WATER AND THE MOUNTAINS: MAYA WATER MANAGEMENT AT CARACOL, BELIZE

by

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ABSTRACT

Water management techniques in the Southern Maya Lowlands are both regionally diverse and site specific. This thesis examines the water management strategies of the Classic Period Maya at the site of Caracol, Belize. While it is likely that elites at Caracol controlled the redistribution of resources, i.e. craft and agricultural products, it is probable that the production of agricultural resources and the maintenance of water resource acquisition took place on a more local level. In order to test this hypothesis, a sample of five reservoirs were examined through original research – and situated in conjunction with past settlement studies - to determine the water storage capacity and likely function of different water management features throughout the built environment of Caracol. As a result, this thesis argues that the placement and construction of water management features - i.e., reservoirs - at the site of Caracol, Belize are indicative of specific landscape patterns which are expressed by a distinct vernacular construction style and are also a reflection of the socio-political organization present within the site during the Late Classic Period.

ACKNOWLEDGMENTS

Archaeology is inevitably a team effort and this thesis would not have been possible without the help of several individuals. I would like to thank Drs. Arlen and Diane Chase for their support and advice not only in the field, but in the classroom as well. Their guidance has afforded me many opportunities that few people are able to experience. Many fellow graduate students also helped me during the research process of this thesis, specifically Andrea Slusser and Lucas Martindale-Johnson who spent much of their free time in the field taking compass and tape bearings even when those measurements inevitably took them through a thorny patch of undergrowth. Amanda Groff, Jorge Garcia, Lisa Lomitola and other members of the Caracol Archaeological Project also provided much needed moral support and advice. A great deal of thanks is warranted for Dr. John Walker who provided many helpful suggestions regarding my thesis. In addition, I would like to thank Meggan Jordan for her moral support throughout my time at U.C.F. and John Warner for his good advice and much needed levity.

Dedicated to Wayne and Sharon Crandall

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CHAPTER 1: INTRODUCTION

Mesoamerica's physical environment presents challenges so daunting to sustainable agriculture that it is a wonder that the Classic May developed such complex social, political, and cultural achievements. The ancient Maya overcame geographical hardships through cultural means in order to thrive. The Classic Maya created unique representations of art and architecture that depicted both the physical and metaphysical world. Archaeological scholars in the past have debated the degree to which environmental limitations affected the development of Classic Maya social complexity (Turner 1978). Recent studies of Maya sites have employed a comprehensive settlement approach to mapping and site testing, thereby revealing the true urban nature of Classic Maya cities (A. Chase et al. 2002). Not surprisingly, studies throughout the Maya world have uncovered diversified water management systems. These constructs were designed to solve practical problems such as groundwater seepage and water accessibility at Maya cities like Edzna (Matheny et al. 1983), Tikal (Scarborough and Gallopin 1991), and Copan (Davis-Salazar 2001) (Figure 1). Scholars investigating Maya sites have noted these types of alterations in the physical environment for sometime (e.g. Matheny 1978). Yet only recently have these alterations been scrutinized by anthropological and interdisciplinary studies (Scarborough 2006: 224-225).

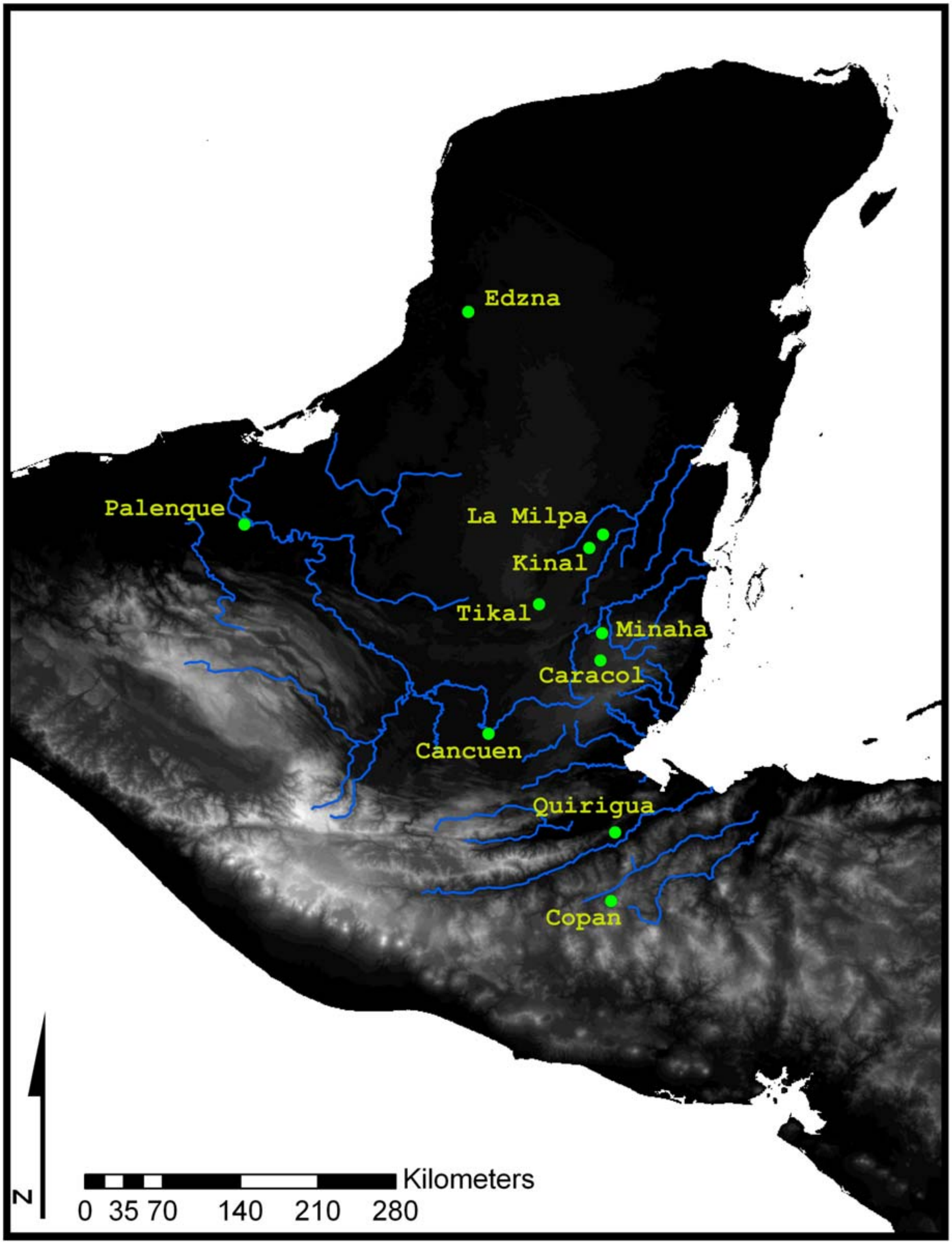

Figure 1: Overview map of the Maya lowlands and sites mentioned in the text

Today Caracol, Belize, a primate center for a former Maya polity, is covered with thick vegetative undergrowth and shaded by tall trees that form the extensive tree canopy of a tropical forest. Navigating the jungle floor can be treacherous business during times of heavy rains; the ground surface develops a universally muddy viscosity which is exaggerated by the presence of leaves detached from the tree canopy above. Moreover, safe travel through this terrain is hampered by creatures who find themselves flooded out of their underground dwellings. The terrain throughout much of Caracol is a contrast of narrow gorges and steep inclines (Figure 2). Low lying mountains contain the artificially altered landscape where the people of Caracol constructed houses and temples in antiquity. Surface springs have been detected in the area; however the closest lies some 4km to the west at Valentia Camp (Arlen Chase personal communication 2009). The closest source of perennially flowing water is the Macal River system, which lies some 20km distant from Caracol's epicenter. The surrounding environment of Caracol is greatly affected by the 3 1/2 month dry season, roughly from mid-January through April, when surface water becomes scarce within natural surface depressions. The Classic Maya of Caracol altered their natural environment by constructing reservoirs and areas of water catchment in order to serve the agricultural and domestic needs of an urban populace during this dry period and the rest of the year.

Some of the first archaeological investigations at Caracol revealed a site that did not conform to previous concepts of Maya site organization. Although limited early investigations during the 1950's concentrated on the monumental architecture and removal of artwork present within the site's core (Beetz and Satterthwaite 1981); later investigations (Healy et al.1983) discovered vast networks of terracing that subdivided the residential house groups outside of the epicentral zone of the site. At the time of this discovery patterns of research in Maya archaeology were moving away from a focus solely on monumental palaces and temples towards an examination of the quotidian existence of the ancient Maya. This shift in focus towards a comprehensive view of site patterning and organization allows archaeologists to better study the social divisions, political relationships, and everyday agency that mold our perception of the past.

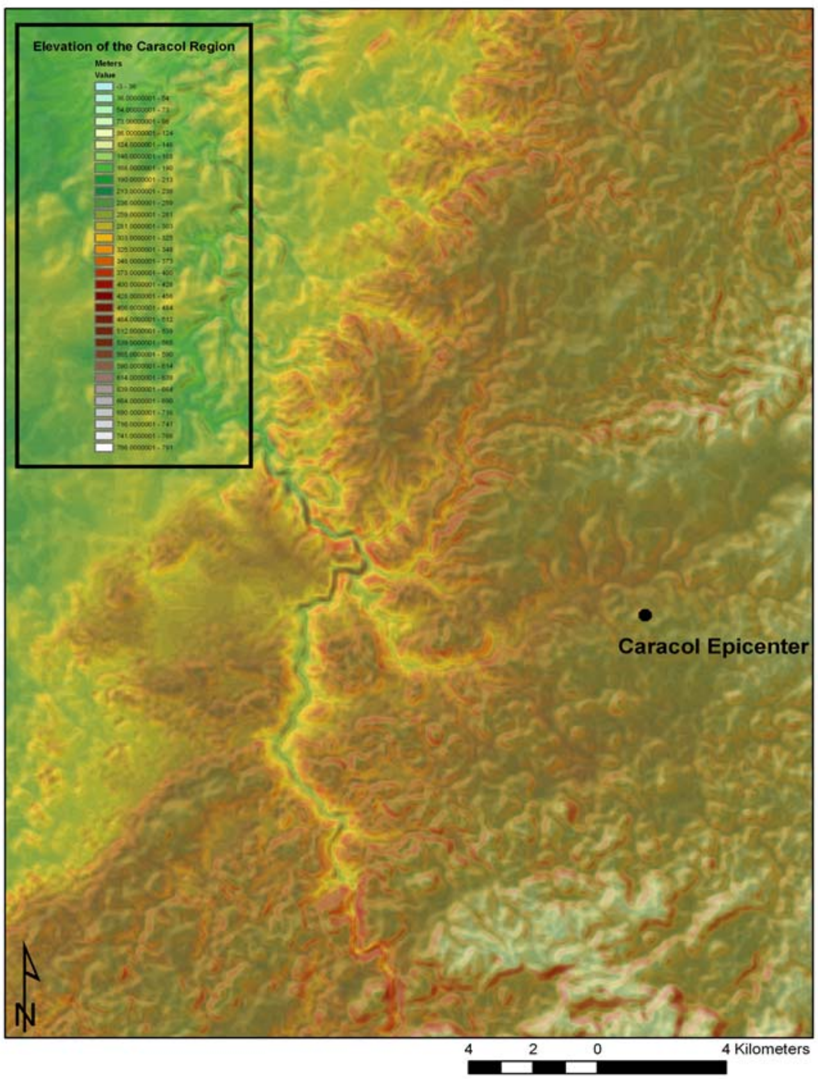

Figure 2: DEM of Caracol created from SRTM Data

Archaeological evidence recovered from twenty-five years of continuous research by the current Caracol Archaeological Project has unveiled a clearer view of how Classic Maya states operated internally. Extensive mapping efforts and settlement analysis at Caracol have revealed that the expression of the urban environment at Caracol consists of an intricate web of domestic activity interspersed with labor invested features where intensive agriculture took place within the boundaries of the city itself (A. Chase and D. Chase 1998:61). Although the economy of the site is still being investigated (Martindale-Johnson 2008) it is likely that internal markets existed within the site itself. A. Chase and D. Chase (2004a) have argued that distribution centers located along the constructed road system at Caracol were likely representative of an internal market economy, despite the difficulty of examining marketplaces archaeologically. They (2004a:118) further suggest that craft production took place at the household level. An extensive investigation of the integrated agricultural features at Caracol suggests that terraces and other complex agricultural features of this integrated environment were also likely maintained at the household level (Murtha 2002:297). It is following this line of evidence that I suggest the majority of water management features at Caracol were also likely constructed and maintained at the household level.

