *Slope:* 1, 2; *Drainage:* 1; *Soil/Bedrock:* 1; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* H, C, T; *Civic Rank:* 2; *Structure Preservation:* G, F, P; *Dwellings:* 22 (CD = 12; ED = 7; RS = 3); *House Groups:* (R = 3; E = 2; C = 7); *Domestic Altars:* - ; *Civic Structures:* 2 (P = 1; B = 1); *Civic Altars:* - ; *Terrace Preservation:* G, F, P; *Dryslope Terraces:* 45

Notes: Unlike many other civic-ceremonial centers with ballcourts in the Morelos Piedmont, MR 5 is not situated on a hilltop. Rather, it is situated on a gentle rise on the landscape at the northern end of an elaborate terrace system. The view afforded from the primary pyramid allows one to take-in the entire extent of the terrace system and the dozen and all of the structures associated with the center. Two low field walls run perpendicular to the gentle slope near the center of the site. Many of the terraces end at the wall, therefore it appears to be contemporaneous with the construction of the terraces. The function of the field walls is unknown, but the slightly elevated ground between them could have served as a walkway between terrace walls.

MR 6

UTM: 624 E, 1772.5 N; *Altitude:* 1206 masl; *Slope:* 1, 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 70/30; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W; *Date:* PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* F, P, T; *Dwellings:* 16 (CD = 11; ED = 5); *House Groups:* (E = 1; C = 6); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* 12

Notes: MR 6 is directly north (up the hill) from MR 4. It is almost entirely situated on a flat mesa on top of the hill. The vegetation here is tropical deciduous making it much more difficult to find and map structures and terraces. The terrain here is very rugged with lots of bedrock exposures and large stones.

MR 7

UTM: 623.7 E, 1772.6 N; *Altitude:* 1200 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* TD, C; *Current Land Use:* P; *Date:* PC; *Type:* T; *Civic Rank:* 5; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* - ; *Check Dams:* 18

Notes: MR 7 is a terrace system set in the bottom of a ravine. The hillsides surrounding it slope sharply. The terraces at the southeast end of the system (AT1 – AT 8 or 9) are check dams. Although the system is dry right now, during the rainy season water washes down from the hillsides, bringing sediment along, and passes over and through the check dams. This is evidenced by the transport of differently sized stones down slope from the check dams (smaller stones farther way; larger stones closer to terraces walls). Also, there are gaps in some of the terrace walls where it appears water has broken through. The soil has built-up deeply behind the terrace walls and in some cases covers the top stones further indicating that the flow of water might be responsible for this phenomenon, and the check dams served to check their flow and distribute water and soil below. Farther up the terrace system (AT 8 or 9 – the top), the slope of the hillsides is less severe and the terraces resemble the dry slope variety. But, they are constructed similarly to the check dams below and therefore may have served a similar purpose. Overall, this appears to be a check dam system where the terraces capture soils eroding from the hillsides, and where the flow of water carries soil down slope over the terrace walls. To the immediate S of AT 1, some stone alignments were found that might be part of the terrace system. However, they were too small and poorly preserved to say for sure and therefore were not mapped along with the other terraces.

MR 8 "Mano de Leon"
UTM: 623.4 E, 1772.3 N; *Altitude:* 1240 masl; *Slope:* 1, 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W, P; *Date:* LTC, PC; *Type:* H, C, T; *Civic Rank:* 3; *Structure Preservation:* G, F, P, L; *Dwellings:* 16 (CD = 5; ED = 10; RS = 1); *House Groups:* 8 (R = 1; E = 2; C = 5); *Domestic Altars:* - ; *Civic Structures:* 1 (P = 1; B =); *Civic Altars:* - ; *Terrace Preservation:* G, F, P; *Dryslope Terraces:* 16
Notes: MR 8 is located on a hilltop with steeply sloping hills on all sides (see site map). A good view of the flat lands to the southeast is afforded from the site's largest structure (ST 5), and presumably of MR 57, Tenam Soledad, to the northeast but dense vegetation blocks the sight line.

MR 9, 10, 11
UTM: 624 E, 1772.9 N; *Altitude:* 1220 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* P; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 4 (CD = 4); *House Groups:* 4 (C = 4); *Domestic Altars:* 1; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* 10; *Check Dams:* 14
Notes: Because of their close proximity, MR9, 10, and 11 have been grouped together. MR 10 is a system of dryslope terraces. Many of the terraces have been severely altered and/or destroyed by locals. Many of the stones that apparently once formed the terrace walls have been stacked in numerous tall piles along the hillside. The vestiges of the old terraces can still be seen stretching across the hillside. To the immediate east of MR 10 is a small system of check dams, MR 11; and to the immediate west of MR 10 is a larger system of check dams, MR 9, which line the bottom of a small ravine. The preservation of the check dams at MR 9 is much better than at MR 10. Near MR 9 ST 1 two apparent "hornos" (ovens) were found. The locals say that they were used in ancient times for lime processing. Each is cut deeply into a hillside bedrock exposure. They are oval shafts which descend about 1 m into the ground, and each has an opening at the bottom presumably where the fuel would be added.

MR 12
UTM: 623.8 E, 1772.9 N; *Altitude:* 1210 masl; *Slope:* 1; *Drainage:* 2; *Soil/Bedrock:* 2 70/10; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* T; *Dwellings:* 1 (CD = 1); *House Groups:* 1 (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -

MR 13
UTM: 625.1 E, 1770.5 N; *Altitude:* 1122 masl; *Slope:* 1; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* L, S (at MR 14); *Vegetation:* C; *Current Land Use:* F; *Date:* LTC, PC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* P, T; *Dwellings:* 7 (CD = 7); *House Groups:* 3 (C = 3); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 13 (TR-53) is situated on a gentle rise among otherwise flat terrain near the modern road leading to V. Guerrero. To the north the hilltop civic-ceremonial center MR 57, Tenam Soledad, can be seen clearly. A sherd scatter was noted about 50 m northeast of the cluster of housemounds.

MR 14 “El Camino”
UTM: 625.7 E, 1770.1 N; *Altitude:* 1126 masl; *Slope:* 1; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* L, S; *Vegetation:* C; *Current Land Use:* M, F, P; *Date:* LTC, PC; *Type:* H; *Civic Rank:* 4; *Structure Preservation:* G, F, P; *Dwellings:* 90 (CD = 50; ED = 37; RS = 3); *House Groups:* 36 (R = 3; E = 6; C = 27); *Domestic Altars:* 5; *Civic Structures:* - ; *Civic Altars:* -
Notes: The road leading to V. Guerrero runs through the middle of MR 14. MR 14 stretches all the way to the modern settlement of V. Guerrero, where a large limestone quarry has been dug. Locals say that it is a modern quarry that did not exist a few decades ago. It appears that the quarry truncates part of MR 14, probably having destroyed housemounds. Between the quarry, the eastern part of MR 14, and the modern road, there is a low-lying zone that the locals say fills shallowly with water in the rainy season. But it was completely dry when we passed through. This low-lying zone may have served as a water source in ancient times. MR 57, Tenam Soledad, can be seen clearly from MR 14. MR 57 commands a great view of all of MR 14, and the surrounding zones, from it’s perch to the north.

MR 15
UTM: 624.4 E, 1773.5 N; *Altitude:* 1282 masl; *Slope:* 2; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* T; *Dwellings:* 1 (CD = 1); *House Groups:* 1 (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* G, F, P; *Dryslope Terraces:* 17
Notes: MR 15 is a system of dryslope terraces with one housemound and a chultun. A field wall runs northeast-southwest and separates the terrace system into two distinct parts. In some places, stones at the base of terrace walls abut stones at the base of the field wall which indicates that they were probably built at the same time. The field wall consists of between 0 to 3 stones stacked on top of one another, in some places it appears to be directly on top of bedrock. Also, some smaller stones, which appear to have been haphazardly tossed, are on top of the field wall and some of the terrace walls. The locals say that they place these stones here to remove them from the fields when farming. In some places terrace stones were placed directly on top of bedrock.

MR 16
UTM: 624.8 E, 1773.4 N; *Altitude:* 1297 masl; *Slope:* - ; *Drainage:* - ; *Soil/Bedrock:* - ; *Nearest Water Source:* - ; *Vegetation:* - ; *Current Land Use:* - ; *Date:* LTC, PC; *Type:* Sherd scatter; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - (P = ; B =); *Civic Altars:* -
Notes: MR 16 is a sherd scatter just east of MR 17. The sherd scatter is on top of a small hill with a clear view of MR 17 to the west, and Tenam Soledad to the east. The area of the scatter measured about 5 m x 5 m, and the distribution of sherds is fairly dense especially considering that we haven’t found any housemounds in the adjacent zones. We also found a few small pieces of obsidian.

MR 17
UTM: 624.4 E, 1773.2 N; *Altitude:* 1266 masl; *Slope:* 2; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* C, TD; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic*

Altars: - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 38

Notes: MR 17 is a terrace system with no housemounds. Terraces AT 1-22 have smaller stones stacked/thrown on top of the ancient constructions. Most of the terraced zone has been cleared for milpa or pasture, therefore visibility is good. Some zones of dense tropical deciduous vegetation exist between ATs 1-6, 22-25 and ATs 7-21. MR 17 is geographically situated between sites MR 5 and MR 57. Most of site MR 17 is in clear view of MR 57, however MR 5 cannot be seen. We made a diligent search for structures, chultunes, other cultural features on the landscape but found nothing except for what appears to be a slightly elevated platform constructed on the east end of AT 24. From on top of the platform (which rises about 1 m above the terraced fields below, making use of a natural rise in the terrain on the north and east side of the platformed area) a good view is afforded of much of the terraced zone. No clear evidence for housemound(s) was found on or near the platform. This does not look like a housemound created by an ancient dwelling or other structure.

MR 18 "Poco Uinik"

UTM: 623 E, 1774.9 N; *Altitude:* 1402 masl; *Slope:* 1, 4; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S (Poco Uinik); *Vegetation:* TD; *Current Land Use:* W; *Date:* LTC, PC; *Type:* H, C; *Civic Rank:* 2; *Structure Preservation:* G, F, P; *Dwellings:* 18 (CD = 8; ED = 8; RS = 2); *House Groups:* 10 (R = 2; E = 1; C = 7); *Domestic Altars:* - ; *Civic Structures:* 4 (P = 3; B = 1); *Civic Altars:* -

Notes: The terraces and walls surrounding the civic core of MR 18 (TR-50) are poorly preserved with a lot of earth and soil washed over and through them, and a lot of wall fall. This is probably because the slope is so steep here. However, the upper wall surrounding the core of the site is in a good state of preservation. None of the terraces appear to have been used for agricultural as all support structures, civic and otherwise. Structures 14, 15, 16 are separated from the civic structures on the civic plaza, they are set at a lower elevation down the slope. Therefore, they have been classified as commoner dwellings. On the west side of the hill (near the base) upon which MR 18 is situated, we found a pair of structures (STs 22 and 23) that appear to be at the base of a stairway which leads up to MR 18. The slope is incredibly steep here, about 35-45 %. The stairway is fair to poorly preserved, but a series of what looks like short steps lead up the hill. At the base of the hill they are about 10-15 m in length, but become more narrow as you move up the hill. At the base of the hill each "step" is about 65 cm high (mean stone size = 43 x 40 x 10 cm). Between each step is between 40 – 60 cm of flat step space before the stones of the next step begin. Farther up the hillside, near STs 24 and 25, the stairway is only about 1 – 2 m in length but with stones stacked consecutively to create the stairway (about 10 rows of stones observed in one place, then a flat step space for about 40 cm before next consecutive series of stones creating the next part of the stairway). STs 24 and 25 are on either side of the stairway, and just to the northwest of ST 25 are two rock shelters. As you climb the stairway and cross the lower wall surrounding the mesa and civic core it becomes difficult to see the stairway. This zone, as with the entire hillside zone immediately surrounding MR 18 inside of the lower wall, has many large stones and poorly to terribly preserved vestiges of what may have been other walls, terraces, or steps. But due to the poor preservation it's difficult to discern their function. Immediately south-southwest of MR 18 is a Canada the locals call Pojo Uinik. Although it is currently dry, the locals say that a seasonal stream flows during the rainy season.

MR 19

UTM: 622.8 E, 1775.2 N; *Altitude:* 1378 masl; *Slope:* 1, 2; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S (Poco Uinik); *Vegetation:* C; *Current Land Use:* M; *Date:* LTC, PC; *Type:* Sherd scatter; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -

Notes: Just northwest of MR 18, MR 19 is a small sherd scatter recorded on gently sloping terrain at the base of the hill that MR 18 is on. Just east of MR 19 are some more modern terraces that the locals say they built, little by little, over the course of the last decade or so.

MR 20

UTM: 623.1 E, 1774.8 N; *Altitude:* 1292 masl; *Slope:* 2, 3, 4; *Drainage:* 1, 2; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S (Poco Uinik); *Vegetation:* C, TD; *Current Land Use:* W, P; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 18

Notes: MR 20 is a terrace system with no housemounds. A gentle, natural rise in the terrain with a lot of bedrock exposure runs through the middle of it. The terraces are situated on a gentle slope at the base of steeply sloping hillsides. To the immediate north-northwest of MR 20 is the base of the hill leading up to MR 18, Poco Uinik. In the northwest corner of MR 20 is a small terraced enclosure. Within the enclosure the soil appears to be very deep. The mean height of the outer wall is about 0.4 m and the interior walls about 0.1 - 0.3 m. The mean stone size is 30 x 26 x 9 cm. No housemounds found on top of it or nearby. The function of this enclosure is unknown, but may have been reserved for special cultivars or for use as a seed bed.

MR 21

UTM: 623.3 E, 1774.5 N; *Altitude:* 1265 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* - ; *Check Dams:* 8

Notes: Southeast of MR 20 on the other side of a small hill, is MR 21, a system of check dams. The check dams lead down slope to a small seasonal stream (currently dry). Water flow and foot/hoof traffic over many years has left the check dams severely damaged, with the walls completely collapsed in parts. However, enough of the terrace walls were sufficiently well preserved to permit mapping. The check dams span the width of a small ravine formed by the junction of two small hills. No housemounds or terraces could be found on top of either hill. The check dams appear to have functioned as traps for colluvial soils that would have likely washed down the hill sides in the rainy season. Depending on how much water flowed through this small ravine, it's also possible that they functioned to more evenly distribute water and soil on their down slope surfaces.

MR 22

UTM: 623 E, 1774.5 N; *Altitude:* 1274 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W; *Date:* LTC, PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ;

Civic Structures: - ; *Civic Altars:* - ; *Terrace Preservation:* G; *Dryslope Terraces:* - ; *Check Dams:* 4
Notes: MR 22 is a series of four very large check dams in a small, shallow ravine just south of MR 18, Poco Unik. The flow of water and/or foot/hoof traffic has broken down the check dam walls in parts, but the walls of this dam are huge (average height about 1.5 m).

MR 23
UTM: 622.7 E, 1774.7 N; *Altitude:* 1361 masl; *Slope:* 3; *Drainage:* 1, 2; *Soil/Bedrock:* 2 85/15; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W, P; *Date:* LTC; *Type:* ; *Civic Rank:* 5; *Structure Preservation:* F, P; *Dwellings:* 4 (CD = 4;); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 23 is situated on a ledge about half-way down the hill that MR 18 is on, on the southwest side. MR 23 consists of four structures on a natural ledge created by a bedrock outcrop.