Epigraphic evidence at Caracol has been recovered from a number of contexts similar to that of other sites in the Southern Maya Lowlands. Glyphs are depicted on carved stelae, altars, painted ceramics, and fragmented stucco facades that once covered the upper portions of many epicentral structures. These texts have illuminated scholarly interpretation of the Classic Maya in terms of the way the Maya at Caracol and other sites viewed the world around them. However, these texts are often incomplete and at best give a narrow viewpoint into the lens of prehistory. Inscriptions on public monuments, such as stone stelae, are the most elaborate historical records available from the Maya, yet the recorded information is limited to elites vested with power and interested in projecting such representations of power upon the populace which they ruled (see Marcus 1992).

Retrospective texts from the Late Classic period at Caracol suggest that a privileged group of individuals came to power at some point during the fourth century A.D. (Chase et al. 1994; Martin and Grube 2000:86). Inscriptions and iconography found throughout the site indicate that these individuals or elites embodied both a religious and political authority which lasted throughout much of the Late Classic Period. Altar 21, a large stone monument recovered from an epicentral ballcourt, retrospectively indicates that Caracol defeated Tikal in the sixth century A.D., possibly inducing a Late Classic political hiatus at the latter site (Houston 1987: 93-94). While a series of individuals imbued with dynastic inheritance played a major part in Caracol's political history, during the early part of the Late Classic Period, a complete chronology of the site's political rulership is fragmentary and several periods remain epigraphically undocumented (Martin and Grube 2000: 85-99). During the late ninth century A.D. the site's written record of ceases; however, occupation of the site continued well beyond its written record through the end of the Terminal Classic period (D. Chase and A. Chase 2000:75).[1]

Research for this thesis was carried out under the general aegis of the Caracol Archaeological Project supervised by Arlen and Diane Chase. My original interest in the water management features at the site of Caracol stems from a simple concern. Where was all of the water stored and how did the ancient Maya at Caracol compensate for a scarcity of necessary

[1] For a more detailed description of the epigraphic record and dynastic history of Caracol, Belize see (A. Chase et al. 1991, D. Chase and A. Chase 2008, Beetz and Satterthwaite 1981, Houston 1987, and Grube 1994).

resources? Access to water is a modern concern for members of the Caracol Project and Belizean caretakers who live at the site for extended periods of time. Previous research and mapping at the site of Caracol, Belize (A. Chase and D. Chase 1987, 1998, 2001a) have demonstrated that water management features do exist throughout the site despite the paucity of standing water; although several of these features had been previously investigated (Jaeger 1991), their relationship to Maya political and social organization was not fully defined.

During the 2007 field season, a project designed by the author and aided by several fellow graduate students, investigated several water management features at the site of Caracol in order to determine their volumetric carrying capacity as well as their specific functions within the Caracol built environment as they related to the social and political organization of the Late Classic Maya. Hence, the goal of this project is fourfold: 1) to identify those features that are characteristic of specific water management features and their respective volumetric carry capacities; 2) to identify what features the Maya at Caracol were constructing; 3) to define what function these specific water management features served; and finally, 4) to answer the question of whether those water management features associated with households were sufficiently large enough to sustain the Maya through the prolonged dry season without relying on large reservoirs likely controlled by elites. After an evaluation of Caracol's water management features, the data suggest that the Maya at Caracol adapted the landscape for two separate purposes: first, certain features present at Caracol represent adaptations for the purpose of improving the practice of rainfall agriculture; and second, other features represented adaptations to improve long-term storage of drinking water for the city's populace. When these features are viewed within the larger context of the built environment, it is clear that the majority of water management resources were maintained at a local level and not as an apparatus of the state.

Chapter Two discusses approaches to water management studies the have been utilized throughout Mesoamerica and the New World. In addition, this chapter examines what environmental strategies different groups cultivated under different social, political, and environmental constraints. Chapter Three explores original research undertaken at Caracol, Belize using this same focus of research. In addition to this data set, the specific methodology that was used is presented and the constraints on landscape research are explored in order to understand the specific limitations that are inherent to landscape studies under different environmental conditions. Chapter Four is a discussion section that explores previous postulations made by other scholars with regard to Maya water management and the implications that this discussion has for future research. I conclude with a final analysis of the data presented here and what definitive assertions can be made about the water management strategies of the Classic Maya at Caracol.

CHAPTER 2: WATER MANAGEMENT AND THE BUILT ENVIORNMENT

What is the built environment? Lawrence and Low (1990:454) define it as:

> "…any physical alteration of the natural environment, from hearths to cities, through construction by humans. Generally speaking, it includes built forms, which are defined as building types) such as dwellings, temples, or meetings houses) created by humans to shelter, define, and protect activity. Built forms also include, however, spaces that are defined and bounded, but not necessarily enclosed, such as the uncovered areas in a compound, a plaza, or a street."

The nature of the built environment is complex and distinct to individual cultures. Its structure and appearance is constantly negotiated by the needs and values that both individuals and groups enact upon its expression. However, its shape is determined by a multitude of coexisting political, social, and religious factors, as well as its functional nature. Archaeologists are often concerned with the physical features that make up the cultural environments which they study. As a result, archaeological work often consists of inferring meaning in the absence of language, where those individuals of the past cannot recount to modern peoples the importance of the material culture which they produced. It is at this point where it becomes necessary for anthropologists to examine culture on the most general level, where modern people can be considered as a focus of study in order to better develop an understanding of how individuals interacted with and built upon their environments in the past. The manner in which these built forms are constructed on the landscape is as varied as the limits of human expression. Jerry Moore (1996:10) has observed that in order for an anthropological approach to the built environment to be successful it must be understood as "…a culturally constructed landscape which, like other cultural dimensions, includes utilitarian and non-adaptive, innovative and conservative elements." By breaking down these elements and examining them within a specific cultural context it is possible to understand how past peoples utilized their environments. In some cases it may be possible to understand these specific elements within a larger social framework. Inferences also can be made about how past peoples viewed their environment and what meaning they placed upon it.

It is important to study the "built environment" because its expression reflects the epistemological underpinnings of archaeological research and interpretation. It is possible to scour the landscape through survey and to detect and record countless features in the landscape, but it is impossible to infer any meaning about what these features represent without an understanding of what these expressed features represented in the past. From a structuralist, functionalist, and social theoretical standpoint, Johnston and Gonlin (1998) have explored the question "what do houses mean?" Their argument is couched in the nature of the object or feature under study, where different architectural structures require different fundamental approaches. However, a similar question could be asked: "What is a Palace?" Are Classic Maya palaces symbolic representations of authority (Fash 1998:260): are they functional living spaces (Webster 1998:25): or are they spaces of socio-economic production (Inomata 2001)?; or, are they a combination of all three purposes (A. Chase and D.Chase 2001b)? In reality, they likely served multiple purposes and conveyed different intrinsic messages to outsiders. Much like houses and palaces water management features are merely another aspect of the built environment. Reservoirs, just like houses, can be studied in terms of their functional capabilities, their symbolic expression, and their importance to the socio-economic well-being of households and communities.

Amos Rapoport (1969:1) has observed that: "Architectural theory and history have traditionally been concerned with the study of monuments. They have emphasized the work of men of genius, the unusual, the rare." Focusing solely on monumental creations invites a limited perspective of anthropological and archaeological study. In his cross-cultural study of house forms, Rapoport (1969: 47) argues:

> "…that house form is not simply the result of physical forces or any single causal factor, but is the consequence of a whole range of socio-cultural factors seen in their broadest terms. Form is in turn modified by climatic conditions…and by methods of construction, materials available, and the technology…[where] the socio-cultural forces [are] primary, and the others secondary or modifying."

The causal relationship can be expanded to include the totality of the built environment. While the shape of the cultural landscape is inherently affected by environmental factors, the form in which it is expressed is inevitably determined by social action and interaction.

The urban environment is the pinnacle of social-environmental expression. Yaeger (2003a: 123) observes that, "…three aspects of the city - the center of larger social networks, a physical place, and a symbol of identity - cannot be meaningfully separated, because they all interrelate to structure social practice and thus affect urban development." Whereas the study of the built environment can be difficult in terms of social action and symbolic meaning, the functional nature of the built environment for practical purposes is often apparent. The study of water management features and their place within constructed urban landscapes is one manner of inquiry that can be viewed as symbolic, functional, and social.

A Review of Water Management in Mesoamerica

Water management features are one representation of the built environment. Usually, they are constructed to accommodate both agricultural and nonagricultural functions. The Maya altered their surroundings in order to meet specific needs; however, the form of both agricultural and nonagricultural adaptations varies in different regions of Mesoamerica. Scarborough

(2003:79-89) has identified nonagricultural water management features as serving the following functions: transportation; defense; drainage and flood control; ritual; and symbolic statements. In terms of transportation the construction of canals in order to transport marketable goods is a world wide phenomenon where environments are amicable. With the exception of Edzna (Matheny et al. 1983), it does not appear as though the Maya constructed canals large enough for transportation purposes; however, the Maya certainly took advantage of riverine systems of the Southern Lowlands for transportation purposes (D. Chase and A. Chase 1989). For defense, constructed features in this category are often represented as ditches surrounding defensive structures. Although defensive walls and palisades around Terminal Classic Maya sites are certainly visible in the archaeological record (Palka 2001:427-428), evidence of extensive ditch works for the purpose of defense is sparse (but see Webster 1976). Drainage and flood control systems are specifically designed to reallocate water away from community areas to prevent damage to infrastructure. Such systems were also incorporated into Caracol's terrace system (A. Chase and D. Chase 1998). Ritual and water management have recently become a focus of discussion in terms of the authority of Maya elites (e.g. Lucero 2006a). Many cultures utilize water and ritual in different ways and the Maya are no exception, Maya elites, those individuals depicted upon stelae and in other artwork, commonly associated themselves with the divine and with water symbolism (Scarborough 1998:148-155). Water management systems could also be considered symbolic statements (see Cortés 1989). Scarborough (2003:84) suggests that these expressions of *landesque capital*[2] are intended to reinforce "socioeconomic inequalities and

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[2] *Landesque capital* here can be defined as "the principal labor input [which] occurs during the permanent modification of an agricultural landscape, through the construction of terraces, irrigation canals, and similar infrastructure." (Kirch 1994:19) However, I argue that any investment within the landscape can be considered *Landesque capital* as the socioeconomic returns resulting from permanent modifications within the landscape, i.e. monumental architecture, may result in the increased prestige of those individuals undertaking such efforts. The resulting prestige may result in increased status and socioeconomic returns that are difficult to observe in the archaeological record (see Kolb 1994).

solidif[y] elite dominance." However, water management systems in Mesoamerica that can be viewed as labor invested expressions of authority are the exception rather than the norm. Scarborough (2003) does not discuss water management in terms of storage for drinking. However, many cultures residing in areas lacking perennial water resources, such as the Hohokam of the Sonora desert, constructed elaborate storage facilities in order to meet the basic resource needs of individuals (Bayman et al. 2004:134-137). Furthermore, many water storage features are capable of serving multiple functions. The utilization of these water management categories may appear transparent; however, the manner in which these functional qualities are expressed is partially dependant on the environmental restrictions inherent in the landscape and, to a lesser degree, on the technological knowledge of those individuals constructing water control features. The following is a general synopsis of how the ancient Maya, and other cultures throughout Mesoamerica, engineered the natural environment in order to better utilize water for specific purposes.