MR 24 "El Cipres"
UTM: 622.5 E, 1775 N; *Altitude:* 1400 masl; *Slope:* 1, 2, 3, 4; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* C, TD; *Current Land Use:* W, M, P; *Date:* LTC, PC; *Type:* H, C, T; *Civic Rank:* 1; *Structure Preservation:* G, F, P; *Dwellings:* 169 (CD = 150; ED = 15; RS = 4); *House Groups:* 88 (R = 3; E = 4; C = 81); *Domestic Altars:* - ; *Civic Structures:* 4 (P = 3; B = 1); *Civic Altars:* 1; *Terrace Preservation:* F, P; *Dryslope Terraces:* 35; *Check Dams:* 16
Notes: MR 24 is in the northwest corner of the survey zone. From the southeastern part of MR 24 a great view is provided of MR 18, Poco Unik, MR 57, Tenam Soledad, and the entire Morelos ledge except for a ridge which extends southward from the center of the contemporary Morelos settlement. The hillside here is hardscrabble with a fair amount of bedrock exposure. No terraces found on hillside between MR 24 and MR 19. But, bedrock creates natural ledges that at first glance appear to be terraces, but they are not. Much of MR 24 is on V. Guerrero's wood reserve (*ampliación*). Another portion of the site is on the property of a small ranch. We got permission to enter their property. The ballcourt appears to be I-shaped. On the southeast end of the ballcourt an alignment of large stones, and a bit of bedrock outcrop, form an end zone. On the northwest end a crude, poorly preserved alignment of stones can be seen. The southwest side of ballcourt appears to be supported by a long platform that runs past the limits of the ballcourt on either side and creates a natural ledge, dropping down about 1 m. On the northeast side of ballcourt at the ends, small, short poorly preserved walls complete the "I's". From the center of the ballcourt, the southwest wall is about 1 m high; the northeast wall is about 1.8 m high. The civic-ceremonial core of MR 24 is situated among rugged terrain. To the immediate south (leading down to an ST, S), the hillside is covered in steep barrancas. The slope here is very steep (> than 40 % in most places). The slope is less steep around the civic-ceremonial core, varying from 5-25%. But barrancas and other bedrock outcrops create many natural ledges upon which some of the housemounds are set. Along the hillside in which the civic-ceremonial core is situated are some very small, short terraces. There are also some longer walls that may or may not be ancient (similar to field walls we've seen at other sites that appear to be historic or modern). These walls typically do not run horizontal to the slope of the hillside and therefore do not appear to be agricultural terraces. No long terraces that appear to have had an agricultural function are found in the heart of the civic-ceremonial core, or to the south of it. Perhaps the

terrain is just too steep, undulating and rugged? However, north of the civic-ceremonial core, just below and above the modern road, long agricultural terraces are found.

A walk-in well was found near a modern/historic well, above the civic-ceremonial core and just below the modern road. There was a lot of vegetation covering the well (especially dead, deciduous vegetation that had fallen from trees), but the workers cleared away much of it for mapping. The stones appear to line the small depression leading down to the actual well (although many appear to be missing). Some long, thin wooden logs have been shoved down the well's surface opening in recent years (perhaps to prevent cattle from falling in?). The well is clearly not in current use.

On the eastern side of MR 24 are numerous terraces and housemounds scattered throughout the hillside. The terrain here is rugged and undulating with the slope of the hillside varying from 5% to more than 45%, in some cases changing in less than 15 m. Some bedrock outcrops, but not as much as around the civic-ceremonial core of the site. In some cases housemounds are situated upon flat, natural ledges on the hillside, in other cases they are on short, small terraces. To the south and southeast of this zone the hillside becomes a lot more steep and barrancas are found. The vegetation throughout this zone is very dense and appears to be tropical deciduous-like (due to the dense thicket-like understory), but with a lot of cypress trees and some pines. No oaks are found here which makes me reluctant to call it a Pine-Oak vegetation formation. But the abundance of cypress and the presence of pines gives it a Pine-Oak feel. The dense vegetation here made mapping difficult

The northeastern part of MR 24 is largely cleared of all vegetation. The house in the southwest corner of this zone belongs to Rodulfo Hernandez. He privately owns much of the land here. The modern houses to the north and northwest of this zone are still part of the Morelos ejido. A few ancient agricultural terraces were recorded in this zone, but there may have been more. Due to the stony, rugged terrain with bedrock exposures it was difficult to follow apparent terrace walls and differentiate between man-made terraces and natural ledges. It's possible that many of the natural, bedrock outcrops behind which soil collects and results in relatively flat surfaces, were used by the ancients as agricultural terraces as they are today.

The northwest portion of MR 24 has steeply sloping terrain with housemounds and a few terraces scattered throughout. The slope in this zone ranges from about 16-30% or more, and gets even steeper on the northwest, west and southwest sides at the slopes lead down to the ST, S and a check dam system. The terrain in this zone is extremely rugged, much more so than in the northern central and northeastern parts of MR 24. In this zone, many large stones, bedrock outcrcrops and barrancas line the hillside with housemounds nestled-in amongst them. In some cases housemounds are situated upon bedrock outcrops that provide natural ledges. In other cases, housemounds are situated upon terraces. In a few cases terraces could be followed for relatively great distances along the hillside. These terraces appear to have served an agricultural function as they run on for great lengths without any housemounds situated on top. There were probably more terraces in this zone, but due to the rugged terrain it was difficult to differentiate between natural ledges and man-made terraces. To the north-northeast of this zone the hillside continues up for about 100 m before flattening out in a very small mesa. No housemounds or terraces were found here, and few sherds were found. All of the current milpa zones of site MR24 have at least been hand plowed, and many appear to have been plowed with beasts of burden.

The check dams in the northwestern part of MR 24 do not appear to have been as carefully constructed as the other check dams in the survey zone. The stones appear to have been placed/tossed haphazardly into the check dam walls rather than carefully stacked. Some of the stones are badly eroded, so it's possible weathering of the stones has resulted in this appearance. Each check dam has been compromised in at least one place where water has flowed through over the years bursting through the terrace wall and carrying the stones away, depositing them farther down stream. Where the terrace walls are intact, a lot of soil has built-up resulting in a fairly deep potential planting surface.

MR 25
UTM: 623.1 E, 1775 N; *Altitude:* 1300 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 70/30; *Nearest Water Source:* ST, S; *Vegetation:* TD, C; *Current Land Use:* W, M; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 13
Notes: MR 25 is a system of thirteen terraces at the base of the hill (on the northeast side) that MR 18 is on. It is located on hardscrabble, with a lot of bedrock outcrops. Adjacent to MR 25, to the northeast, is a field of modern terraces. The locals confirmed that this small group of terraces were constructed in recent years.

MR 26
UTM: 623.6 E, 1774.6 N; *Altitude:* 1349 masl; *Slope:* 2; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* TD, C; *Current Land Use:* W, M; *Date:* LTC, PC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* F, P; *Dwellings:* 2 (CD = 2); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* P; *Dryslope Terraces:* 1
Notes: MR 18 is situated on the mesa of the hill just southeast of MR 26. Only two housemounds and one small terrace that, because of it's small size and housemound on top, probably would not have contributed much to agricultural production. It's possible that production on the terrace supported the residents of these two small housemounds. A great view of MR 18, MR 57, and much of Morelos is had from MR 26.

MR 27
UTM: 623.8 E, 1774.7 N; *Altitude:* 1369 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 85/15; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* F, P; *Dwellings:* 8 (CD = 8); *House Groups:* 5(C = 5); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* P, T; *Dryslope Terraces:* 14
Notes: MR 27 is situated near the northeastern edge of the same mesa that MR 26 is on. Most of the terraces are poorly to terribly preserved and the locals have placed many smaller stones on top of ancient terrace walls. Many of the terrace walls have slumped. MR 27 is in view of MR 18 and MR 57, and much of the contemporary Morelos settlement can be seen from here.

MR 28
UTM: 624.2 E, 1774.2 N; *Altitude:* 1289 masl; *Slope:* 1, 2, 3; *Drainage:* 1, 2, 3; *Soil/Bedrock:* 1, 2 90/10; *Nearest Water Source:* H, ST, S; *Vegetation:* C; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* H, T, C; *Civic Rank:* 3; *Structure Preservation:* F, P, T; *Dwellings:* 36 (CD = 32; ED = 2; RS = 2); *House Groups:* 18 (R = 2; C = 16); *Domestic Altars:* 2; *Civic Structures:* 1 (P = 1); *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* 36; *Check Dams:* 7

Notes: MR 28 is on the western edge of the contemporary Morelos settlement. A few small modern houses are scattered within MR 28's boundary, in many cases apparently destroying ancient housemounds. Much of the base of the hillsides here, and of the undulating, gently sloping terrain of the land between the hills and Morelos is covered in agricultural terraces. Most of them are in a fair to poor state of preservation. Much of the land is cleared for milpa and the terraces appear to have been re-used for generations. Some zones are currently being used as pasture. The fields appear to have been mechanically plowed. Visibility overall is fair to good. Many of the nearby houses have built walls with stones from the ancient constructions. The terraces on the western side of MR 28 extend east all the way to the base of the hill that El Cerrito is on.

Along the northern edge of MR 28, numerous small ravines carved by seasonal streams flow down from the hills to the north and northeast. Many of these ravines have vestiges of ancient check dams. All of the ravines are currently dry. Below the check dams, where the terrain opens-up and the slope decreases, dry slope terraces were constructed. It does not appear that a lot of water flowed down these ravines, and the locals say that the water flow is moderate. The ravines themselves are small (compared to other ravines in the zone like Poza Honda and Poco Unik) and the check dams are very small compared to others. But, spots where water flow has broken through and carved-out a path in check dam walls can be seen in some of the check dam walls. It appears that these check dams would have served to check the flow of water and sediment as it came off the hillside, more evenly distributing it down slope resulting in relatively flat planting surfaces. Dry slope terraces served a conventional dry slope function and were found below the check dams in flatter, less steep zones where the flow of water from the ravines likely lost its force delivering very little by way of sediment.

Many of the structures recorded for MR 28 were found on the hill sides overlooking the terraced fields and the relatively flat zones in the southern portion of MR 28. The locals say that these southern zones are some of the best agricultural soils in Morelos.

MR 18 is in clear view from most of MR 28, but MR 57 cannot be seen. Nor can MR 5 be seen (barely, it's just over a ridge). Two water holes are on the southern side of MR 28. It's difficult to say if one, or both, are ancient and the locals said that they did not know when they were constructed. During excavation at El Cerrito (TR-42), Clark and Lowe (1980) mention the waterholes and suggest that at least one of them may date to prehispanic times. Some housemounds and rubble sherd scatters were recorded adjacent to the water holes.

The three principal mounds at El Cerrito (based on Clark and Lowe's map), and one terrace adjacent to them, are still fairly well preserved, but no other housemounds could be discerned. There are a number of recently constructed houses on the hill that have subsumed this part of MR 28. One of the principal mounds is the backyard of a house and we could not get permission to map it. About 3-4 agricultural terraces were noted on the southwest side of the hill, but the locals told us that they are recent constructions. The terraces on the slopes of the hillside surrounding El Cerrito (as reported by Clark and Lowe 1980) are either completely destroyed or terribly preserved. None were found that could be accurately mapped.

The largest agricultural terraces at MR 28 are in the northeast corner. Parts of these terraces have been reconstructed in recent years, but the ancient constructions can still be seen at the base of the terrace walls. It's difficult to say how high these terraces stood in ancient times, but given the slope of the hillside and information obtained from the locals, it appears that they would have stood near the height they are today.

MR 29

UTM: 624 E, 1774.2 N; *Altitude:* 1289 masl; *Slope:* 1, 2; *Drainage:* 1, 2; *Soil/Bedrock:* 1; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC, PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* 10; *Check Dams:* 4

Notes: MR 29 is just west of MR 28. One of the terraces was constructed using huge stones. Some of the stones are as large as 170 x 70 x 58 cm. The locals claim that they are ancient, and we found many sherds in and around the terrace walls, but the large size of the stones make this terrace unlike any other in the zone. MR 29 has been plowed repeatedly for many years. As a result, it’s possible that housemounds once existed here but have been destroyed. There is a very high sherd density here, much higher than on any part of MR 28. On northern side of MR 29 is a small check dam system. Like at MR 28, it spans relatively small ravine where rain water runs off. At the base of the check dam system, where the terrain gets a bit flatter, are a few dry slope terraces. It appears that the check dams functioned to check the flow of water and soil washing down the steep slope in the ravine, not only resulting in level planting surfaces behind the check dam walls, but also distributing soil and water onto the dry slope terraces farther down slope.

MR 30

UTM: 623.8 E, 1774 N; *Altitude:* 1244 masl; *Slope:* 1, 2; *Drainage:* 1,2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* ST, TD; *Current Land Use:* W, P; *Date:* PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 3 (CD = 3); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 2

Notes: MR 30 is a small terrace system with three housemounds and a sherd scatter. A modern road passes through the center of MR 30. MR 30 is situated on sloping terrain just above a ravine with a seasonal stream.

MR 31

UTM: 623.9 E, 1773.7 N; *Altitude:* 1225 masl; *Slope:* 1, 2; *Drainage:* 3; *Soil/Bedrock:* 1; *Nearest Water Source:* M (La Cieneguilla); *Vegetation:* C; *Current Land Use:* P; *Date:* LTC, PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* P; *Dryslope Terraces:* 1

Notes: MR 31 is situated within a marsh (La Cieneguilla) on a small rise in the terrain. The locals say that the marsh inundates with water in the rainy season, but currently it is mostly dry. One small housemound was mapped, but it appears too small to have served a dwelling function. On one side of the housemound is a terrace wall, on the other side is a modern/historic wall that does not appear to be ancient.

MR 32

UTM: 623.6 E, 1773.9 N; *Altitude:* 1230 masl; *Slope:* 2; *Drainage:* 1, 2; *Soil/Bedrock:* 1; *Nearest Water Source:* M (La Cieneguilla); *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* F; *Dwellings:* 6 (CD = 6); *House Groups:* 1 (C = 6); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 8

Notes: MR 32 is on a gentle slope (5-15%) surrounded by flat, good farm land. It is in view of MR 5.

MR 33
UTM: 623.5 E, 1773.3 N; *Altitude:* 1220 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P, T; *Dryslope Terraces:* 2 ; *Check Dams:* 11
Notes: MR 33 is a small check dam system situated in a small ravine with a lot of bedrock outcrops. It leads down to a small seasonal stream. As with other check dams in the zone (e.g. MR 28, 29), a few dry slope terraces were constructed at bottom of system where the terrain flattens out.

MR 34
UTM: 623.4 E, 1773.5 N; *Altitude:* 1250 masl; *Slope:* 1, 2, 3; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* M (La Cieneguilla); *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* F; *Dwellings:* 10 (CD = 10); *House Groups:* 5 (C = 5); *Domestic Altars:* 1; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 34 is a cluster of eleven housemounds situated on top of a small hill. Great view of MR 5, MR 18, MR 57 and much of modern Morelos settlement. No terraces, although hillsides have variable slopes about 15-25%. Rugged hardscrabble with bedrock exposures. MR 28, 29 a short walk from here.

MR 35
UTM: 623.2 E, 1773.8 N; *Altitude:* 1253 masl; *Slope:* 1, 2, 3; *Drainage:* 1; *Soil/Bedrock:* 2 85/15; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 4 (CD = 4); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* P, T; *Dryslope Terraces:* 4
Notes: MR 35 is a small, with four housemounds and a few terraces. It is situated on a small hill with hillsides of about 20-25% slope, above a modern road leading to the modern Morelos settlement.

MR 36
UTM: 623.2 E, 1773.2 N; *Altitude:* 1242 masl; *Slope:* 1; *Drainage:* 2; *Soil/Bedrock:* 2 75/25; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* PC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* F, P; *Dwellings:* 11 (CD = 11); *House Groups:* 1 (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 36 is on a relatively flat part of a small hill (same flat hilltop that MR 34 is on). Eleven housemounds in a U-shaped configuration. It's possible that a few of the recorded housemounds are actually one structure, but what is on the map is the best interpretation of what was observed in the field. Lots of bedrock outcrops and large stones, very rugged terrain. Clear view of MR 18.

MR 37

UTM: 623.1 E, 1773 N; *Altitude:* 1200 masl; *Slope:* 2; *Drainage:* 1; *Soil/Bedrock:* 2 85/15; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* P, T; *Dryslope Terraces:* 4

Notes: MR 37 is situated on a point formed by two, dry seasonal streams. Many small stones stacked on top of ancient terrace walls, some river cobbles included. Directly north of here is a steep zone of barrancas, very rugged terrain.

MR 38

UTM: 622.9 E, 1773.7 N; *Altitude:* 1246 masl; *Slope:* 1; *Drainage:* 2; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* PC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 2 (CD = 2; *House Groups:* 1 (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -

Notes: MR 38 consists of five small housemounds. It is situated in a relatively flat zone, very rugged with bedrock outcrops and large stones. Three of the housemounds are too small to have served a dwelling function, but aren't that much smaller than the two structures longer than 3 m in length. They have been classified as unidentified structures.

MR 39

UTM: 623 E, 1775.3 N; *Altitude:* 1347 masl; *Slope:* 2, 3, 4; *Drainage:* 1; *Soil/Bedrock:* 2 80/20; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* - ; *Check Dams:* 5

Notes: MR 39 is a check dam system in a ravine to the north of MR 18. This might be TR-208 as reported by Clark and Lowe (1980).

MR 40, MR 52

UTM: 624 E, 1775 N; *Altitude:* 1334 masl; *Slope:* 2, 3, 4; *Drainage:* 2, 3; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C, TD; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 3 (CD = 3); *House Groups:* 1 (C = 3); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 40 ; *Check Dams:* 6

Notes: MR 40 and MR 52 were mapped separately but have been combined because of their close proximity. They are located along a small seasonal stream (currently nearly dry, but some water could be observed trickling through). To the north, the terrain slopes sharply upwards. To the south is the seasonal stream with a steep cliff on the other side of it forming a natural boundary. Some of the terraces along the north-central portion of MR 40, 52 are small check dams with relatively level planting surfaces behind them. Small seasonal streams empty onto the surfaces of these check dams. But the streams are currently completely dry. It appears that the terraces near the top of the system would have served to check the flow of water, while the lower ones would have captured much of the soils eroding off the steep hillsides surrounding them. The three housemounds and chultun are situated on gently sloping hillside above most of the terraces. Although trees obscure the view of much of the terraces, if they were removed nearly all of the terraces would be visible.

MR 41
UTM: 623.5 E, 1775.4 N; *Altitude:* 1321 masl; *Slope:* 2, 3; *Drainage:* 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* C, TD; *Current Land Use:* M, P; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F; *Dryslope Terraces:* 18 ; *Check Dams:* 12
Notes: MR 41 which is a terrace system situated between a steep hill to the north and a seasonal stream to the south. No housemounds were found.

MR 42
UTM: 622.4 E, 1773.6 N; *Altitude:* 1225 masl; *Slope:* 1; *Drainage:* 2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* F, P; *Date:* PC; *Type:* H; *Civic Rank:* 5; *Structure Preservation:* P; *Dwellings:* 1 (CD = 1); *House Groups:* 1 (C = 1); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 42 is one housemound. It is set in relatively flat terrain with some bedrock exposures. About 50 m west of MR 42 is a zone of weathered bedrock which leads down to a small ravine with a seasonal stream.

MR 43 “El Cerrito de Panteon”
UTM: 622.5 E, 1773.4 N; *Altitude:* 1225 masl; *Slope:* 1; *Drainage:* 1, 2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* F, P; *Date:* LTC, PC; *Type:* H, T; *Civic Rank:* 4; *Structure Preservation:* F, P; *Dwellings:* 5 (CD = 5); *House Groups:* 5 (C = 5); *Domestic Altars:* - ; *Civic Structures:* 1 (P = 1); *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 9
Notes: MR 43 contains terraces and 6 housemounds. The terraces are located on a very gentle slope (about 5%) in a rugged zone with a fair amount of bedrock outcrops (especially in the N part of the terrace system where some of them create natural terraces that may have been used as milpa as they are today). But the rest of MR 43 is situated on relatively flat terrain with only one relatively large patch of bedrock exposed.

MR 44
UTM: 622.7 E, 1773.7 N; *Altitude:* 1243 masl; *Slope:* 1, 2; *Drainage:* 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* TD; *Current Land Use:* W; *Date:* LTC; *Type:* Sherd scatter; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 44 is a small sherd scatter with no housemounds or terraces nearby.

MR 45
UTM: 621.9 E, 1772.9 N; *Altitude:* 1204 masl; *Slope:* 2, 3, 4; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M; *Date:* LTC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* F; *Dwellings:* 5 (CD = 5); *House Groups:* 2 (C = 2); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F; *Dryslope Terraces:* 41
Notes: MR 45 is a terraced zone with five housemounds on the western limit of the survey zone, situated between two small hills. Some of the terraces are directly on top of bedrock. Also, many of them had medium-sized oblong stones at the base of the terrace walls. By oblong I

mean more rounded and less rectangular (as are the majority of the terraces mapped). The terrain immediately surrounding MR 45 is fairly flat but very rugged with a fair amount of bedrock exposure (85/15 bedrock to soil) and relatively shallow soils. Farming is possible on these lands but the locals say that yields are low. That's probably why the agricultural terraces were built here.

MR 46 "Jasam"
UTM: 622.7 E, 1773.1 N; *Altitude:* 1219 masl; *Slope:* 1, 2; *Drainage:* 2, 3, 4; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* L; *Vegetation:* C; *Current Land Use:* M, P; *Date:* LTC; *Type:* H, C; *Civic Rank:* 2; *Structure Preservation:* F, P; *Dwellings:* 75 (CD = 58; ED = 13; RS = 4); *House Groups:* 41 (R = 4; E = 6; C = 31); *Domestic Altars:* 5 ; *Civic Structures:* 5 (P = 4; B = 1); *Civic Altars:* 6; *Circular:* 2
Notes: MR 46 (0TR-241) is a civic center defined by a relatively large low-lying zone near the center. The locals have planted corn on the banks of the low-lying zone (recessional farming). The modern well on the edge of the low-lying zone has water in it. The water level is about 1 m below the ground surface. After a rain storm the low-lying zone began to fill shallowly with water. It does not appear that the water level would be able to surpass depths of between 10-50 cm (deeper in the corner around the modern well and becoming gradually shallower as you move northwest). From on top of MR 46's primary pyramids a clear view is provided (and vice versa) of MR 18, MR 24, MR 57, and possibly MR 5 (trees obscure the view). The majority of the terraces at MR 46 support housemounds and do not appear to have served an agricultural purpose.

MR 47
UTM: 622.7 E, 1773 N; *Altitude:* 1200 masl; *Slope:* 1, 2; *Drainage:* 2, 3; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 9
Notes: MR 47 is a system of dryslope terraces situated on gently sloping terrain just south of MR 46.

MR 48
UTM: 622.8 E, 1773.4 N; *Altitude:* 1204 masl; *Slope:* 1, 2; *Drainage:* 1; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* Sherd scatter; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 48 is a small sherd scatter.

MR 49
UTM: 623.2 E, 1772.4 N; *Altitude:* 1190 masl; *Slope:* 2; *Drainage:* 1, 2; *Soil/Bedrock:* 2 90/10; *Nearest Water Source:* ST, S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* Sherd scatter; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* -
Notes: MR 49 is a sherd scatter near the base of the hill that MR 8 is situated upon.

MR 50

UTM: 623.1 E, 1772.8 N; *Altitude:* 1233 masl; *Slope:* 1; *Drainage:* 1, 2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C, ST; *Current Land Use:* P, M; *Date:* LTC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 13

Notes: MR 50 is a system of dryslope terraces situated in relatively flat terrain. The slope that the terraces are on is only about 5% and the surrounding terrain is not all that steep (with the exception of steeper barrancas to the north. The surrounding terrain has some bedrock outcrops.

MR 51

UTM: 624 E, 1773.4 N; *Altitude:* 1240 masl; *Slope:* 1, 2; *Drainage:* 1, 2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* T; *Civic Rank:* - ; *Structure Preservation:* - ; *Dwellings:* - ; *House Groups:* - ; *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* G, F, P; *Dryslope Terraces:* 23

Notes: MR 51 is situated among gently sloping terrain which leads down to a small seasonal stream. The terraces on the eastern side of MR 51 are just over 100 m from the terraces on the western side of MR 5. Therefore, it's possible that these terraces were part of MR 5. Some of the terrace walls have been reconstructed in recent years, but the locals confirm that they were originally ancient constructions. Most of the terraced zone has been cleared of vegetation, but some short tree is present on the gentle rise in the center of the system, and along some of the terraces in the northeast portion of MR 51. Here current land use is pasture. The rest of the terraces are in modern re-use as milpa. To the north of the terraced zone are a few modern houses. To the west-northwest of MR 51 is a small seasonal stream (currently dry), and on the other side of it is a small milpa with a few modern terraces. We previously surveyed that zone and found no sherds; furthermore the terraces are too well built to be ancient. The locals attest to their recent construction. To the south and east is rugged terrain with a lot of bedrock outcrops.

MR 53

UTM: 624.3 E, 1774.8 N; *Altitude:* 1330 masl; *Slope:* 2, 3, 4; *Drainage:* 1, 2; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST, S; *Vegetation:* C, ST; *Current Land Use:* M, P; *Date:* LTC; *Type:* H, T; *Civic Rank:* 5; *Structure Preservation:* P, T; *Dwellings:* 7 (CD = 6; ED = 1); *House Groups:* 6 (E = 1; C = 5); *Domestic Altars:* - ; *Civic Structures:* - ; *Civic Altars:* - ; *Terrace Preservation:* G, F, P; *Dryslope Terraces:* 26; *Check Dams:* 6

Notes: MR 53 (TR-41) is situated in undulating terrain with the hillside to the north sloping steeply upwards. To the south of MR 53, on the other side of the modern ox road, the terrain slopes steeply downward (variable 20-30%) away from MR 53. Here the terrain is very rugged with a lot of bedrock outcrops and some low brush and some tall grass. No housemounds or terraces were found in this zone.

MR 54

UTM: 625.9 E, 1773.1 N; *Altitude:* 1280 masl; *Slope:* 1, 2, 3; *Drainage:* 1, 2, 3, 4; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* L; *Vegetation:* C, ST; *Current Land Use:* M, P; *Date:* LTC, PC, F; *Type:* H, C, T; *Civic Rank:* 4; *Structure Preservation:* F, P; *Dwellings:* 30 (CD = 23; ED = 7); *House Groups:* 20 (E = 4; C = 16); *Domestic Altars:* - ; *Civic Structures:* 1 (P = 1; B =); *Civic Altars:* - ; *Terrace Preservation:* F, P; *Dryslope Terraces:* 62

Notes: MR 54 (TR-47) is set among gently sloping terrain at the base of a steep hillside to the north. Three small seasonal streams emerge from the hillside, but they are currently dry. There is a clear view of Tenam Soledad from just about all of MR 54, and vice versa. MR 54 stretches from the base of the hillside in the north for several hundred meters southwest.

Some of the terraces have been at least partially reconstructed, and many have smaller stones that have been piled on top of the ancient stones in recent years. terrain slopes gently down over a series of terraces to what appears to be a rejollada.

A low-lying zone near the center of MR 54 had some water in it. A low, modern wall that serves as the eastern edge of an ox road spans the width of the southwestern half of the low-lying zone. It has two rows of stones about 1 m apart with fill in the middle. It appears to be preventing water in the low-lying zone from washing onto the ox road. It's difficult to tell if this low-lying zone would have filled with water without the aid of the modern wall. The terrain to the south of the low-lying zone slopes away gently (about 5%, maybe a little less). Today the low-lying zone is used as mainly as milpa (beans). But some water can be seen collecting in the southwestern portion near the modern wall.

On the top of a small ledge immediately south of the low-lying zone are nine pits dug into the limestone bedrock which the locals say served as ancient ovens for the firing of limestones. They cut relatively deeply into the bedrock and have openings at the base to provide access. Dimensions of well-preserved ovens are as follows (diameter x depth): 90 x 130 cm, 84 x 90 cm, 97 x 180 cm, 76 x 174 cm, 90 x 135 cm. Dimensions of basal openings (width x height): 75 x 50 cm, 55 x 40 cm, 50 x 36 cm, 71 x 50 cm, 51 x 38 cm, 62 x 57 cm, 78 x 58 cm.

Near the modern Morelos houses on the northwestern edge of MR 54 are a few modern terraces. These terraces are pristine (i.e. very clean with little soil having washed over them). I spoke with the farmer who cultivates them and he confirmed their relatively recent construction. He also confirmed that many of the terraces we have been mapping are ancient.

MR 55

UTM: 625.5 E, 1772.7 N; *Altitude:* 1260 masl; *Slope:* 1, 2; *Drainage:* 1; *Soil/Bedrock:* 2 95/5; *Nearest Water Source:* ST S; *Vegetation:* ST; *Current Land Use:* P; *Date:* LTC; *Type:* H, C, T; *Civic Rank:* 3; *Structure Preservation:* F, P; *Dwellings:* 18 (CD = 13; ED = 3; RS = 2); *House Groups:* 11 (R = 1; E = 1; C = 9); *Domestic Altars:* - ; *Civic Structures:* 1 (P = 1; B =); *Civic Altars:* - ; *Terrace Preservation:* F; *Dryslope Terraces:* 5; *Check Dams:* -

Notes: MR 55 is situated on gently sloping terrain just south of MR 54. The two range structures at first glance appeared to be a ballcourt, but the anomalous form of one of the ranges (it has a boot-like shape) indicates otherwise. Furthermore, neither range structure has a bench. The anomalous "boot" is not just wall fall. Some clear stone alignments can be seen. Also, it does not appear to be a separate structure. There is not gap, or even a dip, in the mounding from the south end of the boot to the N end of the structure.

MR 57 "Tenam Soledad"

UTM: 625.3 E, 1772.6 N; *Altitude:* 1290 masl; *Slope:* 1, 2, 3, 4; *Drainage:* 1, 2; *Soil/Bedrock:* 2 85/15; *Nearest Water Source:* ST S; *Vegetation:* C, ST, TD; *Current Land Use:* M, P; *Date:* LTC, PC; *Type:* H, C, T; *Civic Rank:* 1; *Structure Preservation:* F, P; *Dwellings:* 46 (CD = 15; ED = 26; RS = 5); *House Groups:* 18 (R = 4; E = 7; C = 7); *Domestic Altars:* - ; *Civic Structures:* 2 (P = 1; B = 1); *Civic Altars:* 2; *Terrace Preservation:* F, P; *Dryslope Terraces:* 56; *Check Dams:* 18

Notes: MR 57 (TR-44) is the polity capital. The small house group on the northeast edge of MR 57 is at the base of the hill that the civic core is situated upon. It was originally assigned the number MR 56, but has since been combined with MR 57. It is situated among fairly rugged terrain with a lot bedrock outcrops. There were a few farmers planting corn in the civic core while we were there. This zone has been hand plowed numerous times over the years. There is a small Ox road that leads up to the civic core on the north side of the hillside. Many of the larger mounds show signs of recent looting with relatively fresh holes and misshaped excavation ditches. Also, some holes have been dug in various parts of the plazas where no mounding is found.

Previous reconnaissance efforts in this zone mention a second ballcourt on the north side of the central pyramid. But no trace of a structure could be found. There is no mounding in this zone and no foundation stones. The ground can be clearly seen and there does not appear to have ever been a structure here.

The approach to MR 57 from the north and northeast side is by far the gentlest with the least slope. The slope here is variable, between 5-25%, but it is not very far (compared to the other sides of the hill) to reach the civic center. At the base of the hill on the north and northeast side the terrain gets flat before transitioning into the gentle slopes and barrancas that lead to MR 55.

The steps on the south side of MR 57 are small, foundation-looking constructions that lead back into the hillside. In a few places where they are well-preserved individual, small step-like stones can be seen. They are too narrow to be dwellings. Given the steepness of the slope steps probably would have been necessary for moving up and down the hillside. We searched but could not find any evidence that these steps continued further up or down the hillside.

The check dams on the east side of MR 57 have fairly level, deep planting surfaces behind the terrace walls. The two small hills on either side of the check dams are severely eroded with a lot of bedrock exposures. There is some short tree savannah vegetation in this zone with a few some dense patches of tropical deciduous. Neither of the hills are particularly high, but they do form a small, shallow crevice. The check dams are at the base of the crevice and do not show signs of having been reconstructed in the modern era. Currently this zone is used as pasture.

A commanding view of most of the core of the Morelos polity can be seen from the civic plaza. It's possible to see the hilltops that MR 18 and MR 24 are located on. Just about all of the best farming zones to the south and southwest can be clearly seen from here.