The volume of food production undertaken by a population solely practicing swidden agriculture is inherently limited in an urban environment. Therefore, if Classic Maya communities were practicing swidden agriculture, their crop yields would not likely have been large enough to support the population numbers that have been suggested for some of the more expansive Maya sites based on house mound counts (Rice and Culbert 1990:21). However, research on modern populations has shown that, even in agricultural systems where swidden agriculture is taking place, many modern Maya still plant both dry and wet season crops by utilizing separate fields along river ways during the dry season (Wilk 1985). Culbert et al. (1978:159) have observed that modern multi-cropping takes place throughout the modern Maya lowlands; yet, the methods used by farmers often varies according to environmental conditions, such as rainfall and the presence of river systems; they also suggest that such multi-cropping practices often produce low crop yields in areas of low rainfall. Clearly, Maya farmers who lived at sites, such as Caracol, away from natural water resources would have had to travel great distances in order to farm along river systems. To date there is no evidence that the Classic Maya practiced migratory agriculture at sites where water resources were scarce, but river systems closest to water-poor sites should be considered for future settlement research. Yet, the Classic Maya landscape was drastically different than that of modern Maya communities; sites in the Southern Lowlands exhibit characteristics of an integrated rural-urban environment (A. Chase and D. Chase 1998). The presence of terracing at many sites was one way in which the Classic Maya mitigated risk and possibly created larger crop yields.

The practice of terracing in the southeastern Maya Lowlands appears to have been fairly common place (Puleston 1978: 230-234; A. Chase and D. Chase 1987, 1998; Fedick 1994, Murtha 2002). The creation of terraces alters the landscape in very permanent and drastic ways. In karst areas where the landscape drastically slopes, such as on the Vaca Plateau, the creation of terraces would appear to have been a necessary eventuality. In a large survey designed to determine the predictability of terrace placement using soil quality in the Upper Belize River Valley, Fedick (1994:124) concluded that "terracing is most commonly associated with densely settled upland land resources of the highest agricultural capability (under hand cultivation technology)." The practice of creating terraces has an additional side effect, besides preserving upland soil. Water-sheds are also created where diversionary structures are built in upland environments. The dual fill construction techniques used in Maya terracing (Murtha 2000) is similar to that used in Inca subsurface geologic water storage tanks. Fairly (2003:199-200) suggests this technique helps prevent disruptive plant growth while aiding subsurface water retention.

While Maya sites, such as Caracol, lack the immediate presence of perennial water sources, some sites in the Southern Maya Lowlands are located along the banks of rivers that seasonally flood. While the water management systems of non-riverine sites focus on water retention, sites located on flood plains often emphasize water diversionary systems. In some cases, such as at Quirigua (Sharer 1988:39), the management systems failed regulating water runoff, resulting in thick deposits of silt over structures. In other cases, the Classic Period water management systems were more successful. Recent archaeological work at Cancuén, Guatemala has uncovered the existence of several canals that would have diverted water overflow away from the constructed *aguadas* in the center of the site and into the Rio Pasión, forcing water away from the elevated ground surface where most of the settlement structures at the site were located (Barrientos et al. 2005:5-9). Subsurface canals and diversionary features placed within plazas were used as flood control measures at Copan, where the epicentral district lies adjacent to the Copan River (Davis-Salazar 2006). Formalized subsurface aqueducts, under the sites' constructions, were used to divert rain-fall runoff into the steep arroyos that surround Palenque (French 2002). While *aguadas* are still present at these sites and small reservoirs were often still constructed, the shape of the built environment at sites like Palenque and Copan appears to treat water as a nuisance rather than as a resource.

Research of water control features in Mesoamerica has been defined in the most general terms, usually only focusing on what constitutes a water management feature. Paul Matheny (1978:185-186) defined water management in the Maya region: "Water controls are construed to refer not only to reservoirs, canals, and drains, but also to terraces, raised fields, including *chinampas*, embankments, garden beds, and other constructions designed to alter the normal flow of water in soil." The majority of research in the Maya Lowlands of Mexico, Guatemala, and Belize has generally followed this definition. Much of the research conducted in the Maya Lowlands focuses on the specific role of a water management feature within the context of an individual site, whether that feature is a dam (Barrett and Guderjan 2006), canal (Matheny et al. 1983), reservoir (Beach and Dunning 1997; Healy 1983), or terrace (Healy et al. 1983). Agricultural and non-agricultural water management adaptations vary drastically from site-to-site and region-to-region. It is important to understand that water management systems are representative of social processes. Different water management systems are often systematically contingent on the nature of the native environment; yet, this fact has not resulted in a uniform approach to water management. Rather, descriptive models are often assumed when much variation exists from site-to-site. The ancient Maya certainly adapted differently to different environmental and socio-political pressures. Thus, a complex system of water control can be interpreted as a reflection of the political, religious, or social influence needed to construct and maintain such control mechanisms. Inferences can be made regarding the political and social structure of the Classic Maya by examining the manner in which shared ideals are expressed in the archaeological landscape. The limitations imposed upon a population by strong social and political forces should be evident in this expression of constructed space, where the degree to which individuals are allowed to construct features related to their every day lives is visible. The examination of integrated water management features is one avenue of inquiry where the limitations of strong or weak social and political forces can be interpreted.

CHAPTER 3: CARACOL RESERVOIR AND WATER MANAGEMENT DATA

Conducting any type of settlement research in a jungle setting can be difficult. As Chase (1988: 22) has pointed out, the methodological mapping of ruins in the Maya area is often hindered by thick jungle overburden. This deterrent makes any exercise in mapping both time consuming and difficult to conduct accurately, as the definitions of specific features are often obscured unless the bush is removed. Large-scale mapping at the site has utilized a methodology where cross-cutting long transects were cut to place visible surface features, such as buildings, plazas, terraces, causeways, and reservoirs into a survey grid. These features were later rectified on the larger site map. When excavations at Caracol are conducted, smaller more detailed maps are created using a transit and stadia rod system to define even more specific facings and walls uncovered by a detailed exploration of individual residential groups or other features. These more accurate maps are also tied into the larger, rectified, site map. The difficulties encountered during the process of site mapping at Caracol - i.e. the obscuration of features by jungle surface vegetation - are also a deterrent to smaller focused research at Caracol, without a large labor force. Reservoirs and other water management features are sometimes located in vacant terrain, away from readily visible architectural structures. In addition, the remains of water management features are often silted in or over from a thousand years of biological debitage. Further problems arise in dating immobile features such as reservoirs. In general, the Maya did not live or bury their dead within the water reservoirs that fulfilled an essential need; contaminating such as resource would have been detrimental to the population's general health. As a result, few materials recovered from water reservoirs can be used to directly date these features. Therefore, it is assumed that the majority of constructed reservoirs were in use during the Late Classic Period at Caracol when the city's population reached its apogee and the city's landscape was the most urban (A. Chase and D. Chase 2003: 109). These limiting factors affected the research carried out and described below.

The following research was not intended to give a complete narrative of all water management features at Caracol; instead, those units that were considered for volumetric studies were chosen for both utilitarian and sampling reasons. The corpus of earlier settlement research conducted at Caracol (A. Chase and D. Chase 1987, 1998, 2001a, 2005; D. Chase and A. Chase 2003, Jaeger 1991), which only identified water management features peripherally, However, in conjunction with the exploration of water management features presented in this thesis, a healthy representative sample of water management activity throughout the site can be garnered that is indicative of what specific tasks were being carried out by the Maya.

The water reservoirs identified for research during the 2007 season were chosen in order to elucidate the visibly expressed differences of these features throughout the Caracol landscape, while simultaneously considering practical time and labor constraints. Research for this project could only be undertaken when there was free time away from the project's primary goals for the 2007 field season (see A. Chase and D. Chase 2007a). Therefore, only reservoir locations that had been previously identified or that could be readily discerned within the landscape were chosen for exploration.

Previous research at the site of Caracol has identified significant differences in the distribution and spread of items often associated with the presence of elites during the Terminal Classic period (A. Chase and D. Chase 2004b), where those items, such as elite fineware ceramics, are often only found within the site's epicenter during the last occupational phases of

Caracol's history. In addition, mortuary studies conducted on the internment practices of the Caracol population have revealed that individuals interred in different regions of the site likely had differential access to resources, such as jadeite (D. Chase 1998) and certain ceramic forms (A. Chase and D. Chase 2008), despite the apparent uniformity of Caracol's ethnic identity (D. Chase and A. Chase 2004: 142-144). Previous settlement research at Caracol has also demonstrated the urban nature of Caracol's residential population where residential groups dominate the expanse of Caracol's integrated landscape (A. Chase and D. Chase 1998) and alterations to the landscape, as represented by water reservoirs, are fairly uniform to the amount of approximately 5 per square kilometer (A. Chase and D. Chase 1996a; 1996b; 2007b). It is within this context of an urban environment populated by individuals with differential access to resources and a uniform integrated latticework residential occupation that a sample of water management features was chosen.

Methodology

The proximity of the five reservoirs examined in this study to the site's epicenter suggests that, regardless of function, these features were likely in the domain and control of Caracol's elite population. However, settlement research conducted by Jaeger (1991: 82-83) shows that this pattern of reservoir distribution remains consistent throughout the residential landscape of Caracol. Thus in effect, this small subset of constructed features was chosen as a representative sample of the overall integrated urban environment of Caracol. Water management features, such as *aguadas* (or natural surface depressions), are also plentifully distributed throughout the landscape of Caracol (Figure 3). However, without excavation or readily identifiable surface alterations - i.e., walls lined with cut stone - it can be difficult to determine if and how these features were utilized by the Classic Maya from surface survey alone. Often, however, naturally occurring *aguadas* at Caracol were completely ringed by terraces, thus indicating their Classic Period existence (A. Chase 2009 Personal Communication). A single natural *aguada*, located within the site's epicenter, was selected for volumetric measurement in order to give a comparative example of volumetric carrying capacity between constructed reservoirs and the natural depressions that dot the landscape. However, in general naturally occurring *aguadas* such as those identified at Caracol, Minaha, (Primerose 2002), Copan (Weiss-Krejci and Sabbas 2002), and elsewhere in the Southern Maya Lowlands were excluded from this study. The following methodology was employed to determine the limits of each constructed reservoir's volumetric carrying capacity, the relative uniformity of construction methods used to build each reservoir, and the relative placement of each reservoir with regard to the surrounding environment in order to better understand the specific function of each feature.

Figure 3: A "natural" aguada from Caracol

With the exception of a single reservoir located near Structure A18, all reservoirs within this study appear on previously published survey maps of Caracol (see A. Chase and D. Chase 1987:63-84; 2001a). U.T.M. coordinates for each individual reservoir were not taken because the thick tree canopy at Caracol made accurate G.P.S. coordinates impossible to obtain. However, each reservoir's location can easily be found within walking distance from the site's epicenter (Figure 4).