MR 58

UTM: 625.5 E, 1772.3 N; Altitude: 1231 masl; Slope: 1, 2; Drainage: 1; Soil/Bedrock: 2 80/20; Nearest Water Source: ST S; Vegetation: ST, TD; Current Land Use: P; Date: LTC; Type: T; Civic Rank: - ; Structure Preservation: - ; Dwellings: - ; House Groups: - ; Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: P, T; Dryslope Terraces: 9; Check Dams: -

Notes: MR 58 is set among gently sloping terrain (5-10%) in short-tree savannah vegetation with some patches of tropical deciduous forest. In some places bedrock has been incorporated into the base of terrace walls, and the entire system is surrounded by bedrock outcrops and gentle barrancas. It's possible that some of the barrancas and linear bedrock outcrops could have been used as natural terraces, there are a few outcrops below the terrace system (to the south) that potentially could have been used as such. None of the terraces appear to have been re-used or reconstructed in modern times.

MR 59, MR 60
UTM: 625 E, 1770.3 N; Altitude: 1120 masl; Slope: 1; Drainage: 1, 2; Soil/Bedrock: 2 95/5; Nearest Water Source: ST S; Vegetation: C, ST; Current Land Use: P, M; Date: LTC, PC; Type: H, C; Civic Rank: 3; Structure Preservation: F, P; Dwellings: 97 (CD = 71; ED = 22; RS = 4); House Groups: 42 (R = 4; E = 3; C = 35); Domestic Altars: 4; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: The core of MR 59 (TR-40) is situated in a zone that is a bit more rugged than the adjacent terrain. In this zone there is a fair amount of bedrock outcrops soil depth = 2 (90/10). The adjacent terrain is very flat with some gentle undulations but no slopes greater than about 5%. To the immediate southwest of MR 59 is a small area with 4 or 5 modern agricultural terraces. These terraces are very "clean", with little or no soil build-up on top of/through them and few sherds (much less dense than closer to the housemounds). MR 60 is located just southeast of MR 59 and appears to have been part of that settlement. Therefore, MR 59 and MR 60 have been combined here.

MR 61
UTM: 625.2 E, 1770 N; Altitude: 1116 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 2 95/15; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC, PC; Type: H, C; Civic Rank: 3; Structure Preservation: F, P; Dwellings: 49 (CD = 32; ED = 13; RS = 2); House Groups: 24 (R = 2; E = 4; C = 18); Domestic Altars: - ; Civic Structures: 1 (P = 1); Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: (TR-60)

MR 62 "San Jose"
UTM: 626.4 E, 1770.2 N; Altitude: 1129 masl; Slope: 1, 2; Drainage: 1, 2, 3; Soil/Bedrock: 2 95/5; Nearest Water Source: L; Vegetation: ST; Current Land Use: P; Date: LTC, PC; Type: H, C; Civic Rank: 2; Structure Preservation: G, F; Dwellings: 17 (CD = 8; ED = 4; RS = 5); House Groups: 9 (R = 4; E = 1; C = 4); Domestic Altars: - ; Civic Structures: 3 (P = 2; B = 1); Civic Altars: 1; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: MR 62 (TR-55), San Jose, is a ballcourt center set in short tree savannah that has some extremely dense patches of thicket-like vegetation. Many of the structures are completely engulfed by this dense vegetation. There are some field walls that run throughout the civic core. They appear to be ancient constructions and not the result of recent stacking of stones. Stone courses can be clearly seen deeper in the ground (as opposed to recently placed stones on top of soils, grasses, etc.), and they connect with corners of structures. None of these field walls are more than .2 or .3 m high (maybe higher in the past?) and they consist predominantly of medium sized stones (30-38 cm x 27-32 cm x 12-14 cm). They do not appear to be "terraces" in that there is very little to no slope where they occur. MR 62 is situated on a gentle rise in the terrain that is very flat, creating sort of a small plateau among otherwise relatively flat, lower-lying terrain. To the south of the civic core, there is a slope of about 10-15% that leads down to a flat, low-lying zone. We found some structures on the other side of this low-lying zone with deep, rich soils. The adjacent hillsides contribute much soil to this low-lying zone (through erosional forces) and in the southeast corner some water has collected. Also, there is a small channel that appears to drain this zone. It's possible that this was an ancient rejollada (similar to the low-lying zone at MR 46). There is a modern alignment of stones in this zone that passes through the eastern half of the low-lying zone. Also, the western slope appears to have two natural ridges

running roughly north to south with some groundstone river cobbles collecting on them. These do not appear to be ancient terraces. Just below them is another ridge with some river cobbles and limestones that runs about halfway across (north to south) the low-lying zone. It does not appear to be ancient.

MR 63
UTM: 626.3 E, 1770.5 N; Altitude: 1110 masl; Slope: 1; Drainage: 2,3; Soil/Bedrock: 2 95/5; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 4; Structure Preservation: F, P; Dwellings: 6 (CD = 3; ED = 2; RS = 1); House Groups: 4 (R = 1; E = 1; C = 2); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: MR 63 is situated on top of a gentle rise in otherwise flat terrain. The range structure is a very long structure with no clear division within it that, if present, might indicate that it is two structures. The height of the mounding is uniform throughout and there is no clear alignment of stones anywhere on top that might indicate two structures. The entire extent of MR 63 is in short tree savannah vegetation with tall grasses and some dense thickets of vegetation making visibility generally fair.

MR 64
UTM: 625.9 E, 1771.1 N; Altitude: 1131 masl; Slope: 1, 2; Drainage: 1, 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: TD; Current Land Use: WR; Date: LTC, PC; Type: H, T, C; Civic Rank: 3; Structure Preservation: G, F; Dwellings: 14 (CD = 3; ED = 9; RS = 2); House Groups: 8 (R = 2; E = 3; C = 3); Domestic Altars: - ; Civic Structures: 2 (P = 2); Civic Altars: - ; Terrace Preservation: F, L; Dryslope Terraces: 7; Check Dams: -
Notes: MR 64 is located northwest of MR 62, on the other side of two of the modern San Jose ranch houses. MR 64 is engulfed in tropical deciduous vegetation and visibility is fair to poor throughout. It is situated on a flat spot on a gentle slope. The slope is predominantly about 5% but increases to close to 10% in a few places. The terrace walls here are constructed of limestones as we've seen in just about all of the other terraces in the Morelos polity, but they also incorporate some of the expediently available groundstone river cobbles (found in the seasonal stream), especially the larger stones. It appears the all of the structures have some of these river cobbles in their constructions as well. There is a lot of soil and vegetation cover on all of the structures and terraces and therefore it is difficult to ascertain how much, and to what extent, the groundstones were utilized.

MR 65
UTM: 625.6 E, 1771.3 N; Altitude: 1140 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: TD; Current Land Use: WR; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 6 (CD = 6); House Groups: 5 (C = 5); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:

MR 66
UTM: 625.2 E, 1771 N; Altitude: 1142 masl; Slope: 1; Drainage: 1, 3; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: C; Current Land Use: M; Date: PC; Type: H; Civic Rank: 5;

Structure Preservation: P; Dwellings: 3 (CD = 3); House Groups: 1 (C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:
MR 67
UTM: 625.2 E, 1771.1 N; Altitude: 1140 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: C; Current Land Use: M; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 5 (ED = 5); House Groups: 1 (E = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:

MR 68
UTM: 625.3 E, 1771 N; Altitude: 1158 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC, PC; Type: SS; Civic Rank: - ; Structure Preservation: - ; Dwellings: - ; House Groups: - ; Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: MR 68 is a sherd scatter.

MR 69
UTM: 625.1 E, 1771.5 N; Altitude: 1150 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 1 (CD = 1); House Groups: 1 (C = 1); Domestic Altars: 1; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:

MR 70
UTM: 625.5 E, 1771.5 N; Altitude: 1148 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: TD; Current Land Use: WR; Date: PC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 5 (CD = 5); House Groups: 1 (C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:

CV 1
UTM: 619 E, 1760.8 N; Altitude: 792 masl; Slope: 1; Drainage: 2; Soil/Bedrock: 2 95/5; Nearest Water Source: San Lucas river; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 5 (CD = 5); House Groups: 1 (C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 1 consists of five small structures on relatively flat terrain near a small ox road.

CV 2
UTM: 619.2 E, 1760.6 N; Altitude: 786 masl; Slope: 1, 2, 3; Drainage: 2; Soil/Bedrock: 2 95/5; Nearest Water Source: San Lucas river; Vegetation: ST, C; Current Land Use: P, M; Date: LTC;

Type: H; Civic Rank: 4; Structure Preservation: F; Dwellings: 24 (CD = 20; ED = 3; RS = 1); House Groups: 6 (R = 1; C = 5); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 2 is situated on relatively flat terrain at the edge of a steep slope leading down to a canada. It is surrounded by a plentitude of deep, relatively flat-lying soils. Some of these flat zones are currently used as milpa, but the majority of the landscape around CV 2 is short tree savannah.

CV3
UTM: 618 E, 1759.4 N; Altitude: 746 masl; Slope: 3; Drainage: 1; Soil/Bedrock: 2 95/15; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: SS; Civic Rank: - ; Structure Preservation: - ; Dwellings: - ; House Groups: - ; Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 3 is a sherd scatter.

CV4
UTM: 618.5 E, 1759 N; Altitude: 711 masl; Slope: 1; Drainage: 1, 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: C; Current Land Use: M; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: P; Dwellings: 2 (CD = 2); House Groups: 1(C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 4 is situated on flat terrain near the base (about 200 m southeast) of the slopes to the north. This entire flat zone has been plowed with a tractor over the last 10 years or so and it's possible that other structures had once existed here but have since been destroyed. No rubble sherd piles were found, but sherds were found up to 50-75 m away from the two structures, and appear to be especially dense to the southwest of the structures (about 5 sherds per square-meter).

CV5 "Bolohuitz"
UTM: 618.1 E, 1758.2 N; Altitude: 715 masl; Slope: 1; Drainage: 1, 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H, C; Civic Rank: 2; Structure Preservation: F, P; Dwellings: 4 (ED = 4); House Groups: 2 (E = 2); Domestic Altars: - ; Civic Structures: 2 (P = 1; B = 1); Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 5 (TR-86), Bolohuitz, is a small ballcourt center situated on a gentle rise in otherwise relatively flat terrain about 150 m southwest of the base of Cerro Bolohuitz. Currently it is fallow milpa where tall grasses and some small trees have regrown. But plow marks can be seen where tractors have tilled the earth. A diligent search turned up only seven structures including a small, open-ended ballcourt. Upon close inspection the faint remains of what might have been parts of the benches were visible, but they were not clear enough (nor conclusively benches) to incorporate into the map. To the immediate north of CV 5 is a modern milpa with 2 or 3 modern terraces on gently sloping terrain (about 5%). No other terraces were found in this zone.

CV 6 "Cerro de Bolohuitz"
UTM: 618.6 E, 1758.4 N; Altitude: 725 masl; Slope: 1, 2, 3, 4; Drainage: 1; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: TD; Current Land Use: WR, P; Date: LTC; Type: H;

Civic Rank: 5; Structure Preservation: F, P; Dwellings: 4 (CD = 4); House Groups: 1 (C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 6 consists of four fair to poorly preserved structures situated on top of Cerro Bolohuitz. The vegetation here is extremely dense in many places making visibility fair to poor. But we managed to survey the entire hilltop and slopes and found no other structures or terraces.

CV 7
UTM: 619.5 E, 1758.9 N; Altitude: 704 masl; Slope: 1; Drainage: 1, 2; Soil/Bedrock: 1; Nearest Water Source: ST S; Vegetation: C; Current Land Use: M; Date: LTC, PC; Type: H; Civic Rank: 5; Structure Preservation: F; Dwellings: 7 (CD = 5; ED = 2); House Groups: 5 (E = 1; C = 4); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 7 (might be TR-85, but appears to be too far to the north) has a few fairly large structures and is situated along a modern road. It is situated on a gentle rise in otherwise relatively flat terrain that is cleared of vegetation and currently used as milpa. On the northeast side of CV 7 there are a few (3 or 4) small modern stone piles that the locals said were not structures but simply the result of piling stones from the milpa. They were also able to point-out a few of these piles that were ancient structures, so I had no reason to believe they were mistaken. We inspected these modern stone piles closely but could find no foundation stones (visible for all of the other mounds at the site) that would indicate that they were indeed ancient constructions. Therefore, they were not mapped.

CV 8
UTM: 618 E, 1762.2 N; Altitude: 789 masl; Slope: 1, 2; Drainage: 1; Soil/Bedrock: 2 95/5; Nearest Water Source: San Lucas river; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 6 (CD = 3; ED = 3); House Groups: 2 (E = 1; C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 8 is situated on a bluff overlooking Canada Cruz Antonio. At the base of the canada are fairly flat-lying soils, narrow but long stretching all the way to the San Lucas river. To the immediate north is undulating terrain with slopes varying between 5-25% and a lot of places where terraces could have been constructed, but none were found.

CV 9
UTM: 618.4 E, 1763.7 N; Altitude: 829 masl; Slope: 1, 2; Drainage: 1; Soil/Bedrock: 2 90/10; Nearest Water Source: San Lucas river or ST S; Vegetation: ST; Current Land Use: P, M; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 19 (CD = 19); House Groups: 10 (C = 10); Domestic Altars: 1; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 9 is set on a relatively flat ledge just southeast of a steep hill adjacent to the modern Los Laureles houses. To the southeast of CV 9 the terrain slopes downhill to Canada Mata Piojo. The soils at CV 9 are fairly deep, but the terrain is undulating and bedrock exposures exist in some places.

CV 10
UTM: 619.3 E, 1764.2 N; Altitude: 835 masl; Slope: 1, 2; Drainage: 1; Soil/Bedrock: 2 90/10; Nearest Water Source: San Lucas river or ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: F, P; Dwellings: 5 (CD = 5); House Groups: 2 (C = 2); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes:

CV 11
UTM: 620.3 E, 1764.2 N; Altitude: 843 masl; Slope: 1, 2; Drainage: 1; Soil/Bedrock: 2 95/5; Nearest Water Source: ST S; Vegetation: ST; Current Land Use: P; Date: LTC; Type: H; Civic Rank: 5; Structure Preservation: P; Dwellings: 2 (CD = 2); House Groups: 1 (C = 1); Domestic Altars: - ; Civic Structures: - ; Civic Altars: - ; Terrace Preservation: - ; Dryslope Terraces: - ; Check Dams: -
Notes: CV 11 is situated on top of a long, narrow hill that divides two small canadas with an extensive distribution of flat-lying soils and seasonal streams.

APPENDIX C

SAMPLE FIELD FORMS

Recorded by_______ Date____

STRUCTURE FORM

Str. #	str. type	height	prservation	quality of construct.	on terrace?	other arch. details	assoc'd artifacts?	collections made?	lot #	photo #	notes:

Recorded by ______ Date____

AGRICULTURAL TERRACE FORM

Terrace #	terrace type	prservation	quality of construct.	other arch. details	modern re-use?	soil depth behind	assoc'd artifacts?	collections made?	lot #	photo #	notes:

Recorded by_______ Date____

NATURAL ENVIRONMENT DESCRIPTION FORM

site #	coords.	land ownership	altitude masl	ecological zone	local topography	slope/sus. to erosion	drainage	bedrock exposure	nearest water source(s)	water source(s) name(s)
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									
	N E									

NATURAL ENVIRONMENT DESCRIPTION FORM (p. 2)

site #	vegetation formation	current land use	other resources	notes:

Ceramics Site # ____________ Lot # ___________ Recorder(s) ___________

Morelos & Clavo Verde Surveys 2005

	Forms				Parts						Numbers	
TYPES	Jar	Bowl	Oth	Und	Body	Rim	Nck	Base	Oth	Und	Total	notes

small (1-2 cm in length) medium (2-5 cm in length) large (5+ cm in length)

eroded (completely without slip)

not eroded (traces of slip to completely slipped)

APPENDIX D

HOUSE GROUPS

D.1 MORELOS POLITY LATE-TERMINAL CLASSIC PERIOD HOUSE GROUPS ORGANIZED BY HOUSE GROUP CLUSTER

Morelos Polity Late-Terminal Classic Period				
House Groups by Type				
(grouped by house group cluster)				
Range Structure Elites				
(n = 41)				
House Group #	# of Range Structures	# of Dwells 9 to 11 m	# Dwellings 3 to 9 m	Total # of Dwellings
MR14HG11	1		3	4
MR14HG2	1	1	2	4
MR14HG8	1		4	5
MR18HG4	1		2	3
MR18HG5	1		1	2
MR24HG3	2		1	3
MR24HG5	1		1	2
MR24HG6	1		3	4
MR28HG5	1	1	1	3
MR28ST39	1			1
MR3HG1	1		2	3
MR46HG10	1		1	2
MR46HG12	1		1	2
MR46HG13	1		3	4
MR46ST83	1			1
MR4ST16	1			1
MR4ST7	1			1
MR4ST8	1			1
MR55HG5	2		1	3
MR57HG1	1		5	6
MR57HG10	1		1	2
MR57HG4	1		4	5
MR57HG5	1		4	5
MR57HG6	1	1	1	3
MR59HG6	1		1	2
MR59ST45	1			1
MR5HG5	1	1		2
MR5HG6	1	2		3
MR5ST13	1			1
MR60HG1	1		4	5
MR60HG14	1		2	3
MR61HG10	1		1	2
MR61HG2	1		3	4
MR62HG1	2		3	5
MR62ST4	1			1
MR62ST5	1			1
MR62ST6	1			1
MR63HG2	1		1	2
MR64HG2	1		3	4
MR64ST2	1			1
MR8ST6	1			1
TOTAL	**44**	**6**	**59**	**109**

Non-Range Structure Elites (n = 52)				
House Group #	# of Dwells. 9 to 11 m	# Dwellings 3 to 9 m	Total # of Dwellings	
MR14HG1	1	4	5	
MR14HG10	1	7	8	
MR14HG12	1	3	4	
MR14HG14	1	1	2	
MR14HG21	1	3	4	
MR14HG3	1	3	4	
MR18HG3		2	2	
MR24HG13	1	2	3	
MR24HG30	1	2	3	
MR24HG40	1	1	2	
MR24HG7		2	2	
MR3ST1	1		1	
MR46HG5	1	2	3	
MR46ST80	1		1	
MR46ST82		1	1	
MR46ST89	1		1	
MR46ST90		1	1	
MR46ST91		1	1	
MR4HG2	1	1	2	
MR4ST14	1		1	
MR53ST7	1		1	
MR54HG5	1	2	3	
MR54HG6		2	2	
MR54ST19		1	1	
MR54ST26	1		1	
MR55HG3		2	2	
MR57HG7		2	2	
MR57HG8	1	2	3	
MR57ST13		1	1	
MR57ST26	1		1	
MR57ST32		1	1	
MR57ST7		1	1	
MR57ST8		1	1	
MR59HG1	2	6	8	
MR5HG7	1	2	3	
MR5ST12	1		1	
MR60HG10	1	4	5	
MR60HG2	1	1	2	
MR61HG1		3	3	
MR61HG3		3	3	
MR61HG4		4	4	
MR61ST10		1	1	
MR62ST11		1	1	
MR63ST4	1		1	
MR64HG1	1	1	2	
MR64HG3	1	1	2	
MR64HG4	1	1	2	
MR67HG1	1	4	5	
MR8HG1	1	4	5	
MR8HG2		3	3	
MR8ST1		1	1	
MR8ST7		1	1	
TOTAL	**32**	**92**	**124**	

Commoners				
(n = 319)				
	# Dwellings	Total # of		
House Group #	3 to 9 m	Dwellings		
MR10ST2	1	1		
MR10ST3	1	1		
MR10ST4	1	1		
MR12ST1	1	1		
MR13HG1	3	3		
MR13HG2	3	3		
MR13ST7	1	1		
MR14HG13	3	3		
MR14HG15	2	2		
MR14HG16	2	2		
MR14HG17	3	3		
MR14HG18	4	4		
MR14HG19	3	3		
MR14HG20	2	2		
MR14HG4	2	2		
MR14HG5	5	5		
MR14HG6	3	3		
MR14HG7	4	4		
MR14HG9	2	2		
MR14ST20	1	1		
MR14ST21	1	1		
MR14ST42	1	1		
MR14ST43	1	1		
MR14ST45	1	1		
MR14ST46	1	1		
MR14ST47	1	1		
MR14ST56	1	1		
MR14ST57	1	1		
MR14ST58	1	1		
MR14ST63	1	1		
MR14ST64	1	1		
MR14ST65	1	1		
MR14ST68	1	1		
MR14ST94	1	1		
MR15ST1	1	1		
MR18HG1	2	2		
MR18HG2	3	3		
MR18HG6	2	2		
MR18ST12	1	1		
MR18ST17	1	1		
MR18ST24	1	1		
MR18ST25	1	1		
MR1HG1	2	2		
MR1ST1	1	1		
MR23HG1	2	2		
MR23HG2	2	2		
MR24HG1	4	4		
MR24HG10	2	2		
MR24HG11	2	2		
MR24HG12	4	4		
MR24HG14	2	2		
MR24HG15	3	3		
MR24HG16	4	4		

MR24HG17	3	3		
MR24HG18	4	4		
MR24HG19	2	2		
MR24HG2	2	2		
MR24HG20	5	5		
MR24HG21	2	2		
MR24HG22	4	4		
MR24HG23	3	3		
MR24HG24	5	5		
MR24HG25	2	2		
MR24HG26	4	4		
MR24HG27	2	2		
MR24HG28	3	3		
MR24HG29	3	3		
MR24HG31	3	3		
MR24HG32	4	4		
MR24HG33	2	2		
MR24HG34	7	7		
MR24HG35	2	2		
MR24HG36	2	2		
MR24HG37	3	3		
MR24HG38	2	2		
MR24HG39	2	2		
MR24HG4	3	3		
MR24HG8	6	6		
MR24HG9	2	2		
MR24ST121	1	1		
MR24ST127	1	1		
MR24ST130	1	1		
MR24ST131	1	1		
MR24ST132	1	1		
MR24ST141	1	1		
MR24ST144	1	1		
MR24ST145	1	1		
MR24ST146	1	1		
MR24ST147	1	1		
MR24ST153	1	1		
MR24ST154	1	1		
MR24ST161	1	1		
MR24ST162	1	1		
MR24ST163	1	1		
MR24ST168	1	1		
MR24ST169	1	1		
MR24ST171	1	1		
MR24ST172	1	1		
MR24ST173	1	1		
MR24ST177	1	1		
MR24ST2	1	1		
MR24ST36	1	1		
MR24ST41	1	1		
MR24ST5	1	1		
MR24ST52	1	1		
MR24ST53	1	1		
MR24ST57	1	1		
MR24ST58	1	1		
MR24ST59	1	1		
MR24ST6	1	1		

MR24ST60	1	1		
MR24ST61	1	1		
MR24ST62	1	1		
MR24ST64	1	1		
MR24ST65	1	1		
MR24ST66	1	1		
MR24ST67	1	1		
MR24ST74	1	1		
MR24ST81	1	1		
MR24ST83	1	1		
MR24ST84	1	1		
MR24ST87	1	1		
MR24ST88	1	1		
MR24ST89	1	1		
MR24ST90	1	1		
MR24ST94	1	1		
MR24ST95	1	1		
MR26ST1	1	1		
MR26ST2	1	1		
MR27HG1	4	4		
MR27ST1	1	1		
MR27ST2	1	1		
MR27ST6	1	1		
MR27ST7	1	1		
MR28HG1	5	5		
MR28HG10	2	2		
MR28HG2	3	3		
MR28HG3	2	2		
MR28HG4	2	2		
MR28HG6	3	3		
MR28HG7	2	2		
MR28HG8	3	3		
MR28HG9	3	3		
MR28ST10	1	1		
MR28ST13	1	1		
MR28ST17	1	1		
MR28ST29	1	1		
MR28ST30	1	1		
MR28ST38	1	1		
MR28ST9	1	1		
MR2ST1	1	1		
MR32HG1	6	6		
MR34HG1	3	3		
MR34HG2	3	3		
MR34HG3	2	2		
MR34ST6	1	1		
MR34ST7	1	1		
MR35HG1	3	3		
MR35ST3	1	1		
MR40HG1	3	3		
MR43ST2	1	1		
MR43ST3	1	1		
MR43ST4	1	1		
MR43ST5	1	1		
MR43ST6	1	1		
MR45HG1	4	4		
MR45ST5	1	1		

MR46HG1	3	3		
MR46HG11	2	2		
MR46HG14	3	3		
MR46HG15	2	2		
MR46HG16	3	3		
MR46HG17	4	4		
MR46HG18	4	4		
MR46HG19	4	4		
MR46HG2	3	3		
MR46HG3	3	3		
MR46HG4	2	2		
MR46HG6	2	2		
MR46HG7	2	2		
MR46HG8	3	3		
MR46HG9	3	3		
MR46ST18	1	1		
MR46ST19	1	1		
MR46ST20	1	1		
MR46ST31	1	1		
MR46ST41	1	1		
MR46ST53	1	1		
MR46ST54	1	1		
MR46ST68	1	1		
MR46ST71	1	1		
MR46ST74	1	1		
MR46ST75	1	1		
MR46ST76	1	1		
MR46ST77	1	1		
MR46ST94	1	1		
MR46ST95	1	1		
MR4HG1	2	2		
MR4HG3	2	2		
MR4ST13	1	1		
MR4ST15	1	1		
MR4ST9	1	1		
MR53HG1	2	2		
MR53ST3	1	1		
MR53ST4	1	1		
MR53ST5	1	1		
MR53ST6	1	1		
MR54HG1	3	3		
MR54HG2	2	2		
MR54HG3	2	2		
MR54HG4	2	2		
MR54HG7	3	3		
MR54ST1	1	1		
MR54ST10	1	1		
MR54ST13	1	1		
MR54ST14	1	1		
MR54ST15	1	1		
MR54ST25	1	1		
MR54ST27	1	1		
MR54ST28	1	1		
MR54ST5	1	1		
MR54ST6	1	1		
MR54ST9	1	1		
MR55HG1	2	2		

MR55HG2	2	2		
MR55HG4	3	3		
MR55ST12	1	1		
MR55ST14	1	1		
MR55ST18	1	1		
MR55ST3	1	1		
MR55ST4	1	1		
MR55ST5	1	1		
MR57HG11	2	2		
MR57HG2	5	5		
MR57HG3	2	2		
MR57HG9	3	3		
MR57ST20	1	1		
MR57ST24	1	1		
MR57ST25	1	1		
MR59HG10	2	2		
MR59HG11	3	3		
MR59HG2	3	3		
MR59HG3	2	2		
MR59HG4	3	3		
MR59HG5	3	3		
MR59HG7	3	3		
MR59HG8	4	4		
MR59HG9	5	5		
MR59ST47	1	1		
MR59ST7	1	1		
MR59ST8	1	1		
MR5HG1	2	2		
MR5HG2	2	2		
MR5HG3	3	3		
MR5HG4	2	2		
MR5ST11	1	1		
MR5ST23	1	1		
MR5ST8	1	1		
MR60HG11	3	3		
MR60HG12	2	2		
MR60HG13	2	2		
MR60HG3	2	2		
MR60HG4	4	4		
MR60HG5	2	2		
MR60HG6	3	3		
MR60HG7	4	4		
MR60HG8	2	2		
MR60HG9	3	3		
MR60ST10	1	1		
MR60ST11	1	1		
MR60ST12	1	1		
MR60ST23	1	1		
MR60ST28	1	1		
MR60ST36	1	1		
MR60ST37	1	1		
MR60ST43	1	1		
MR60ST46	1	1		
MR60ST56	1	1		
MR60ST57	1	1		
MR60ST58	1	1		
MR60ST9	1	1		

MR61HG11	4	4		
MR61HG12	2	2		
MR61HG13	2	2		
MR61HG14	3	3		
MR61HG5	4	4		
MR61HG6	2	2		
MR61HG7	2	2		
MR61HG8	2	2		
MR61HG9	2	2		
MR61ST21	1	1		
MR61ST37	1	1		
MR61ST42	1	1		
MR61ST43	1	1		
MR61ST44	1	1		
MR61ST45	1	1		
MR61ST53	1	1		
MR61ST54	1	1		
MR61ST56	1	1		
MR62HG2	5	5		
MR62ST17	1	1		
MR62ST18	1	1		
MR62ST19	1	1		
MR63HG1	2	2		
MR63ST1	1	1		
MR64ST4	1	1		
MR64ST5	1	1		
MR64ST6	1	1		
MR65HG1	2	2		
MR65ST1	1	1		
MR65ST4	1	1		
MR65ST5	1	1		
MR65ST6	1	1		
MR69ST1	1	1		
MR8HG3	2	2		
MR8ST14	1	1		
MR8ST15	1	1		
MR8ST4	1	1		
MR9ST1	1	1		
TOTAL		**571**		

D.2 CLAVO VERDE POLITY LATE-TERMINAL CLASSIC PERIOD HOUSE GROUPS ORGANIZED BY HOUSE GROUP CLUSTER

Clavo Verde Polity Late-Terminal Classic Period				
House Group by Type				
(grouped by house group cluster)				
Range Structure Elites				
(n = 12)				
	# of Range	# Dwellings	# Dwellings	Total # of
House Group #	Structures	9 to 11 m	3 to 9 m	Dwellings
CV2HG5	1		3	4
RV285HG26	1		1	2
RV289HG26	1	1	1	3
RV289HG8	1		1	2
RV449HG11	1			1
RV449HG6	1			1
RV450HG13	1	1	3	5
RV450HG15	1		3	4
RV450HG22	1		3	4
RV450HG30	1		3	4
RV454HG3	1		2	3
RV466HG1	2	1	1	4
TOTAL	**13**	**3**	**21**	**37**

Non-Range Structure Elites				
(n = 51)				
	# Dwellings	# Dwellings	Total # of	
House Group #	9 to 11 m	3 to 9 m	Dwellings	
CV5HG1	1	2	3	
CV5HG2		1	1	
CV7HG1	1	1	2	
CV8HG2	1	2	3	
RV285HG1	1	1	2	
RV285HG11	1	1	2	
RV285HG15	1	1	2	
RV286HG5	1	2	3	
RV289HG10	1		1	
RV289HG17	1		1	
RV289HG19	1	1	2	
RV289HG22	1	1	2	
RV289HG25	1	1	2	
RV289HG5	1	1	2	
RV289HG6	1		1	
RV289HG7	2		2	
RV409HG19	1		1	
RV412HG10	1	1	2	
RV412HG7	1	1	2	
RV416HG1	1	1	2	
RV416HG2	1		1	
RV416HG21		2	2	
RV419HG1	1		1	
RV422HG2	1		1	
RV425HG17	1	1	2	
RV425HG18	1	1	2	
RV425HG22	1	1	2	
RV425HG26	1	3	4	
RV425HG28	1	1	2	
RV425HG4	1	2	3	
RV446HG4	1	2	3	
RV447HG10		3	3	
RV447HG5		1	1	
RV449HG1	1		1	
RV450HG28	1	1	2	
RV450HG3	1	3	4	
RV450HG37	1	5	6	
RV450HG8	1	2	3	
RV452HG2	1	2	3	
RV454HG6	1	2	3	
RV456HG2	1	1	2	
RV456HG3	1	2	3	
RV457HG1		2	2	
RV458HG1	2	1	3	
RV460HG3	1	1	2	
RV460HG5	1		1	
RV475HG1	1	2	3	
RV477HG1		3	3	
RV477HG10		2	2	
RV477HG11		2	2	
RV477HG9		2	2	
TOTAL	**44**	**68**	**112**	