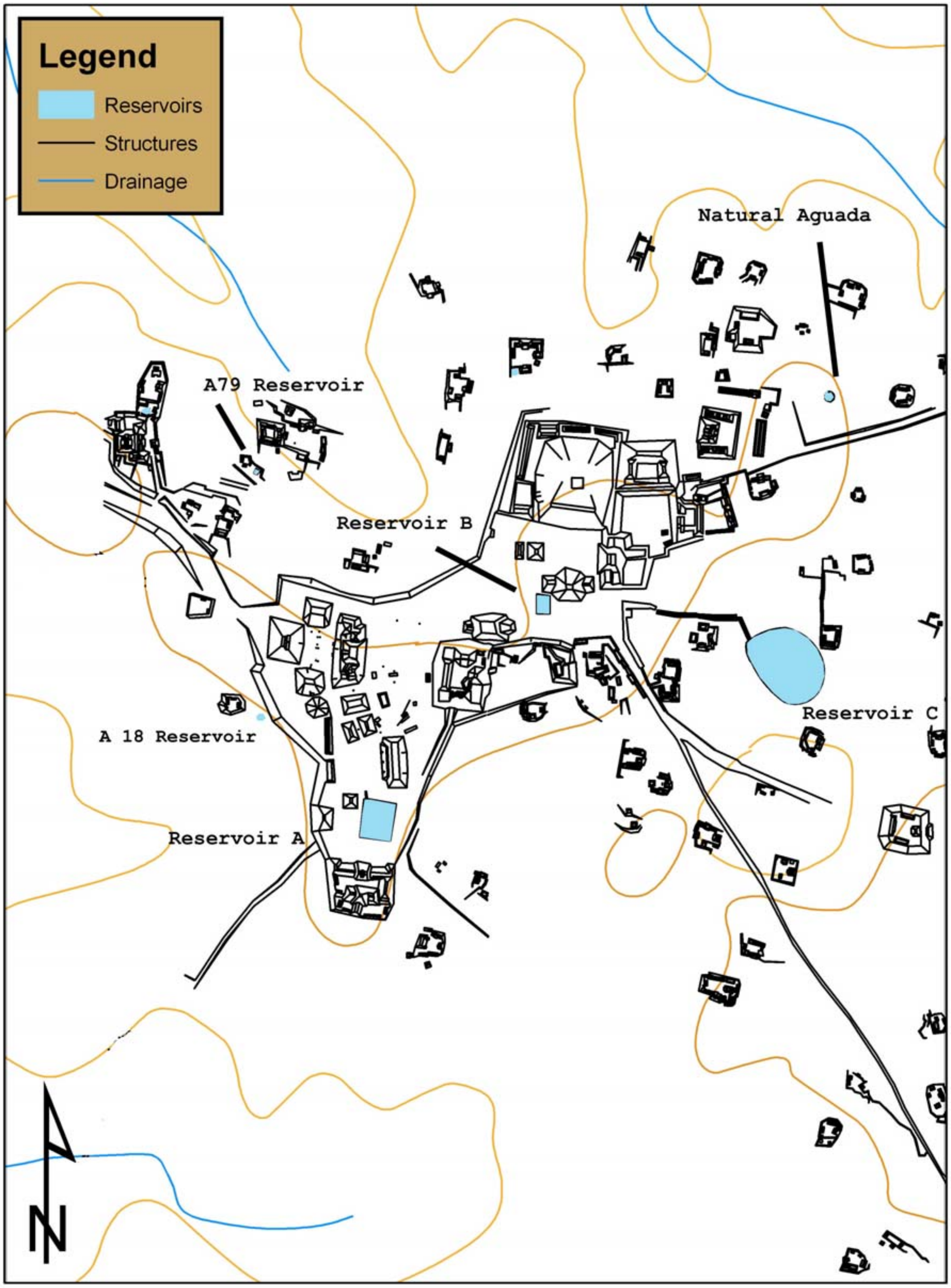

Figure 4: Caracol reservoirs in this study

In order to determine the volumetric carrying capacity of each reservoir at Caracol a methodology similar to the one devised by Gallopin (1990: 103-104) for the Tikal project was repeated. This methodology has to be considered a “best fit” for volumetric estimation under the problematic circumstances described above. Since it was not possible to conduct excavations in order to determine the exact termination depth of each reservoir, the volumetric measurements presented below should be considered accurate but not precise. However, the nature of this analysis can be viewed as comparative, since this methodology has previously been used at Tikal (Gallopin 1990), a site of comparable size and arguably similar political and social organization to Caracol (D. Chase et al. 1990) as well as at Copan (Weiss-Krejci and Sabbas 2002).

Smaller reservoirs at Caracol generally conform to the shape of an elliptical cone and therefore the following formula was used to determine their volumetric capacity:

H (1/3) pi (A/2) (B/2)

H= the maximum height of the cone

A and B= the lengths and widths of the elliptical surface of each reservoir

The measurement of the two larger reservoirs in this study, Reservoir A and Reservoir B, do not conform to the shape of an elliptical cone and therefore were broken down in a similar fashion, following Gallopin’s (1990) methodology by segmenting each reservoir by 1 meter contours and adding each segment to determine the minimum carry capacity of each (Table 1). The volumes of the larger reservoirs were calculated using the standard area volume formula:

V = (L) (W) (Height of each contour)

Table 1: Caracol reservoir volumes in this study

Volumes of Caracol Reservoirs				
		Size (M)		Estimate Using Gallopin 1991 Formulas
Group:	L	W	H	
A79 (Residential Group)	6.9	5.5	1.1	10.9m³
A18 (Residential Group)	6.8	3.4	2.6	15.7m³
Natural Aguada (Epicenter)	18.8	14.8	1.8	131.1m³
Reservoir B (Epicenter)	17.2	15.5	1	266.6
	14	12.8	1	179.2
	12.2	10.4	0.4	50.7
			Total:	496.5m³
Reservoir A (Epicenter)	48.9	40.9	0.44	880
	48.1	39.1	1	1880.7
	45.9	35.8	1	1643.2
	39.8	32.6	1	1297.4
	29.3	23.3	1	682.6
	13.5	5.5	0.25	18.5
			Total:	6402.4m³

Volumetric estimations were also discerned for those reservoirs identified and measured by previous researchers at Caracol (A. Chase and D. Chase 2005, Jaeger 1991). Although measurements for some of these previously identified reservoirs were incomplete, an assessment of each reservoir's minimum volumetric capacity for each is given (Table 2). A depth estimate of one meter was used for those reservoirs that did not have a precise measurement as most other reservoirs at Caracol have a minimum depth of at least one meter.

Table 2: Volume of previously identified Caracol reservoirs

		Size (M)			
Group:	L	W	H	Source	Volumetric Estimate
Vacant Terrain	3.7	4.8	1.5	Jaeger 1991	9.58m^3
Vacant Terrain	8.5	6.3	1.7	Jaeger 1991	35.74m^3
Vacant Terrain	7	5	1.5	Jaeger 1991	18.55m^3
Vacant Terrain	10.7	8.7	*	Jaeger 1991	73.11m^3
Str. C95-C100 (Residential Group)	3.1	4.7	1	Jaeger 1991	5.72m^3
Str. L39-L45 (Residential Group)	8.7	7.4	*	Jaeger 1991	50.56m^3
Str. 2E19-2E25 (Residential Group)	6.7	7.5	1.2	Jaeger 1991	23.67m^3
Str. 3D34-3D35 (Residential Group)	7.5	8.8	1.2	Jaeger 1991	31.1m^3
Str. I21 (Residential Group)	3.46	1.8	.5*	A. Chase and D. Chase 2005	1.22m^3 (19.56m^3)
				* estimates are made using a height measurement of one meter	

Residential Reservoir A79

A small residential group of four small structures on a slightly elevated platform lies slightly to the north of Caracol's epicenter. Upon this raised platform and slightly to the southeast of these structures lies a small rounded depression. Fortunately, locating this feature from Caracol Archaeological Project maps was aided by a nearby mound of leafcutter ants (*Atta sp.*) which had cleared much of the ground surface of underbrush. This depression conforms to the general shape of a shallow elliptical cone and at first appears to be a natural depression (Figure 6). However, a closer inspection of the depression's surface walls revealed several blocks of cut limestone lining the sides of the feature, although the majority of these have been pulled out of place by fallen trees. No surface ceramics or other noticeable artifacts could be visibly associated with this feature. A section line was mapped from a raised line stretched across the surface of the platform to better display the relationship of the small reservoir's limits to the raised platform (Figure 7).

The extent of the A79 Reservoir's surface measures 6.9 m x 5.5 m and would have held approximately 10,900 liters of water. The close proximity of water features such as this does not occur in isolation at Caracol. Excavations (A. Chase and D. Chase 2005) have revealed a small reservoir similar to the A79 Reservoir near Structure I21 to the northeast of the site's epicenter (Figure 8) (Figure 9). The recovery of a small olla from the small reservoir near I21 suggests that it was likely used as a potable water source. The placement of small reservoirs upon raised platforms, where the ground surface slopes with regard to the once plastered ground surface, suggests that raised platforms associated with residential groups were intentionally targeted for reservoir construction by utilizing the platforms as an artificial catchment zone. This technique is similar to water cachement from plaza areas in chultuns described for the Puuc Region (McAnany 1990). In addition, it is likely that these constructed features are more ubiquitous than is readily apparent from surface mapping efforts. Excavation sampling methodology at Caracol often focuses on the trenching or clearing of built structures and, therefore, sampling efforts sometimes ignore depressed features, such as these small attached reservoirs.

Residential Reservoir A18

A second constructed reservoir, located east of Structure A18 was also investigated. This reservoir does not appear on earlier published maps of the site (A. Chase and D. Chase 1987: 63-84) and was obscured in part by thick jungle growth. Over the past several years this reservoir had been used to partially irrigate a modern *milpa* maintained by several of the site's caretakers who guard and maintain the site for tourism. At the time of investigation, during the mid-dry season in early March, a small amount of water was still visible at the bottom of this reservoir. Much like the small reservoir near A79, this reservoir exhibited distinctly altered features, such as stone lining in its walls; however, the lining of this reservoir's walls were far better defined (Figure 10) and preserved (Figure 11). It is not beyond the realm of belief that during the Late Classic Period well-maintained reservoirs such as these could have held water throughout much of the dry season.

This reservoir was constructed near the bottom of steep decline to the west of the site's epicenter. A 50 m section line was used to determine the relative slope of the surrounding landscape (Figure 12); as a result, it appears that the reservoir directly overlooks the flattened field systems where the modern *milpa* was set. This reservoir is located east of Structure A18 near the termination of a terrace to the east and at the bottom of a steep incline. It is in an advantageous position for collecting rain water runoff.

Vacant terrain reservoirs also have been recorded among the terraced landscape of Caracol (Jaeger 1991: 92) and are generally similar in size and proportions to the Structure A18 Reservoir (see tables 1 and 2). The A18 Reservoir measured 6.8 m x 3.4 m and would have held approximately 15,700 liters of water. The positioning of reservoirs below and amid terraced fields suggests that they may have been used for agricultural purposes. A. Chase and D. Chase (1998:71) have observed that any rain water run-off from populated residential groups would likely have made drinking from low-lying reservoirs unsafe due to human contamination. Reservoirs, like the A18 one, are positioned in a similar manner to secondary reservoirs identified at Tikal by Scarborough and Gallopin (1991). However, unlike Scarborough and Gallopin's model, where a series of secondary reservoirs are replenished by several large centralized reservoirs, it appears that reservoirs associated with terrace systems, such as the ones found at Caracol, merely utilized the modified drainage patterns of the Caracol terraces to replenish their water supplies. Currently, such reservoirs do not appear to have led to any tertiary water containment areas or to have been utilized to directly flood adjacent field systems. No clay lined channel systems, like those found at Tikal (ibid.), have yet been identified. It is possible that reservoirs associated with terraces were utilized to conduct a small localized form of "splash agriculture" that is practiced in many parts of Mesoamerica today (Denevan 1982:187-189).

Reservoir B

Three large reservoirs -"A", "B", and "C" – were noted by Satterthwaite (1954) as being associated with the central architecture of Caracol. Reservoir B, south of Structure B6, is a large formally constructed reservoir that lies immediately adjacent to and south of the B plaza (Figure 13). The side walls of Reservoir B are lined with large amounts of cut limestone similar to those used in the construction of buildings at Caracol (Figure 14). During construction the reservoir was either built up from or stripped down to bedrock, which is visible from the surface today. Although Reservoir B does not currently hold water, small improvements would have slowed the rate of water seepage in antiquity. Alterations to constructed reservoirs and other water management features, such as lining reservoir and canal surfaces with clay or other materials, have been reported at Tikal (Scarborough and Gallopin 1991), La Milpa (Scarborough et al. 1995), and Quirigua (Ashmore 1984).

The methodology used to measure the volume of the smaller reservoirs, where a transect line is measured with compass and tape, is not an efficient method of measurement for the larger reservoirs at Caracol. Therefore, a stadia and measuring rod were used in a fixed position to determine the relative depths of the reservoir along a single transect line. Fortunately, the visible exposed bedrock at the bottom of the reservoir and well preserved walls allowed a precise volumetric assessment. Volumetric measurements taken of Reservoir B indicate that this reservoir minimally contained 496,500 liters of water and would have regularly been replenished from the large catchment zone of the B-group plaza and the surrounding area. The results (Figure 15) show that these larger reservoirs share a more formalized construction plan and would have required many more work hours to construct than reservoirs attached to residential groups. However, both the large epicentral reservoirs and the smaller residential reservoirs generally take advantage of the catchment zones created by the raised platform surfaces upon which structure groups are perched.

Reservoirs A and B are rectangular and evince straight-lined stone walls. While smaller reservoirs at Caracol are currently conical in shape, it is suspected that excavation would also reveal that many of these were also constructed with stone walls. These formalized rectangular reservoirs are similar in appearance to those found in Cancuen (Barrientos 2005:42). Barrientos et al. (2005) suggest that the location and the ritualized artifacts recovered from reservoirs at Cancuen indicate that these pools were used to reinforce ideological control through ritually charged symbolic action. Water imagery and depictions of human-deity interaction with water as a symbolic liminal act are certainly present in Classic Maya art (Scarborough 1998:148-155). However, excavations in the adjacent Structure B6 (A. Chase and D. Chase 1987:34-36) indicate that the architecture closest to the Caracol reservoir was likely residential in nature and that its layout spatially emphasized an attachment to the northern B-Group plaza rather than the reservoir to its rear. Interestingly, water imagery is found on the lower masks of the adjacent Structure B5. While the function of Reservoir B and nearby structures may have changed over time, there is no direct evidence that this reservoir was a focus of ritual activity and symbolically charged events. Unless excavations can be used to clarify the specific function of this reservoir it must currently be considered a potable drinking source, albeit a restricted one.