Commoners				
(n = 437)				
	# Dwellings			
House Group #	3 to 9 m			
CV10	1			
CV10HG1	4			
CV11HG1	2			
CV1HG1	5			
CV2HG1	3			
CV2HG2	2			
CV2HG3	5			
CV2HG4	5			
CV2HG6	5			
CV4HG1	2			
CV6HG1	4			
CV7	1			
CV7	1			
CV7	1			
CV7HG2	2			
CV8HG1	3			
CV9	1			
CV9	1			
CV9	1			
CV9	1			
CV9	1			
CV9	1			
CV9HG1	2			
CV9HG2	3			
CV9HG3	3			
CV9HG4	5			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285	1			
RV285HG12	2			
RV285HG20	2			
RV285HG23	2			
RV285HG24	3			
RV285HG27	2			
RV286	1			

RV286	1			
RV286	1			
RV286	1			
RV286HG3	2			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289	1			
RV289HG11	2			
RV289HG13	2			
RV289HG14	2			
RV289HG15	2			
RV289HG18	2			
RV289HG20	2			
RV409	1			
RV409	1			
RV409	1			
RV409	1			
RV409	1			
RV409HG1	2			
RV409HG11	2			
RV409HG12	2			
RV409HG3	3			
RV409HG6	3			
RV409HG7	3			
RV409HG8	2			
RV410HG1	2			
RV410HG2	2			
RV411	1			
RV411HG1	2			
RV412	1			
RV412	1			
RV412	1			
RV412	1			
RV412	1			
RV412HG11	2			
RV412HG2	2			
RV412HG3	3			
RV412HG4	3			
RV412HG6	2			
RV412HG9	3			
RV415	1			
RV415HG2	2			
RV416	1			
RV416	1			
RV416	1			
RV416	1			
RV416	1			
RV416	1			
RV416	1			

RV416	1			
RV416	1			
RV416	1			
RV416	1			
RV416	1			
RV416HG10	2			
RV416HG12	3			
RV416HG15	2			
RV416HG18	2			
RV416HG19	2			
RV416HG20	2			
RV416HG6	2			
RV416HG7	2			
RV417	1			
RV417	1			
RV417	1			
RV417	1			
RV417	1			
RV417	1			
RV417	1			
RV417	1			
RV417HG5	2			
RV417HG6	2			
RV417HG9	3			
RV418	1			
RV418	1			
RV418	1			
RV418	1			
RV418	1			
RV418	1			
RV418	1			
RV418	1			
RV418HG1	3			
RV418HG11	2			
RV418HG13	2			
RV418HG14	2			
RV418HG5	3			
RV418HG7	2			
RV418HG9	2			
RV419	1			
RV419HG2	2			
RV420	1			
RV420HG1	3			
RV420HG2	4			
RV420HG4	2			
RV420HG5	2			
RV421HG1	3			
RV422	1			
RV424	1			
RV424	1			
RV424	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			

RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425	1			
RV425HG1	2			
RV425HG10	3			
RV425HG11	2			
RV425HG12	2			
RV425HG14	2			
RV425HG15	2			
RV425HG19	2			
RV425HG20	2			
RV425HG24	4			
RV425HG27	2			
RV425HG29	2			
RV425HG3	2			
RV425HG32	2			
RV425HG33	3			
RV425HG35	3			
RV425HG36	2			
RV425HG6	4			
RV425HG9	2			
RV426	1			
RV426	1			
RV426HG1	3			
RV426HG2	3			
RV427	1			
RV427HG1	2			
RV427HG3	3			
RV427HG4	3			
RV427HG5	2			
RV446	1			
RV446	1			
RV446	1			
RV446HG1	4			
RV446HG10	2			
RV446HG2	2			
RV446HG3	2			
RV446HG7	2			
RV446HG8	2			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			

RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447	1			
RV447HG1	4			
RV447HG11	2			
RV447HG12	2			
RV447HG13	2			
RV447HG14	2			
RV447HG15	3			
RV447HG16	2			
RV447HG17	2			
RV447HG19	2			
RV447HG20	2			
RV447HG22	2			
RV447HG23	2			
RV447HG27	3			
RV447HG29	2			
RV447HG30	2			
RV447HG34	2			
RV447HG35	2			
RV447HG38	4			
RV447HG39	3			
RV447HG4	2			
RV447HG40	3			
RV447HG41	2			
RV447HG7	2			
RV448	1			
RV448	1			
RV448HG1	3			
RV448HG3	2			
RV448HG5	2			
RV449	1			
RV449	1			
RV449	1			
RV449	1			
RV449	1			
RV449HG10	3			
RV449HG4	2			
RV449HG7	3			
RV449HG8	2			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			

RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450	1			
RV450HG1	2			
RV450HG10	2			
RV450HG11	3			
RV450HG14	5			
RV450HG17	3			
RV450HG18	2			
RV450HG19	2			
RV450HG2	2			
RV450HG20	3			
RV450HG23	3			
RV450HG24	2			
RV450HG26	3			
RV450HG27	2			
RV450HG32	4			
RV450HG38	2			
RV450HG39	5			
RV450HG42	2			
RV450HG43	2			
RV450HG44	2			
RV450HG45	4			
RV450HG47	4			
RV450HG51	4			
RV450HG52	3			
RV450HG53	2			
RV450HG54	2			
RV450HG55	2			
RV450HG56	2			
RV450HG59	2			
RV450HG6	3			
RV450HG7	3			
RV450HG9	2			
RV451HG1	2			
RV451HG2	3			
RV451HG3	4			
RV451HG4	4			
RV451HG5	3			
RV451HG6	2			
RV452	1			
RV452	1			
RV452HG1	2			
RV452HG3	2			
RV453HG1	2			
RV454	1			
RV454	1			
RV454	1			
RV454	1			

RV454	1			
RV454	1			
RV454	1			
RV454HG5	2			
RV454HG8	2			
RV455	1			
RV456HG1	3			
RV456HG4	3			
RV458	1			
RV459HG1	2			
RV459HG2	3			
RV459HG3	2			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460	1			
RV460HG1	3			
RV460HG11	3			
RV460HG12	4			
RV460HG14	2			
RV460HG18	2			
RV460HG7	2			
RV460HG8	3			
RV460HG9	2			
RV461	1			
RV461	1			
RV461	1			
RV461	1			
RV461	1			
RV461HG1	4			
RV461HG2	2			
RV462	1			
RV462	1			
RV462HG1	2			
RV463	1			
RV463	1			
RV463	1			
RV463	1			
RV463	1			
RV463	1			
RV463HG10	3			
RV463HG2	3			
RV463HG5	4			
RV463HG8	5			
RV464	1			
RV464HG1	3			
RV464HG3	2			
RV464HG4	3			
RV465	1			

RV465HG1	2			
RV470	1			
RV470	1			
RV470	1			
RV470	1			
RV470	1			
RV470HG10	2			
RV470HG10	2			
RV470HG3	2			
RV470HG5	2			
RV472	1			
RV474	1			
RV474	1			
RV474	1			
RV474	1			
RV474	1			
RV474	1			
RV474	1			
RV474HG1	3			
RV474HG10	2			
RV474HG2	2			
RV474HG3	2			
RV474HG4	2			
RV474HG5	2			
RV474HG6	2			
RV474HG9	2			
RV475	1			
RV475	1			
RV475	1			
RV475	1			
RV475	1			
RV475	1			
RV475HG2	2			
RV477	1			
RV477	1			
RV477	1			
RV477HG12	3			
RV477HG13	4			
RV477HG14	3			
RV477HG15	3			
RV477HG16	2			
RV477HG18	2			
RV477HG19	2			
RV477HG2	3			
RV477HG4	2			
RV477HG5	2			
RV477HG6	2			
RV477HG7	3			
RV478HG1	2			
TOTAL	**775**			

APPENDIX E

VEGETATION FORMATIONS OF THE UPPER GRIJALVA BASIN, CHIAPAS, MEXICO, BY BARBARA VOORHIES

Vegetation Formations of the Upper Grijalva Basin, Chiapas, Mexico

Barbara Voorhies
University of California
Santa Barbara

1984

Report Submitted to the
New World Archaeological Foundation
Brigham Young University

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VEGETATION FORMATIONS OF THE UPPER GRIJALVA BASIN, CHIAPAS, MEXICO

Barbara Voorhies

University of California

Santa Barbara

INTRODUCTION

Objectives

The purpose of this chapter is to identify the major vegetation communities within the Upper Grijalva Basin and to determine their individual distributions. The report is based on field observations that were carried out with the express purpose of producing phytogeographic information that could be compared with ancient human settlement data for the same area. Accordingly, the principal objective of the vegetation study was to produce a vegetation map of the Upper Grijalva Basin.

Before discussing this study, however, it is useful to consider the reasoning behind my conviction that it can be heuristically valuable to compare the distribution of present day vegetation zones with distribution patterns of ancient human settlements. At its foundation, this conviction rests on the assumption that human populations, like other biotic populations, must adapt to specific biophysical environments. Accordingly, ancient human groups in the Upper Grijalva Basin must have made specific choices concerning preferred settlement locations. These choices would have been governed, in part, by the nature of the environments that these groups encountered. Plant life, an important component of the biophysical environment, would have been a significant factor in habitat selection.

Moreover, since the distribution of plants is controlled by both edaphic and climatic factors, if we are able to identify the presence of a particular community of plants, we are often able to infer additional information about the biophysical environment.

The obvious question which arises, however, is how representative is the present day distribution of plant communities of the ancient environments to which early inhabitants of the Upper Grijalva Basin were adapting? The answer, of course, is that we do not really know at the present time. To determine this would require extensive regional study of paleoenvironments in the Upper Grijalva Basin. Such a study is not presently available, and cannot be achieved either quickly or economically. Therefore, until such a time when paleoecological data are in hand, other less precise ways of determining the paleoenvironments of the study area must be sought.

My reasoning is that when we consider the Upper Grijalva Basin in its entirety (that is, by employing a macroscale level of analysis), and consider the length of time of human occupation of this region (which is short by geologic standards), it is reasonable to assume that the major plant communities manifested spatial continuity through time. That is, I argue that the same types of plant communities that are found today within the study area were also present at least during the last few millennia and that in a general way, the present day and ancient zonal boundaries are somewhat isomorphic. This assumption is based on the idea that the major controlling factors of plant communities, such as topography, soils, radiant energy and water availability, have not changed <u>radically</u> within the time span of the known archaeological record for the area.

I wish to emphasize that I am not proposing that the environment of the Upper Grijalva Basin has remained totally unchanged during the course of human occupation. It most certainly has not. Specifically, I do not believe that within any particular plant community there has been unwavering floristic continuity through time. Humans, as well as other agents, have unquestionably altered the makeup of communities through the application of various forces of selection. My argument is simply that whatever specific changes have occurred, they have not been so great as to make the plant communities totally unrecognizable. I also hope to avoid the misunderstanding that specific zonal boundaries are believed by me to have remained absolutely fixed through time. As I discuss below, there is evidence that such was not the case, although at present we can only guess at the nature of specific changes. Nonetheless, the evidence does indicate that it is logical to assume the expansion of some plant communities at the expense of others during the time under consideration.

This study, then, has been predicated on the assumption that the identification of present day plant communities in the Upper Grijlava Basin provides some insight into the past environment of the same region. This knowledge, although imperfect, can aid the archaeologist in the interpretation of settlement pattern data.

Previous Research

A number of investigators have discussed the vegetative types of Chiapas, but the amount of detail in their coverage is varied. Some researchers such as Goldman (1951), Goldman and Moore (1946), Gómez-Pompa (1965), Gonzales Quintero (1974), Leopold (1950), Miranda and Hernandez (1963), Pennington and Sarukhan (1968), and Wagner (1964) discuss vegetation types for all of Mexico or even larger territories. Consequently, the treatment of Chiapaneca vegetation is necessarily superficial and the vegetation of the Upper Grijalva Basin is not distinguished. Maps accompanying these studies are too small to be adequate for my purposes.

Both Breedlove (1973) and Miranda (1952, 1975) focus exclusively on the vegetation of Chiapas, and therefore these studies have been particularly valuable as aids in the present research. Both of these authors discuss the phytogeography of the state, although they employ different systems for classifying vegetation. Miranda, in addition, provides a wealth of ecological and ethnobotanic information on individual plant species.

Miranda (1975:14) has produced a vegetation map of the entire state of Chiapas, but it is too generalized to permit a useful comparison with the archaeological map of the Upper Grijalva Basin. Thus, the most detailed existing map of vegetation zones is too gross for our purpose.

Definition of the Study Area

The study area is located in the southwestern part of the state, adjacent to the Guatemalan border and is defined by the limits of the municipalities of La Trinitaria, Chicomucelo, and Comalapa (Figure 1). This is the area in which the New World Archaeological Foundation has conducted a settlement survey and subsurface investigations at selected sites. The region is approximately 3700 sq/ km/ in area.

Physiographically, the study area includes a broad, flat basin which forms the eastern portion of the Central Depression of Chiapas. This NW-SE trending basin is occupied by the uppermost portion of the Grijalva river. The northeastern side of the valley ascends toward the Central Plateau in a series of terraces, the lowest of which are included within the study area. The southwestern side of the valley rises sharply to form the Sierra Madre of Chiapas. The lower slopes of this are also included in the region of study. Figure 2 shows a profile section of the valley taken along the transect A-B (Figure 3). A detailed description of the geography of the region has been written by Helbig (1964).

The altitudinal variations, combined with extreme variations in the availability of water, produce a situation in which the diversity of vegetation formations is high. Within the region, contrasts in vegetation abound; swamp formations are found not far from parched thorn thickets, and cool climate pine forests are near to the hot climate evergreen tropical forests. Before describing the vegetation formations in detail I will discuss the methods of investigation.

METHODS

The investigation was carried out by Alejandro Sanchez and myself during two short field seasons in 1977. The first field work took place from mid-February through March during the height of the dry season

(November through May). The second period of investigation was in September during the wet season (June through October). The six month separation between the two phases of the study permitted us to investigate the vegetation during each of the two major seasons of the annual cycle.

Our method of studying the vegetation consisted of 1) describing the local vegetation and collecting herbarium specimens at particular sites, and 2) making observations on vegetation type and plotting these on aerial photographs.

The sites where detailed descriptions were made were chosen in such a way that the major vegetation classes would each be sampled (but no formal method of site survey was employed). At these locations I filled out a field data sheet with entries for the edaphic features of the site and the structure and floristic composition of the vegetation. Photographs in both black and white and color frequently were taken. The locations of sites where botanic field sheets were filled out, or in a few cases where only photographs were taken, are shown by the numbers in the accompanying map (Figure 3), and are identified in Appendix II. A few numbers were accidentally skipped in the field and consequently do not appear on the map.

The identification of plants in the field was done by A. Sanchez, who as a native Chiapaneco with an interest in local flora, was able to identify a large number of dominant species by local names. Sr. Sanchez's home is Chiapa de Corzo, a town located outside the study area and inhabited predominately by Spanish speaking people of Chiapanec descent (Navarrete 1966). Sanchez is himself a descendant of Chiapanec speakers so that his linguistic labeling of plants presumably reflects this heritage.

In addition to this procedure, whenever possible we would waylay local individuals and query them about the names of plants, but informants were not used either systematically or frequently. This is because we rarely encountered knowledgeable and cooperative passersby when working at a station because we tended to work at locations that were somewhat distant from villages. These relatively remote locations are where vegetation appeared to be less disturbed compared with areas closer to population centers. In short, we did not attempt to produce a systematic ethnobotanic study.

We also collected herbarium specimens which were numbered by location and named by Sr. Sanchez wherever possible. These specimens were sent to D.E. Breedlove of the California Academy of Sciences for identification and curation. The results of Breedlove's work are reported in Appendix II.

Mapping was carried out continuously as we traversed the area by truck. Observations of vegetation type were plotted onto transparent sheets covering air photo mosaics. The mosaics are at a scale of approximately 1:20,000. They were constructed of aerial photographs taken by Cia. Mexicana Aerofoto, an aerial photography company based in Mexico City. In general, the scale of the photo mosaics and their quality were adequate for my objectives. The principal difficulty in using these photographs as base maps was that some of the roads that were traveled had been constructed since the photographs were taken, and because of this, it was sometimes difficult to accurately determine ground location on the photographs.