Reservoir A

Reservoir A, near the South Acropolis, is perhaps the largest constructed reservoir at Caracol (Figure 16). Although the reservoir has been partially dug in recent years to provide a ready supply of fresh water to the caretakers and archaeologists at Caracol, it maintains much of its original shape and effectively diverts rain run-off into its large cachement area. Digging the reservoir has shown it to have a thick clay lining (A. Chase Personnel Communication 2009). Reservoir A is also the only reservoir where datable materials have been recovered. Radiocarbon dates recovered by Healy et al. (1983:401) indicate that this reservoir was likely in use from the Early Classic through the Terminal Classic Periods. Reservoir A was analyzed in a similar manner to that of Reservoir B. Fixed transect lines were secured and then measured using a stadia and measuring rod. However, while only two transects were set to measure Reservoir B, three were used on the Reservoir A to establish its horizontal and vertical axes because of its larger size (Figure 17). Water levels were used as a natural line level for volumetric assessment and absolute measurements were taken from the waterline (Figure 18) (Figure 19) (Figure 20). Much like Reservoir B, Reservoir A is an oblong rectangular construction (Figure 21). The majority of the reservoir's walls are lined with cut-stone that can still be discerned from the surface landscape.

The northwest corner of Reservoir A contains the added feature of a constructed drain, where water is gravity-fed into the reservoir from the nearby raised surfaces in front of Structure A13. This massive reservoir would have been replenished throughout the year by the nearby paved surfaces. Even in its current condition, the South Acropolis reservoir is minimally capable of storing 6,402,400 liters of water.

It appears that Reservoir A's function was for water storage as a potable drinking source rather than for agricultural use. Future excavation may yield evidence of any symbolic meaning that the Maya of Caracol placed on this feature. Other large dams in the Southern Maya Lowlands, such as those found at Tamarandito (Beach and Dunning 1997) and Tikal (Scarborough and Gallopin 1991, are incorporated into drainage systems that feed smaller reservoirs and can be opened to channel water for agricultural production. However, Reservoir A is the termination point for a catchment system that is comprised of extended plastered plaza surfaces that extend southward from the A plaza.

Reservoir C

Caracol project maps have identified three large epicentral reservoirs, based on Satterthwaites's (1954) original designations; however, the likelihood that the large depression to the southeast of the epicenter is a formally constructed reservoir is in doubt. The sheer size of the depression would have been able to minimally hold several million liters of water. Unfortunately an accurate assessment of the volumetric capacity of this potential reservoir was not possible due to time and labor considerations. The depression's walls measure between 1-3 m in different areas. Even during the dry season months the ground at the bottom of the depression is spongy and wet in areas. The problem with identifying this depressed zone as a reservoir is twofold. First, the reservoir's walls lack the cut-stone lining found in the other reservoirs of the epicentral zone. Second, small caves pocket the sides of the depression's walls making any retention of water difficult, if not impossible. There is also a vertical cave entrance in the middle of the sink, which would have drained any water (A. Chase Personal Communication 2008).

Several cut stones and a copious amount of slate were discovered at the mouth of a cave entrance lining the outlying eastern wall. The entrance of this cave appears intentionally lined with cut limestone and large chunks of slate in order to create a small drain system (Figure 22) (Figure 23). The cave's entrance is perched 20-30 cm above the modern ground surface level of the depression suggesting that the Maya at Caracol may have altered the cave entrance to act as a drain for water overflow. Future excavation efforts could clarify whether or not this line of cut stone does form a formal overflow drain. The position of this depression, to the north of the southeastern *sacbe*, would have acted as a convenient low-lying runoff basin for the structures immediately surrounding it and may have acted as a source of potable drinking water. Further testing would also indicate whether or not the depression was used for agricultural production like the *sacbe* lined reservoirs of Tikal (Scarborough and Gallopin 1991).

Natural Epicentral Aguada

In addition to the formal reservoirs discussed above natural *aguadas* are present and a part of Caracol's landscape. A readily discernable natural *aguada* lies within the site's epicenter, due east of Structure I21. This *aguada* was chosen for volumetric analysis in order to give a comparative carrying capacity to those formally constructed reservoirs present throughout the site and could be used as a basis for any future more extensive research regarding water management at the site. This natural *aguada* is slightly larger than those constructed reservoirs examined by Jaeger (1991) and the residential reservoirs described above. This particular *aguada* retains water throughout the dry season and measures 18.8 m x 14.8 m x 1.8 m (Figure 24) (Figure 25). Due to its shape, similar to smaller constructed reservoirs, the same methodology for volumetric measurement was employed. In effect, this *aguada* can maintain a capacity of 131,100 liters of water throughout the dry season.

Water Management at Caracol

Other small formally constructed reservoirs have been identified throughout Caracol by previous researchers (A. Chase and D. Chase 1987, 1996b; Jaeger 1991). These reservoir types share similar qualities with both the A79 Reservoir and the A18 Reservoir discussed above. All of these reservoirs fall into two general categories. They are either located in vacant terrain, associated with terrace systems, or they were incorporated into the landscape of residential groups. In general, the reservoirs that were constructed outside of the site's epicenter are of similar size and proportions, and also used a familiar vernacular approach; epicentral reservoirs have a much larger carrying capacity and were constructed using similar techniques, but on a much larger scale.

Some scholars (Puleston 1971) have suggested that other features in the landscape, such as chultuns, could have been used for water storage for domestic use. However, excavation research at Caracol has repeatedly shown that chultuns during the Preclassic and Early Classic periods were used as internment chambers for the dead (A. Chase and D. Chase 1994, 2006; Hunter-Tate 1994). Had these chultuns been utilized for water storage during later time periods, the internments uncovered by careful excavation would have been disrupted. In addition to constructed chultuns, natural *aguadas* are present throughout Caracol and some hold water throughout the dry season; although they were likely utilized for different purposes by the people of Caracol.

Weiss-Krejci and Sabbas (2002) have pointed out the ubiquitous nature of small depressions found throughout Northwestern Belize and the Peten. These naturally occurring and constructed small depressions are of a similar size to many of the smaller reservoirs found both within residential groups and among the terraced terrain at Caracol. While their hypothetical loss/gain analysis (Weiss-Krejci and Sabbas 2002.: 354) does little to successfully demonstrate the ability of these features to maintain a steady water supply for a population during times of drought or environmental stress, it may indicate why the Maya at Caracol took measures to further slow the seepage of ground water in their reservoirs by lining them with stone, clay, and other materials. However, their hypothetical model accounts for nearly double (4.8 liters per day) the amount of water that is considered necessary for human consumption when compared to McAnany's (1990:269) minimum number of 2.8 liters per day. Their results (Weiss-Krejci and Sabbas 2002:354) (Figure 5) indicate that the small depressions at La Milpa, slightly larger than some small constructed reservoirs found at Caracol, could have easily supported those individuals residing within residential groups at La Milpa based on current methods of calculating population estimates based on house mound counts (Rice and Culbert 1990). Comparatively, Caracol is located in a region with some of the highest annual rainfall throughout the Southern Lowlands (Lucero 2006a:71). During the course of research on Caracol's reservoirs, there was insufficient time to measure the exact size of the rainfall cachment zones for Caracol's reservoirs. However, assuming that evaporation and consumption rates are maintained at a constant, using Weiss-Krecji and Sabbas' model, and water input levels are equivalent or higher at Caracol when compared to La Milpa, even small household reservoirs such as Reservoir A79 could have conservatively supported 11 individuals year round.

	Liters				
Month	Water Input[a]	Evaporation[b]	Consumption[c]	Net Storage[d]	Surplus
1993					
January[e]	25,088	7,654	6,994	57,000	10,440
February	5,725	6,844	6,316	49,565	
March	0	8,343	6,994	34,228	
April	34,387	11,405	6,768	50,442	
May	76,236	14,240	6,994	57,000	48,444
June	97,854	14,483	6,768	57,000	76,603
July	25,574	14,369	6,994	57,000	4,211
August	68,879	13,454	6,994	57,000	48,431
September	60,656	12,150	6,768	57,000	41,738
October	44,451	11,154	6,994	57,000	26,303
November	31,369	8,408	6,768	57,000	16,193
December	22,451	6,626	6,994	57,000	8,831
1994					
January	47,539	6,780	6,994	57,000	33,765
February	28,142	8,092	6,316	57,000	13,734
March	10,653	8,861	6,994	51,798	
April	2,256	11,834	6,768	35,452	
May	14,262	14,831	6,994	27,889	
June	41,189	15,147	6,768	47,163	
July	37,094	14,378	6,994	57,000	5,885
August	36,747	13,811	6,994	57,000	15,942
September	65,930	12,304	6,768	57,000	46,858
October	24,255	11,899	6,994	57,000	5,362
November	37,337	8,699	6,768	57,000	21,870
December	10,861	7,136	6,994	53,731	
1995					
January	6,246	6,691	6,994	46,292	
February	5,899	6,245	6,316	39,630	
March	4,164	9,234	6,994	27,566	
April	18,599	14,499	6,768	24,898	
May	104	17,909	6,994	99	
June	62,911	17,132	6,768	39,110	
July	99,242	14,766	6,994	57,000	59,592
August	83,454	16,459	6,994	57,000	60,001
September	59,302	13,146	6,768	57,000	39,388
October	82,690	12,191	6,994	57,000	63,505
November	29,565	9,501	6,768	57,000	13,296
December	21,930	7,768	6,994	57,000	7,168

Figure 5: Hypothetical input/output model of small depression carrying capacity at La Milpa (after Weiss-Krecji and Sabbas 2002:354)

The integrated agricultural landscape of Caracol does not fit the model for other Lowland Maya sites of comparable size, such as Tikal. The latticework of terraces and vacant terrain reservoirs at Caracol is more similar to the agricultural model exhibited by the water management system of Kinal. Scarborough et al. (1994) investigated the presence of several diversion weirs and possibly naturally formed watersheds at Kinal, where rain would gather in catchment zones at the top of raised residential areas and funnel down natural watersheds into small reservoirs. Scarborough and his colleagues (1994:104-105) concluded, that although Kinal's water management system was similar to that of Tikal's, it lacked the centralized feeder reservoirs present in the site's epicenter. The landscape of Caracol mimics this diversionary system of water flow. However, rather than utilizing specialized weirs or check dams, the people of Caracol controlled water flow by diverting its course though terraces into natural gullies and by placing small constructed reservoirs below such systems as well as in association with surfaced residential groups placed on the tops of hills.

CHAPTER 4: DISCUSSION

The question of how political authority was vested in elites and how it was maintained in Maya society is largely unresolved. While many scholars have focused on a single aspect of Maya social practice to explain this phenomenon (McAnany 1995, Lucero 2006b, Yaeger 2003b:48-49), a meta-narrative which defines the political structure of all Maya cities during the Classic Period is unlikely to be agreed upon by scholarly consensus any time soon. Regardless of this fact, the political organization of Caracol can be defined as one that is hierarchically organized and where political authority was likely invested in administrative political nodes placed throughout the site's urban landscape (A. Chase and D. Chase 1996b:805-809; 2007). As Ashmore and Sabloff (2002:201) have observed; "For the ancient Maya, as for many other peoples, it is increasingly clear that maps of civic centers evince considerable planning and meaningful arrangement in the placement of buildings, monuments, and open spaces." The spatial planning of the urban environment can tell a great deal about the manner in which people organize space and is reflective of larger social processes. The invested community effort that codifies monumental architecture, such as those structures found in Caracol's epicenter, is one way to define the hierarchy of social and political processes. Moore (1996:98) suggests, "…there is a direct relationship between a monument's design and its communicative potential, and thus its ability to serve as a marker of social cohesion." However, when investigating a built environment that is the culmination of long term social processes and accretive actions, it is more difficult to discern definitive hierarchical actions and political forces that guide the construction of an urban landscape.

Scarborough and Gallopin's (1991) analysis of the Tikal water management system provides an example of a landscape where the placement of water management features can be clearly defined as centrally organized. The locus of control for this system was maintained within a centralized district that was populated by elites. However, this centralized system appears to be a distinct phenomenon limited to very few Maya sites. While other complex water management systems do exist in the Maya region, such as the Preclassic hydraulic system at Edzna (Matheny et al. 1978), political authority and control should not be viewed as a necessary precursor to complex agricultural intensification and development (see Lansing 1991, Netting 1993, Kirch 1994). In lowland zones where water resources were more readily available from season to season, like those in *bajo* environments, the spatial landscape of agricultural production can be defined along the lines of Netting's (1977) infield/outfield model. Kunen (2004::98) summarizes *bajo* agricultural practices in the southeastern Maya Lowlands where

> "…farming households invested decreasing amounts of labor in cultivation as the distance from house to agricultural field increased. In the immediate vicinity of the residence, kitchen gardens and orchards provided carefully tended spaces for fruits, vegetables, herbs, and medicinal plants. Surrounding the residences were intensively cultivated infields, where staple crops were grown with shortened fallow cycles and with such labor-intensive practices as irrigation and terracing."

Scarborough (1998:144-145) adds that "although functionally sophisticated, the Classic water-control system was never an example of 'total power' a la Wittfogel (1957)," whose theory suggests that as groups developed control over water resources, groups of elites consolidated power, developed intensive agricultural systems, and, eventually, participated in increasingly complex political systems.

Lucero (2006a) has argued that Maya elites in water-poor regions of Mesoamerica maintained control over water resources through ritual action and symbolic association. As elites lost the ability to provide and maintain sufficient water resources to the populace, they also lost their ability to maintain political authority. There are inherent problems with this argument, especially as it applies to Caracol. Lucero (2006a.: 195) assumes that Maya kings controlled and maintained the totality of water management systems under the direct authority of the state. The framework of terraces and the water management features at Caracol, with the exception of epicentral and termini group reservoirs, were likely maintained at the household level. Tim Murtha's study (2002: 299) of the Caracol terraces and its agricultural production system concluded that:

> "Terraces were likely constructed not by some centrally organized system, but by individual households. Unlike complex chinampa systems requiring significant dykes or complex irrigation systems, which may require some organized level of construction, terracing does not require or benefit from major public works. Non-irrigated terracing serves one primary purpose, i.e., to ameliorate the declines of productivity associated with soil erosion."

The vast majority of Caracol's water management system consists of two reservoir types, small constructed reservoirs integrated into the terrace field systems and small constructed reservoirs attached to residential groups. Reservoirs that are present within field systems were small enough to have been easily built and maintained at the household level. Terraced field reservoirs took advantage of naturally occurring watersheds and any similarity in their construction is likely representative of the shared vernacular concept that the Maya of Caracol invested in the built environment.

It is certain that the Maya often imbued water resources with symbolic meaning (Scarborough 1998) and archaeological excavations have suggested that such resources played an important part in ritual action (Barrientos et al. 2005). However, insight into social agency is one of the most difficult aspects of anthropological research when viewed in terms of the archaeological record. Lucero (2006a:188) maintains that elites lost political authority when, "artificial reservoirs no longer adequately fulfilled daily water needs. As a result, commoners stopped congregating at center reservoirs and paying to get in." Yet, elites at Caracol maintained differential access to resources for minimally two generations after the Caracol rulers ceased erecting symbols of their political authority, such as stelae (A. Chase and D. Chase 2007c:22-24). Furthermore, archaeological evidence from areas surrounding epicentral reservoirs at the site do not suggest that these features served as anything other than a reliable source of potable drinking water.

It is clear that some Maya states, such as the one at Tikal, played a dominant role in the control of water management systems and, presumably, agricultural production. However, the built environment of Caracol can be perceived as a less centrally focused agricultural system where the means of production were centered at the household level (A. Chase and D. Chase 1997:10; Murtha 2002: 295-301) and the state maintained privileges of redistribution (D. Chase and A. Chase 2004). The water management systems of the Classic Maya must be viewed in terms of the contexts in which they were constructed. These systems are better viewed as an extension of aggregated growth rather than as control mechanisms devised by Maya kings.

CHAPTER 5: CONCLUSION

The water management features of Caracol present a unique and original frame of study for research on the ancient Maya landscape. The paucity of water in the region forced the Maya of Caracol to adapt their landscape to meet the functional needs of a large population. Small constructed reservoirs located throughout Caracol and throughout the vacant terrain of the built environment do share many similarities. These reservoirs are often small and found either within residential groups or within terraced field systems. Their uniformity of construction methods may at first suggest that their construction was undertaken from a central directing force and perhaps as a direct apparatus of the state. However, it is more likely that this uniformity of construction is the result of shared expressed ideas within a cohesive ethnic group. The end result is the expression of a vernacular agricultural and domestic landscape that is constructed and maintained at the household level.

Models for the Classic Maya that present a vast integrative landscape under centralized control, such as is suggested for sites such as Tikal (Scarborough 1993), are only applicable to Caracol on the most basic structural level (A. Chase and D. Chase 2007). The Classic Maya at Caracol did adapt the natural landscape, through terracing and the construction of small reservoirs, to divert water into natural drainage systems that likely aided agricultural production. However, while Tikal's large integrated systems of reservoirs and drainage watersheds originate within the site's epicentral precinct and expand outward into an interconnected network of elaborate water management, Caracol's water management system does not appear interconnected and mutually reliant, except for where it articulates with the causeway system (A. Chase and D. Chase 2001a). Caracol's large central reservoirs were likely used to store large quantities of potable water, a beneficial resource for Caracol's elite population during the dry season. Others (Barrientos et al. 2005, Lucero 2006b) have suggested that large epicentral reservoirs were the center of ritualistic activities designed to maintain authority through the control of water systems. However, the current paucity of archaeological evidence in epicentral precinct reservoirs relating to ritual activity, when combined with the presence of small constructed reservoirs throughout the region, suggests that while the elite of Caracol likely had some degree of control over water resources, it was limited.

Future Research

Future research along the lines of inquiry presented in this thesis should have several aims. First, the general exploration of residential zones should incorporate some degree of testing to determine the full extent of water resources available to the general population where possible. Since many small reservoirs were incorporated raised platforms in residential groups, they should be easier to locate in map.

Second, a focused excavation program should be devised in order to determine the precise volumetric capacity of other water management features at Caracol and the functions that they may have served (i.e., as a potential component for craft production). Water is a necessary component of ceramic production. If zones of ceramic production can be identified near localized water sources within residential zones, then such evidence would aid in understanding local economies and the level of control that the state imposed upon such economies.

There remains much that is poorly understood regarding the agricultural strategies employed by the Classic Maya and the methodologies that they used to overcome their environmental limitations. It is clear that the Classic Maya residing within the cities of the Northern Lowlands (Matheny et al. 1983) employed different agricultural strategies than those in the Southern Lowlands and that the integrated landscapes within these regions exhibit different qualities of a “managed mosaic” from site to site. An excavation strategy designed to consider the totality of the built environment with regard to agricultural production, rather than focusing on one specific feature, would go a long way to advance our understanding not only of agricultural production but also of the larger social and political forces that affect such processes.