The major vegetation units that have been mapped are FORMATIONS [1] as defined by Beard (1944). As Breedlove (1973:149) has previously stated, Beard's classification system of vegetational formations is remarkably adequate for Chiapas. As defined by Beard, a formation consists of climax communities that are similar in structure and life form. For example, the formation that Beard (1944:136) considers optimum within the American tropics is the Rain Forest. The characteristic features of this formation is the arrangement of the forest into three or four tree strata. Additional characteristics of the Rain Forest formation is the long clean boles of the dominant trees, the lack of lianas, and the accumulation of epiphytes in the upper rather than the lower strata. Thus, the defining characteristics of particular formations concern their physiognomies, rather than their floristic composition or other characteristics. The formations that have been identified in the study area and their diagnostic characteristics are presented in Results and Interpretations. The relationships of these and other formations are diagramatically shown in Figure 4.

RESULTS

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[1] Beard (1944) has proposed a taxonomic system for classification of tropical vegetation in the Americas and the formation constitutes one taxon within this scheme. Formations are subsumed under the taxon named FORMATION-SERIES, a more inclusive taxon that classes habitats. In Beard's (1944:133) view, formation-series are ecologically controlled most significantly by moisture relations. Accordingly, formations are combined to form Formation-series on the basis of similar moisture conditions. However, I have not attempted this classification in the present study.

Formations are composed of plant communities that are floristically uniform and these are known in Beard's system as ASSOCIATIONS. An association is defined as the maximum community that is floristically uniform and is often named for one of the principal dominants in the community. The association is a taxon in Beard's classification that is subordinate to the Formation taxon. I have collected some data on the associations within the field area. However, these data were not systematically collected for the study area and boundaries of associations were never determined. They are not reported here.

In this section I describe each of the formations that has been identified within the study area. In addition, I discuss the spatial distribution of each formation that is graphically displayed in Figure 3.

OPTIMUM FORMATIONS

No optimum formations (sensu Beard 1944) are located within the study area. The reason for this is that the climate of the Upper Grijalva Basin is sufficiently dry to prevent the development of either Tropical Rain Forest or Lower Montane Rain Forest (cf. Figure 4), that is, the optimal formations expected on the basis of altitude. However, the seasonal formation Evergreen Seasonal Forest, which in many ways resembles Tropical Rain Forest, is present and will be discussed in the following section.

SEASONAL FORMATION SERIES

Evergreen Seasonal Forest, Altitude 0-1200 m.

Superficially this formation is similar to the Rain Forest formation, but it differs in having fewer distinct tree strata. According to Breedlove (1973:158) there may be only one tree layer, although two layers are probably more characteristic. The canopy is closed and reaches a height of 14-30 m, which is lower than the closed Rain Forest canopy (Beard 1944:138). Occasional large trees with diameters of 3 meters or more may emerge above the closed canopy to a height of 35 meters.

During the marked dry season the forest floor becomes dry and there is great seasonal variation in the low story of herbaceous plants. In addition, during the dry season some or all of the trees of the upper stratum may experience leaf-loss. These trees are facultatively deciduous in that the degree of leaf-fall varies with drought intensity (Beard 1944:139). Lianas and epiphytes are usually quite abundant and the flora is fairly rich, with 50-80 tree species per association (Beard 1944:139).

Beard (1944) distinguishes between an Evergreen Seasonal Forest and a Semi-evergreen Seasonal Forest but Breedlove (1973:158) considers this split meaningless because of the large zones in intergradation in Chiapas. I have not attempted to separate the two forests but have followed Breedlove in utilizing only a single category. However, I do distinguish two forms: 1) a gallery variety proximate to water courses on the bottom of the depression and 2) a second variety found on the limestone foothills of the southern part of the study area.

The present distribution of the gallery variety of Evergreen Seasonal Forest formation within the study area consists of several widely separated stands, each of which is restricted in extent. These forests are shown by the dark brown areas on the accompanying map (Figure 3). They occur generally in the tributary drainages of the uppermost Grijalva system. The stands are found only in protected areas where the water table is high, often in association with surface water as in the case of the Lagartero forest (Site 16; see Figure 5), which is near a swamp, or the Guajilar forest (Site 73) which fringes the banks of the Río Santo Domingo. Miranda (1975:73), in discussing these forests of the Central Depression, mentions that they are also found on deep soils.

At the present time these patches of Evergreen Seasonal Forests provide hardwoods for use by the local population. The stands are too small to support a major export lumber industry. Miranda (1975:73-74; see also Wagner 1964:248) believes that in general this class of forests in

Chiapas has been subjected to unyielding interference by the human population. In his opinion much of this forest has been removed for agricultural purposes because it is found on deep, fertile soils in areas which are comparatively healthy (compared to Rain Forest) because of the presence of a distinct dry season. The former extensions of these forests are indicated by the presence of occasional guanacaste trees (Enterolobium cyclocarpum) and ceiba trees that have been selectively left standing in otherwise cleared fields. Such isolated large trees are encountered within the study area and provide clues to the climax vegetation which has been otherwise totally removed.

Another type of Evergreen Seasonal Forest is located in the middle elevations of the mountains which lie in the southern portion of the study area (Figure 6). This formation is shown in light green on the accompanying map (Figure 3). The forest is ecotonal and intergrades with oak forest within the study area (Breedlove, personal communication). It forms over limestone bedrock especially on hills in the southeast portion of the study that area have the characteristic form of haystacks. In the case of the Evergreen Seasonal Forest of the middle elevations, it is the abundance of rainfall, rather than a high water table (as in the gallery variety) that determines its presence. In many places the native vegetation has been partially removed in order to grow coffee.

Tropical Deciduous Forest, Altitude 0-1200 m.

This two-storied formation normally attains a height of 10-20 m. and exhibits a dense thicket-like understory. In some riparian situations the trees reach a height of 40-50 m. and have straight trunks. The understory is sparse (Breedlove 1973:159). The formation is floristically diverse, with 30-50 species of trees per assocation. Lianas and epiphytes are present but less abundant compared with the Evergreen Seasonal Forest formation. During the long and severe dry season the majority of trees lose their leaves as do many of the understory plants (Figure 7). Many trees flower at this time (Breedlove 1973:159). During the rainy season the forest becomes verdant; a dense stand of herbaceous plants reaches a height of 1-2 m.

Beard (1944) refers to this formation as Deciduous Seasonal Forest, whereas Miranda (1975) uses the term Selva Baja Decidua.

Tropical Deciduous Forest is the most widespread formation within the study area. It is the characteristic vegetation over most of the broad basin of the Upper Grijalva depression as is shown by the light brown zones in the accompanying map (Figure 3). It is the climatic climax vegetation of the basin forming on rocky or shallow soils (Miranda 1975:84). Consequently, its local absence is due either to removal for cultivation or pasture, or because of the presence of hydrologic or edaphic features that favor other formations within a restricted area. It is also found on the lowest slopes of both the southern escarpment of the Chiapas Plateau and the northern escarpment of the Sierra Madre.

Short Tree Savanna, Altitude 0-1200 m.

This formation consists of widely spaced low trees which may have a grass understory (Figure 8). It is commonly found on deep, poorly drained soils on gradually sloping plains or flat bottomlands (Breedlove 1973:159). During the rainy season savanna soils tend to be waterlogged because of their poor drainage, whereas they are very dry in the dry season (Miranda

1975:94). The trees are gnarled in appearance and rarely attain a height of over 20 m. (Breedlove 1973:160).

The trees of this formation are not floristically diverse and there is a tendency for stands to be monospecific. In Chiapas (Miranda 1975:95-98) the most common short tree savannas have one of the following species as the dominant:

1. Brazil (Haemotoxylon brasiletto), (Figure 9)
2. Espino (Acacia pennatula)
3. Gorgojo or Siete Pellejos (Ateleia pterocarpa)
4. Hojaman or Cacaito (Curatella americana), (Figure 10)
5. Morro or Jicara (Crescentia cujete and Crescentia alata), (Figure 11)
6. Nanche (Byrsonima crassifolia)
7. Quebracho (Acacia milleriana)

It is not known whether Short Tree Savanna is an edaphic climax formation or whether it is a disclimax due to human activities. Miranda (1975:95-96) discusses the problem of origins of this formation. He observes that these savannas are periodically burned by local farmers and that occasionally islands of Tropical Deciduous Forest are found within the savannas on identical soils. These observations lead him to the conclusion that a large part of the present day savannas were once vegetated by Tropical Deciduous Forest (Miranda 1975:95).

The distribution of Short Tree Savanna within the study area is indicated by orange-brown zones (Figure 3). It occurs on the first terrace of the Chiapas Plateau SW of La Trinitaria, and over a wide area in the vicinity of Colonía Las Delicias. This latter region is a highly dissected zone that is intensively grazed and farmed. The underlying white soils appear to me to be very infertile.

Pine-Oak Forest, Altitude 1200-1400 m.

This formation usually consists of mixed stands of pine and oak but pure stands (Figure 12) of either can occur under special edaphic conditions (Breedlove 1973:161). Tree height ranges from 15-40 m. Epiphytes are sparse to common, but heavy only in canyon situations. The understory is herbaceous with occasional shurbs and low grassy patches between the trees (Breedlove 1973:161). This formation is predominant in Chiapas between 1,300 m. and 2,500 m. Occasionally the formation is found as low as 1,000 m.

Within the study area Pine-Oak Forest occurs on both escarpments fronting the Central Depression. It is shown in dark green on the accompanying map (Figure 3). The lower slopes of the Central Plateau that are included within the study area are vegetated with a scrub oak association rather than with tall oak or pines. Tall trees do occur on the same slope at higher elevations than have been included on the map. On the northeastern slopes of the Sierra Madre, the Pine-Oak Forest is fully developed within the study area and the scrub oak association is not present (Figure 13).

WET-LAND FORMATION SERIES

Palm Forest

This restricted formation contains palms as the predominant tree and has a sparse understory. The height of the palm ranges from 24 m. to 40 m.

and individuals can be closely spaced (Breedlove 1973:162). The formation occurs on sandy, alluvial flats and terraces on poorly drained soils (Breedlove 1973:162). The soils tend to be deep and they become waterlogged during the rainy season (Miranda 1975:98). Within the study area the palmares are dominated usually by the palma real (Sabal mexicana; Figure 14) but sometimes by coyol (Acrocomia mexicana; Figure 15).

The distribution of the Palm Forest within the study area is indicated by dark yellow on the accompanying map (Figure 3). Most of these forests are located north of the Río Grijalva at the base of the Central Plateau.

Miranda (1975:98) discusses the similarity between the conditions producing Short Tree Savannas and Palm Forests and the fact that the two formations can occur as a mixed formation. In addition, Miranda points out that the Palm Forest species are resistant to repeated dry season burnings.

Riparian Formations

All riparian formations are shown in blue in the accompanying map (Figure 3). In the higher elevations of the Central Plateau and Sierra Madre a Temperate Riparian Forest formation occurs above 1500 m. (Breedlove 1973:162). Trees range between 10 to 25 m. in height and very pure stands can sometimes be found. In the study area the predominant tree is locally known as alamo (Populus arizonica; Figure 16). The understory is dense and thicket-like.

At lower elevations within the study area, giant bald cypress (Taxodium mucronatum) stand in the beds of perennial streams (Figure 17). Miranda (1975:135) writes that these trees can occur between 500-1,200 meters. An understory of willow thickets is also present (Wagner

1964:263). At the same elevations a variety of Evergreen Seasonal Forest can fringe watercourses that contain intermittent streams.

TREELESS FORMATION-SERIES

Herbaceous Marsh

Herbaceous Marsh is a restricted formation that consists of a herbaceous cover on shallow standing water. Within the study area the associated species are characteristic of temperate marshes. Breedlove (personal communication) lists the following species as generally typical:

(*Cladium jamaicense*)

(*Cyperus spp.*)

(*Ludwigia peruviana*)

(*Lythrum vulnearia*)

(*Rhynchospora spp.*)

(*Typha latifolia*)

Herbaceous marsh occurs only in two patches within the study area at the eastern end of the Central Depression. The formation is shown in red on the accompanying map. The northernmost location is a bog which is seasonally farmed (Figure 18). In the south, the marsh is associated with open water and is perpetually wet. Using Beard's criteria (1944:148), at this location the formation is more accurately described as swamp as he prefers to use the term marsh for situations where inundation is seasonal.

Grassland

A grassland formation occurs on both the western portion of the escarpment of the Central Plateau and the northern escarpment of the Sierra

Madre (Figure 19). It is shown on the map (Figure 3) by light yellow. These grasslands occur at the same elevation at Pine-oak Forest (2,000-4,000 m.) and may be due to frequent burning (Miranda 1975:136).

CONCLUSIONS

I have identified eight vegetation formations within the Upper Grijalva Basin study area following the criteria established by Beard (1944). Within the basin bottomlands, the most widespread formation is Tropical Deciduous Forest, a type of hot country forest which is found where a definite and fairly long dry season occurs. Within the basin this predominant formation is locally replaced by any one of five different formations as a result of either differences in soil nutrients or water availability. For example, the local availability of water produces the linear riparian formation that fringes the major water courses. This factor is also responsible for the Evergreen Seasonal Forest formation which occurs in zones in well-watered and well-drained bottomlands. Abundant water but poor drainage are the significant ecological factors responsible for the local presence of both Palm Forest and Herbaceous Marsh. Since these limiting conditions do not occur widely in the study area, each of the two formations is restricted in extent. Poor drainage is responsible also for the development of the Short Tree Savanna but in addition, I suspect that relatively infertile soils are implicated in producing this formation.

On the slopes of the escarpment of the Central Plateau scrub oak gradually gives away at higher elevations to a fully developed Pine-Oak Forest. In places the Pine-Oak Forest is interrupted by zones of grassland which may be the result of human interference with the climax vegetation but also could be the local climax.

The lower and middle elevations of the escarpment of the Sierra Madre de Chiapas and the Altos Cuchumatanes are vegetated with Evergreen Seasonal Forest, giving way at higher elevations to Pine-Oak Formations. Grasslands are present also in some locations similar to those across the valley.

The present day distribution of vegetation formations may not be absolutely identical to those encountered by the earliest human occupants of the basin. In particular, it is possible that the effect of millenia of human interference with native vegetation has reduced the extent of the gallery variety of Evergreen Seasonal Forest and has extended the areas covered by both Grassland and Short Tree Savanna. The possibility of these changes must be considered in the evaluation of the human settlement pattern of the area.

The potential economic importance of each of the identified vegetation zones is difficult to evaluate. In the first place I have not collected and reported the economic uses of plants. Miranda (1963), however, provides much information on economic botany for a large number of species. Second, the economic potential of plants varies for human populations at different stages of economic development. For example, preferred locations for mobile foraging groups might be places which combine water availability with maximum accessibility to multiple habitats. Accordingly, foragers might prefer locations that maximize access to multiple zones when all other factors are equal. Agricultural communities, in contrast, might seek out locations where a single set of factors combine to produce favorable farming conditions as well as availability of water. Consequently, such peoples would prefer to locate within certain zones favorable for farming, rather than toward zone peripheries. However, agricultural communities might tend also to maximize habitat diversity wherever feasible, because of the necessity of certain critical products such as palm or grass for thatch, lumber for construction, etc.

These considerations lead me to predict that the earliest and largest farming communities within the study area should occur along the major drainages, especially where Evergreen Seasonal Forest, gallery variety or Tropical Deciduous Forest are present, since these zones appear to have high potential for farming. Early farming communities may have avoided Grasslands and Short Tree Savannas (if prehistorically present) for habitation locations both because of the absence of water and apparent low agricultural potential. These zones may well have been economically exploited but on an occasional rather than continual basis. Palm Marsh might also be a less preferred habitation habitat because of annual flooding, but access to Palm Marsh could have been selected for because of the economic importance of palms (for thatch, baskets, mats, etc). Herbaceous Marsh would be a low preference for direct human habitation particularly where there is abundant dry land for the situation of houses. However, the marsh environment provides water, as well as plants and animals of potential economic importance so that habitation near to the Herbaceous Marsh would be readily explicable.

These brief initial considerations will be examined in greater detail in Chapter _ of the present volume.

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Figure 1	Map of Chiapas with physiographic regions outlined (after Mulleried 1957). Location of study area is shown by shading.
Figure 2	Profile section of Upper Grijalva Basin along transect A-B. Vegetation formations are indicated by sketches which are not to scale.
Figure 3	Map of vegetation formations in the Upper Grijalva Basin. Numbers refer to study stations (see Appendix II).
Figure 4	Diagrammatic representation of the vegetational formations of Chiapas (from Breedlove 1973:154).
Figure 5	Evergreen Seasonal Forest formation. Site 16 at Lagartero.
Figure 6	A relic stand of _ramon_ (_Brosimum alicastrum_) in middleground at Site 38. This is an example of Evergreen Seasonal Forest. In the foreground is a recently cleared area whereas Tropical Deciduous Forest covers the hills in the background.
Figure 7	Tropical Deciduous Forest at Site 19 during the dry season.
Figure 8	Short Tree Savanna at Site 8.
Figure 9	Short Tree Savanna formation at Site 18. Dominant tree is brazil (_Haematoxylon brasiletto_). Note the extremely rocky soils upon which this formation is commonly found.
Figure 10	Hojaman Short Tree Savanna near El Ocote. Pines are on ridge in the background.
Figure 11	Short Tree Savanna formation. The dominant tree is bottle quord (_Crescentia_ sp.)
Figure 12	Pine-oak Forest formation. Homogeneous stand of oaks at Site 50.
Figure 13	Pine-oak Forest formation. Taken at Site 47 near Tapezala. A _fresno_ tree (_Tabebuia pentaphylla_) is in the right foreground. The lower boundary of pine-oak forest formation is in the center of the photograph.
Figure 14	Palm Forest formation at Site 17. Dominant tree is _Palma real_ (_Sabal mexicana_).
Figure 15	Palm Forest formation near Site 51. Shows cultivated grass and coyol palms (_Acrocomia mexicana_).
Figure 16	Temperate Riparian Forest formation at Site 41. The Río Yayahuita is fringed by _alamos_ (_Populus arizonica_) in the vicinity of Nueva Morelia.

Figure 17 Tropical Riparian Forest formation. Río Rincon Tigre with sabinos (*Taxodium mucronatum*) lining the river.

Figure 18 Herbaceous Marsh formation at Site 15. Marsh has rushes that have been partially cleared for cultivation (center of photograph). Sabinos fringe the marsh at center left and on the horizon. The Cuchumatanes mountains are in the background.

Figure 19 Grassland formation. View is off hills on the north side of the Río Yayahuita.

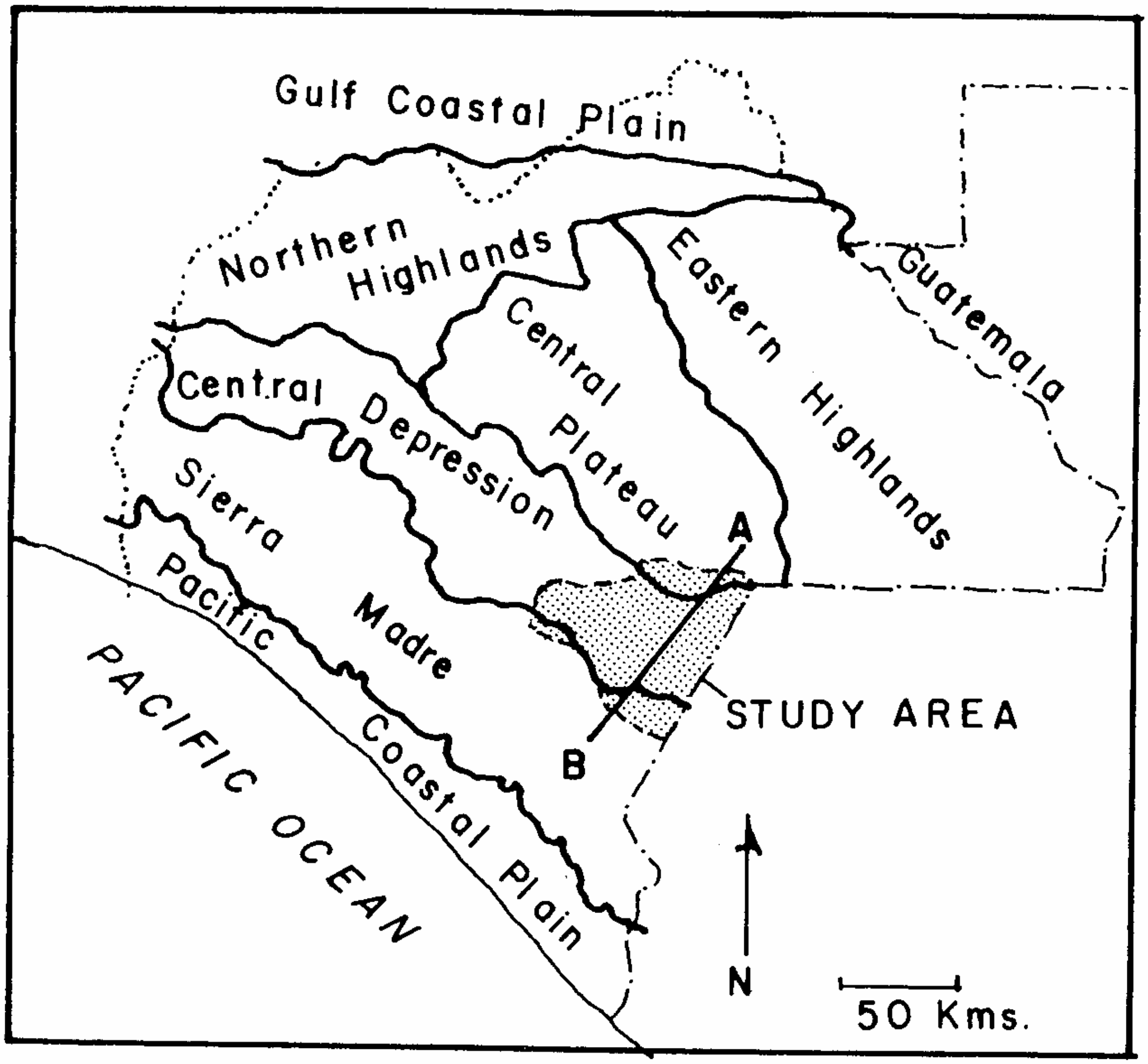

Gulf Coastal Plain
Northern Highlands
Eastern Highlands
Guatemala
Central Plateau
Central Depression
Sierra Madre
Pacific Coastal Plain
PACIFIC OCEAN
A
B
STUDY AREA
N
50 Kms.

Fig. 1.

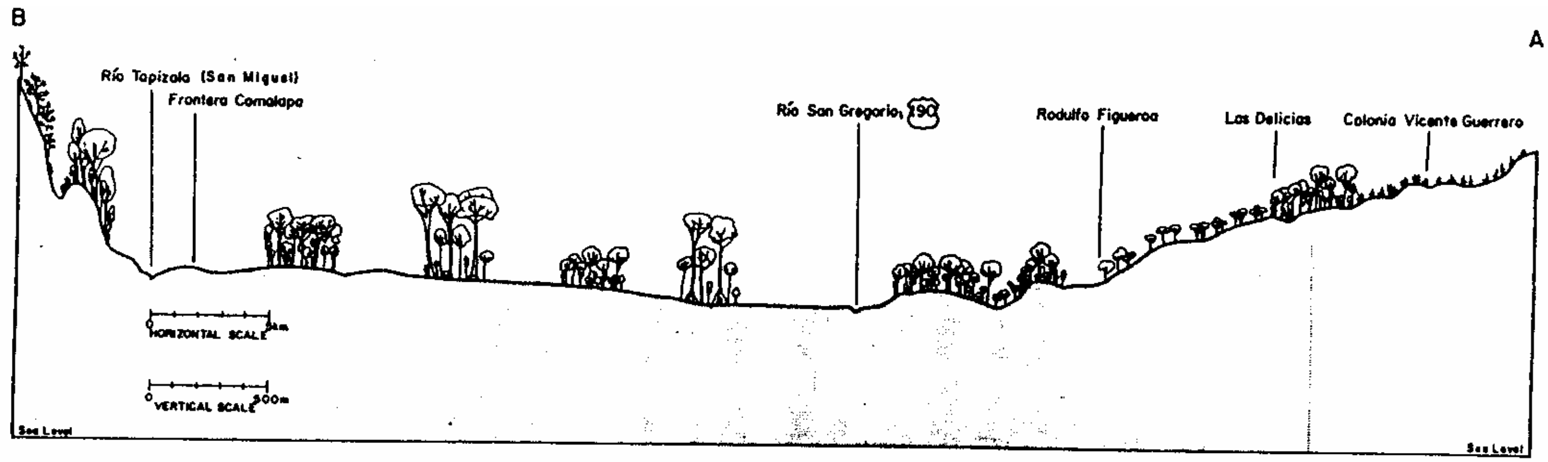
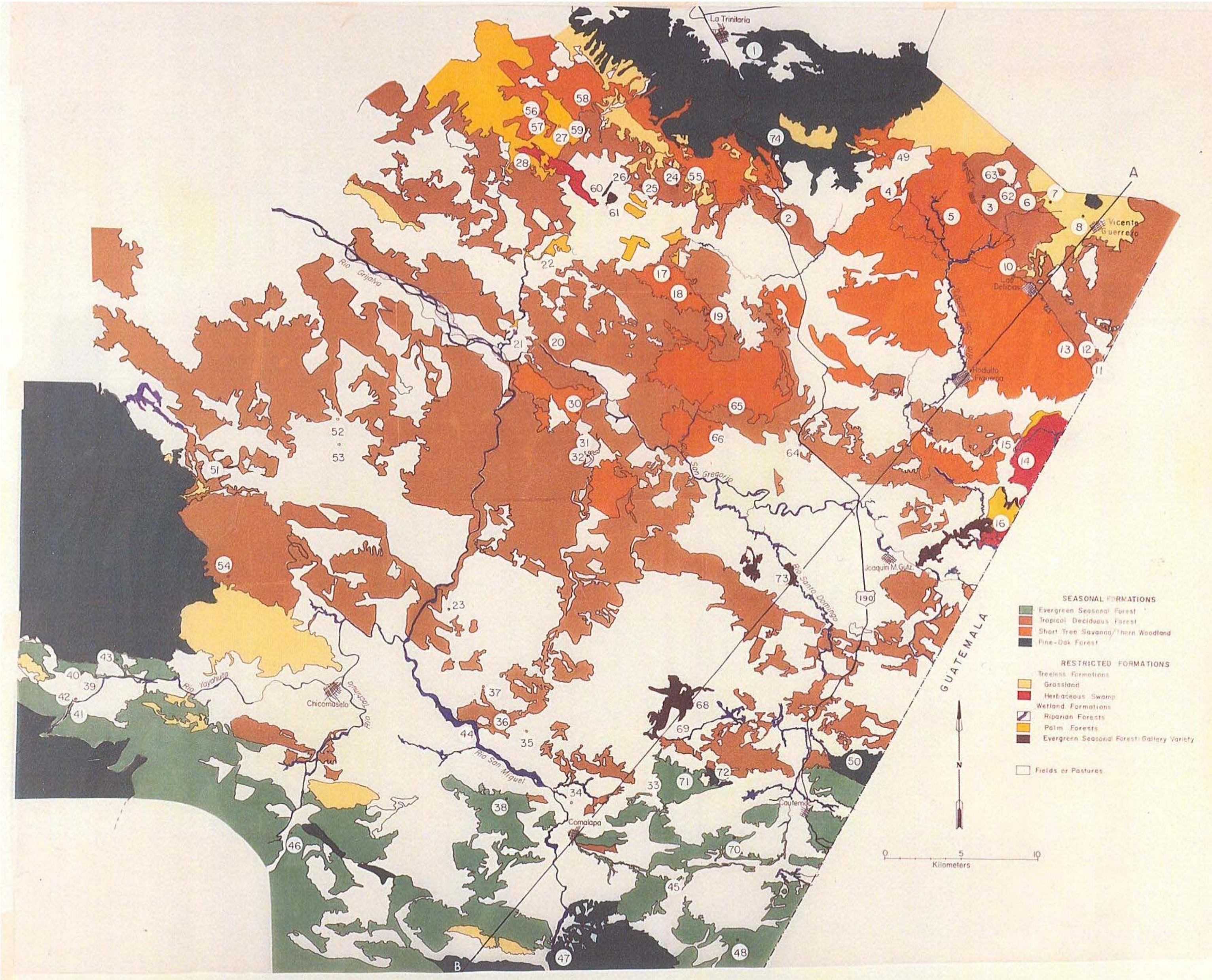

B
A
Río Tapizola (San Miquel)
Frontera Comalapa
Río San Gregorio, 190
Rodulfo Figueroa
Las Delicias
Colonia Vicente Guerrero
HORIZONTAL SCALE
VERTICAL SCALE
0
500m
Sea Level
Sea Level

Fig 2.



La Trinitaria
Vicente Guerrero
Delicias
Rodulfo Figueroa
Joaquin M. Gutz
Chicomuselo
Comalapa
Cuatemoc
Rio Grijalva
Rio Yayahuita
Rio San Miguel
Rio Santo Domingo
San Gregorio
190
GUATEMALA
A
B
SEASONAL FORMATIONS
Evergreen Seasonal Forest
Tropical Deciduous Forest
Short Tree Savanna/Thorn Woodland
Pine-Oak Forest
RESTRICTED FORMATIONS
Treeless Formations
Grassland
Herbaceous Swamp
Wetland Formations
Riparian Forests
Palm Forests
Evergreen Seasonal Forest: Gallery Variety
Fields or Pastures
N
0 5 10
Kilometers

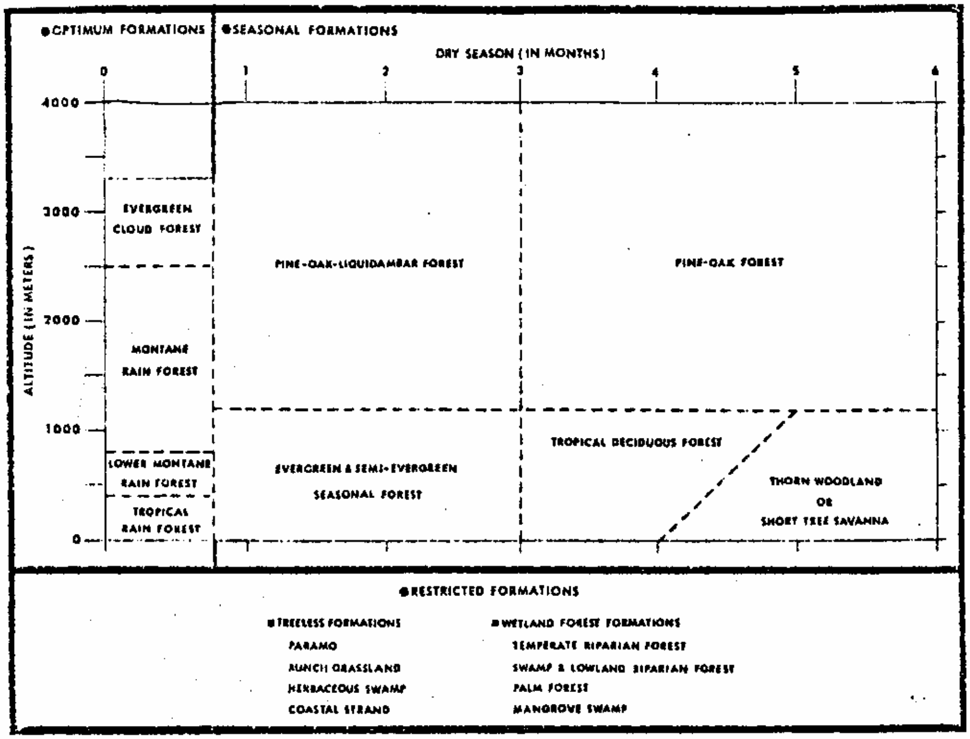


Fig. 4. Diagrammatic representation of the vegetational formations of Chiapas (from Breedlove 1973:154).

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