APPENDIX: ADDITIONAL FIGURES

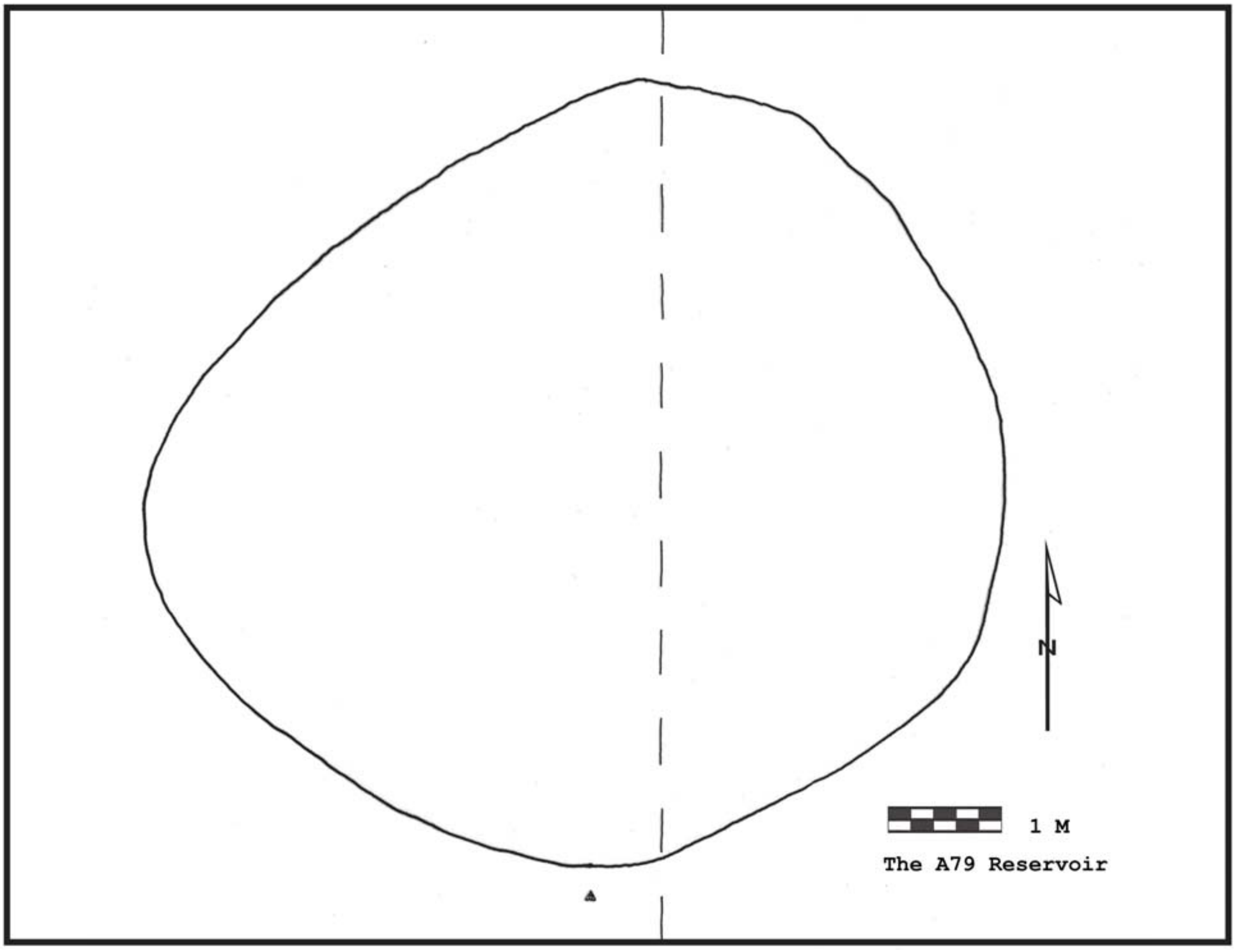

Figure 6: Plan of the A79 Reservoir

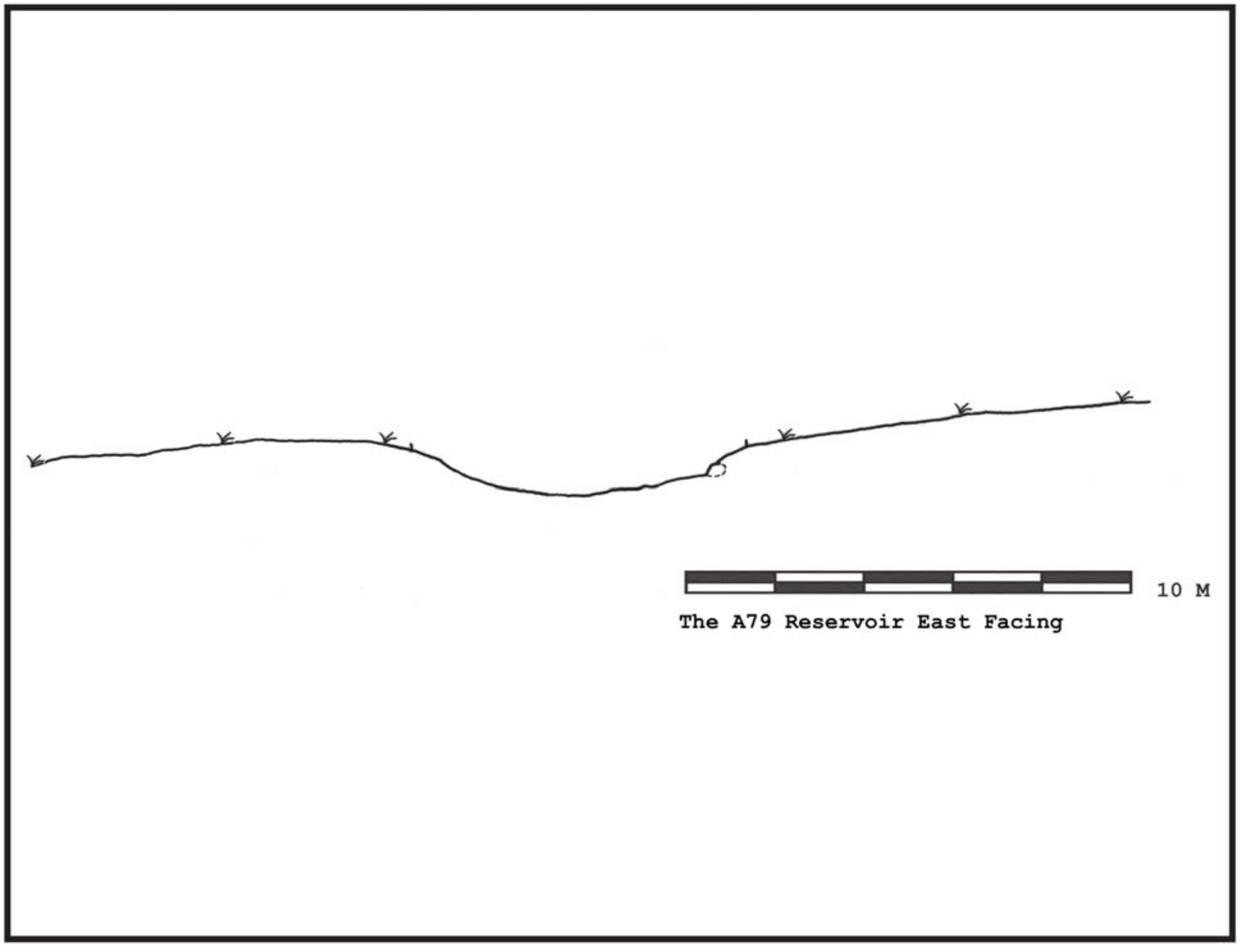

Figure 7: Section of the A79 Reservoir

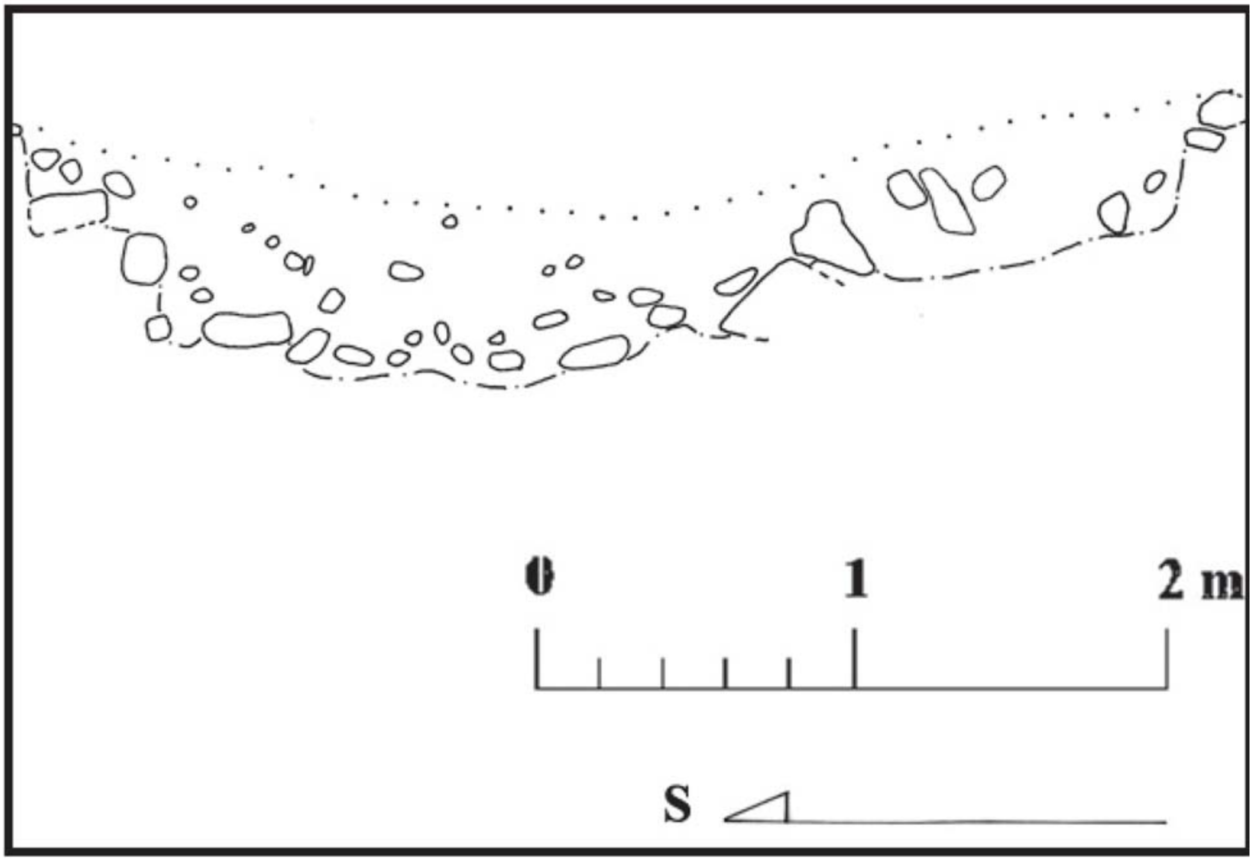

Figure 8: Section of the I21 Reservoir (after A. Chase and D. Chase 2005)

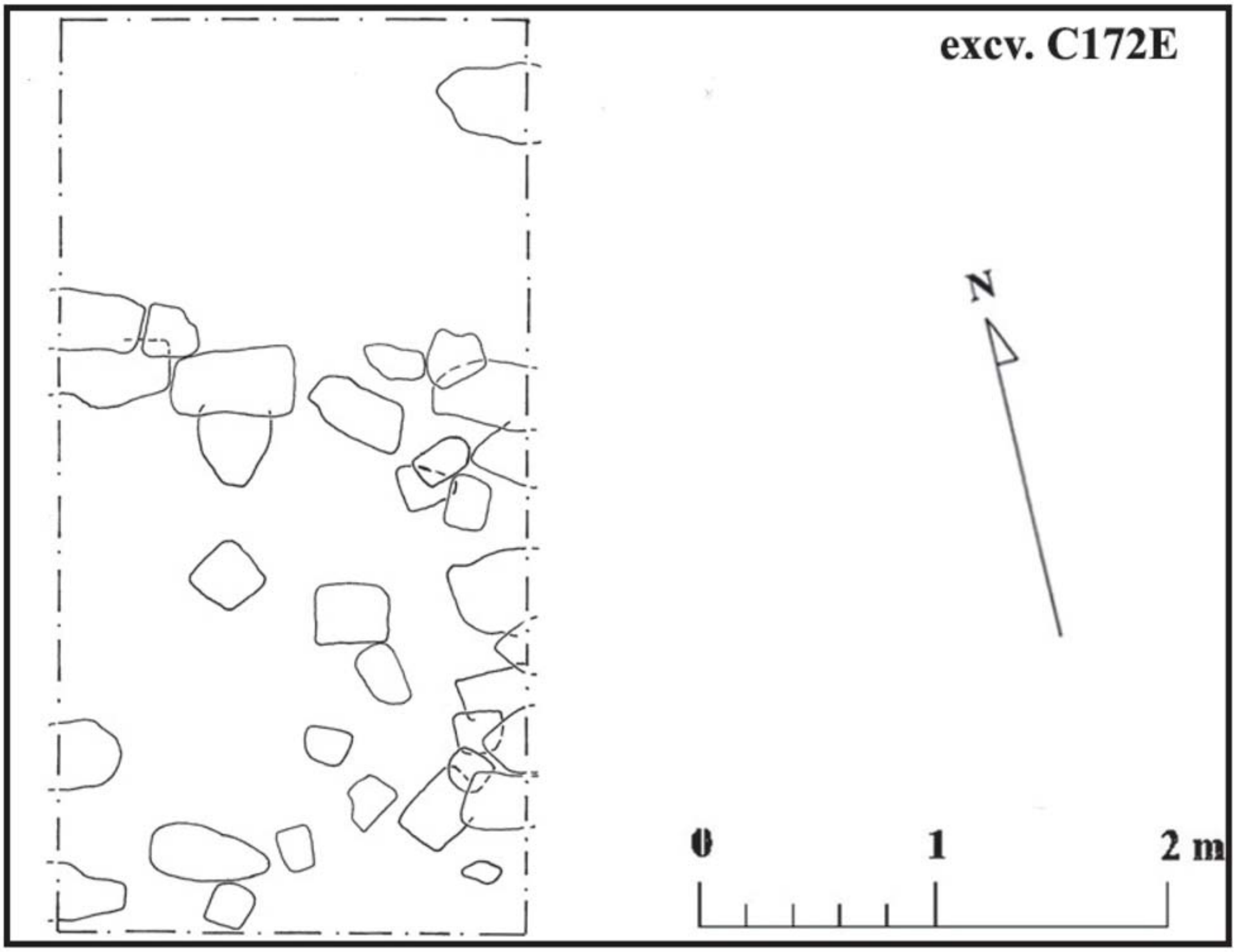

Figure 9: Plan of I21 Reservoir (after A. Chase and D. Chase 2005)

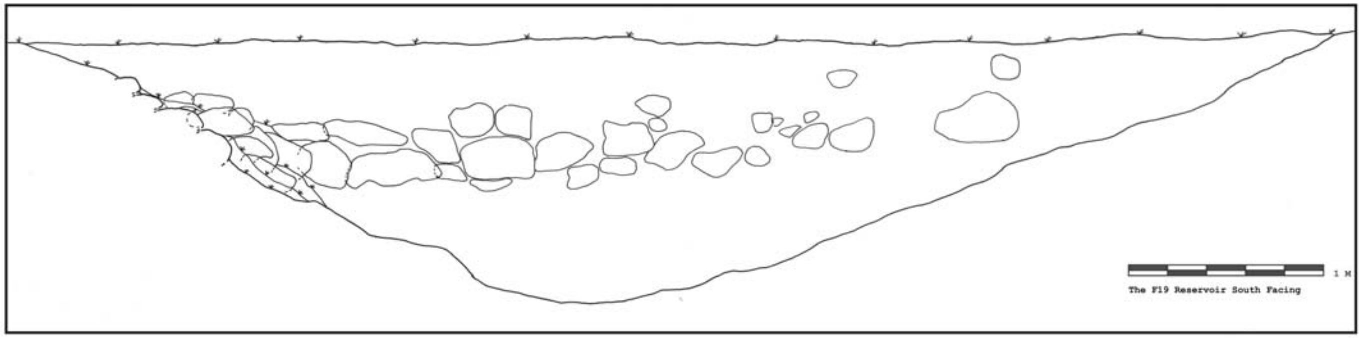

Figure 10: Profile of the A18 Reservoir

Figure 11: Wall lining of the A18 Reservoir. Photo Courtesy of Andrea Slusser

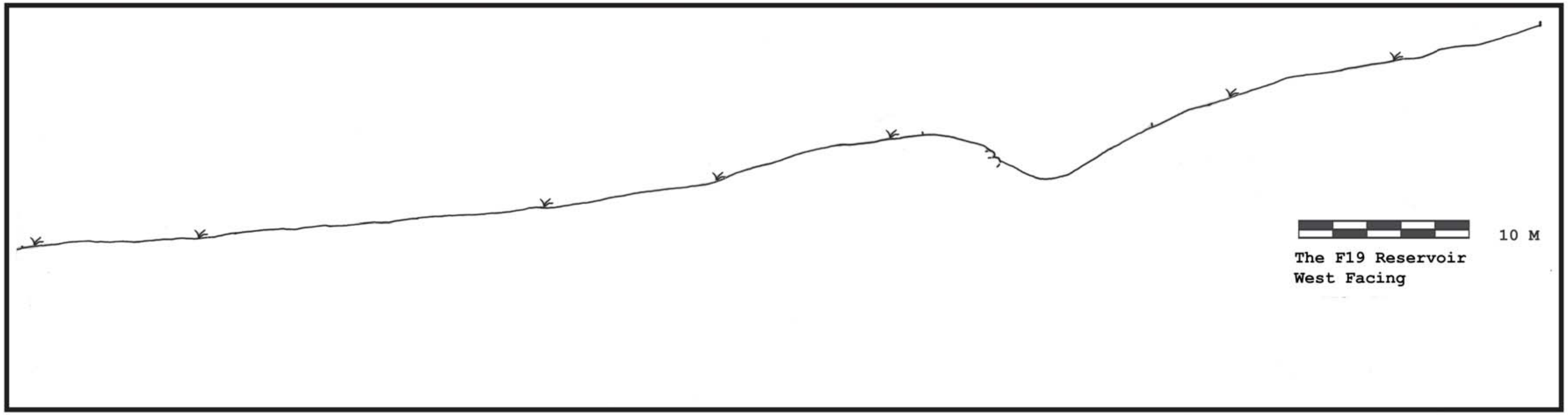

Figure 12: Profile of the A18 Reservoir

Figure 13: Reservoir B, facing north

Figure 14: The cut stone lining of Reservoir B

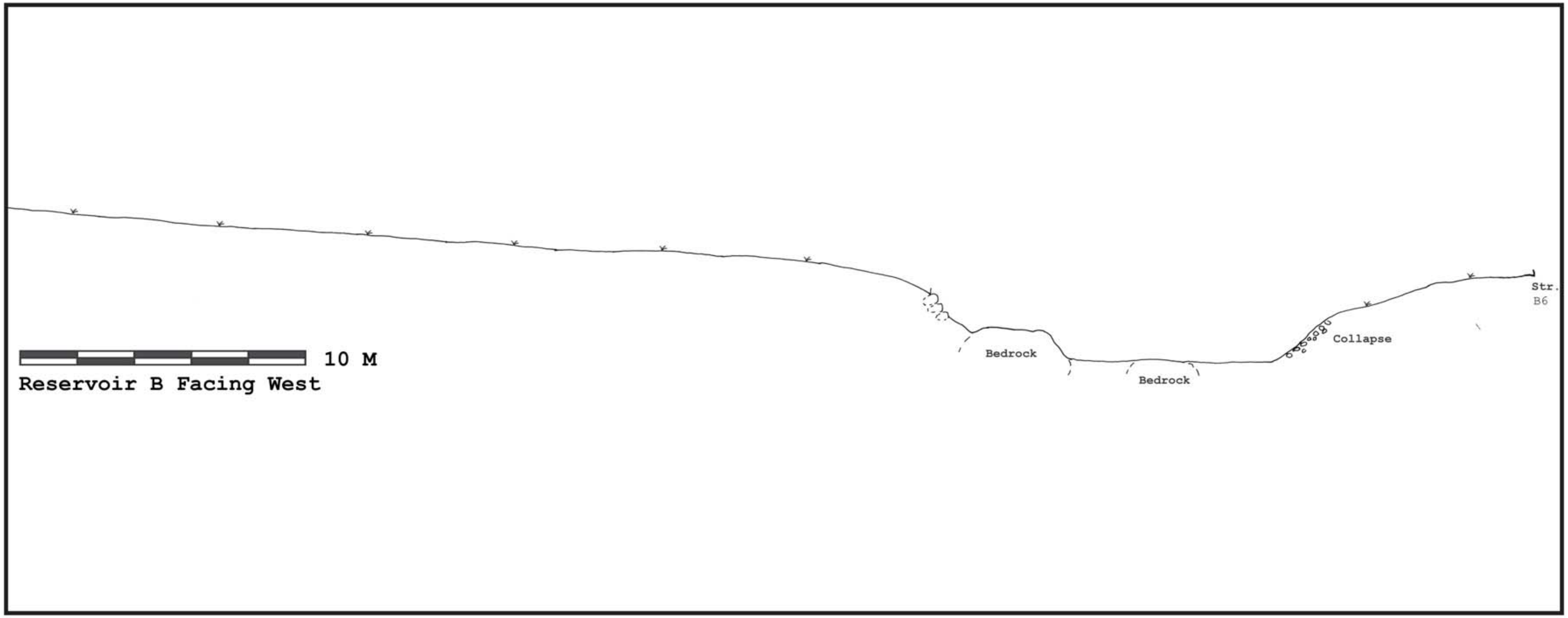

Figure 15: Profile of Reservoir B

Figure 16: Reservoir A, facing southeast

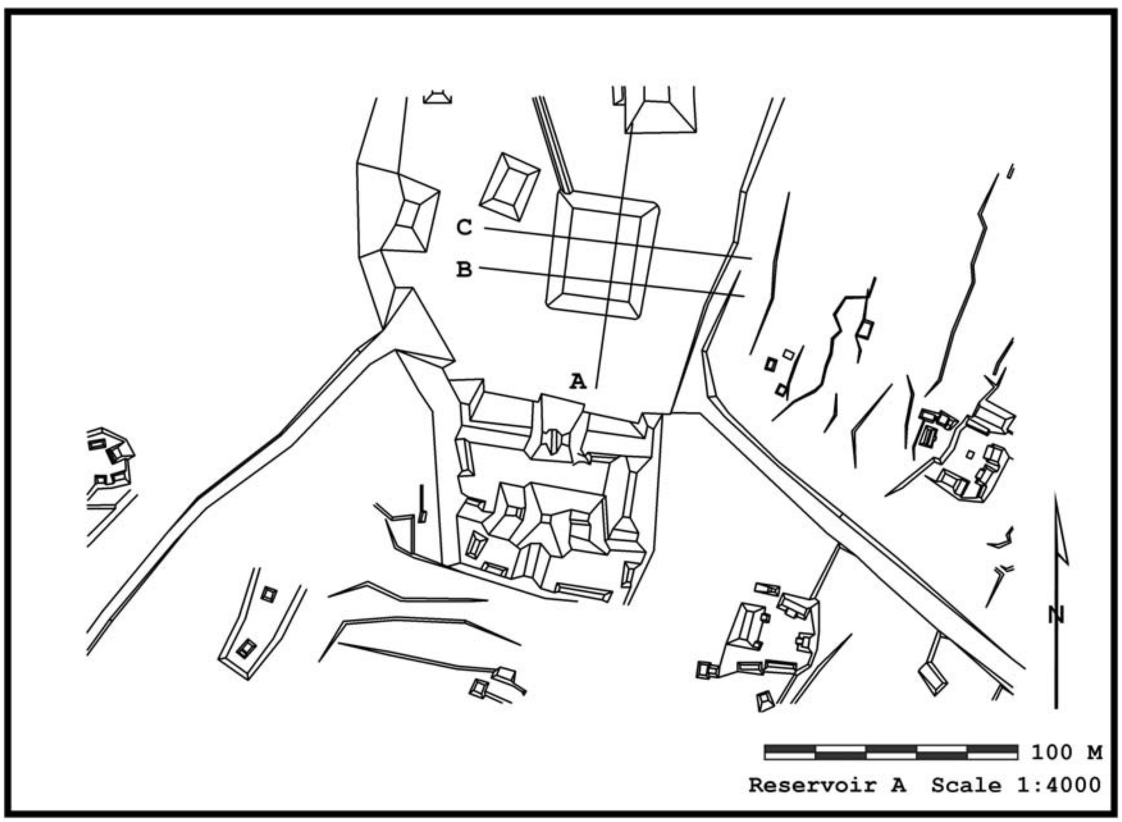

Figure 17: Section lines for Reservoir A (after A. Chase and D. Chase 1987)

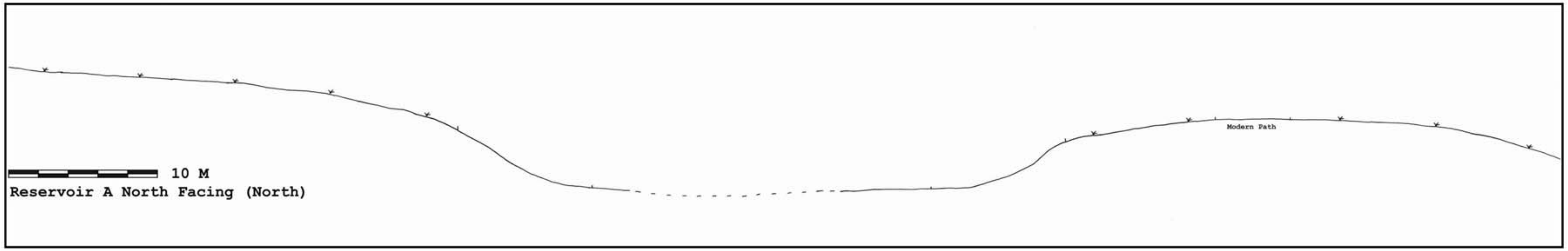

Figure 18: Reservoir A, northern facing (C)

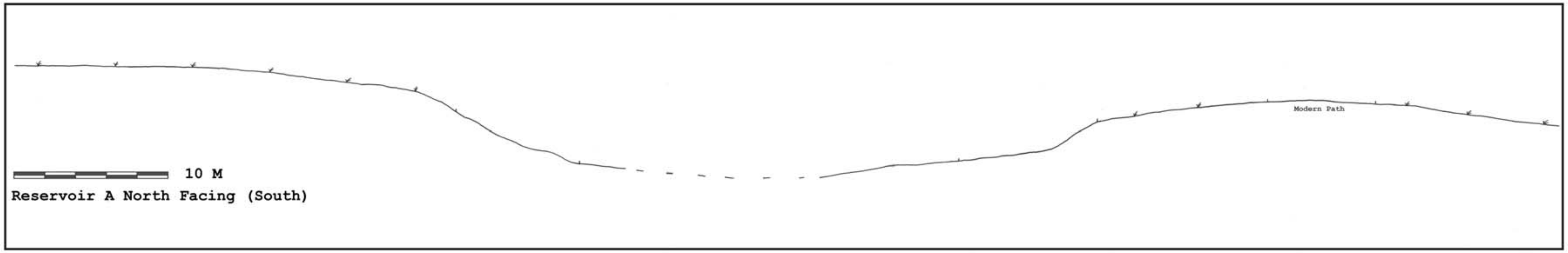

Figure 19: Reservoir A, northern facing (B)

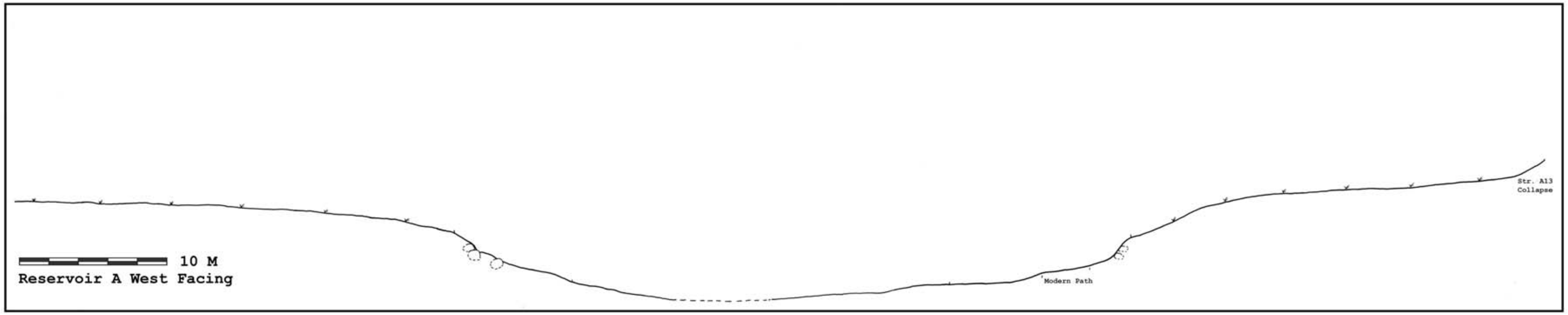

Figure 20: Reservoir A, western facing (A)

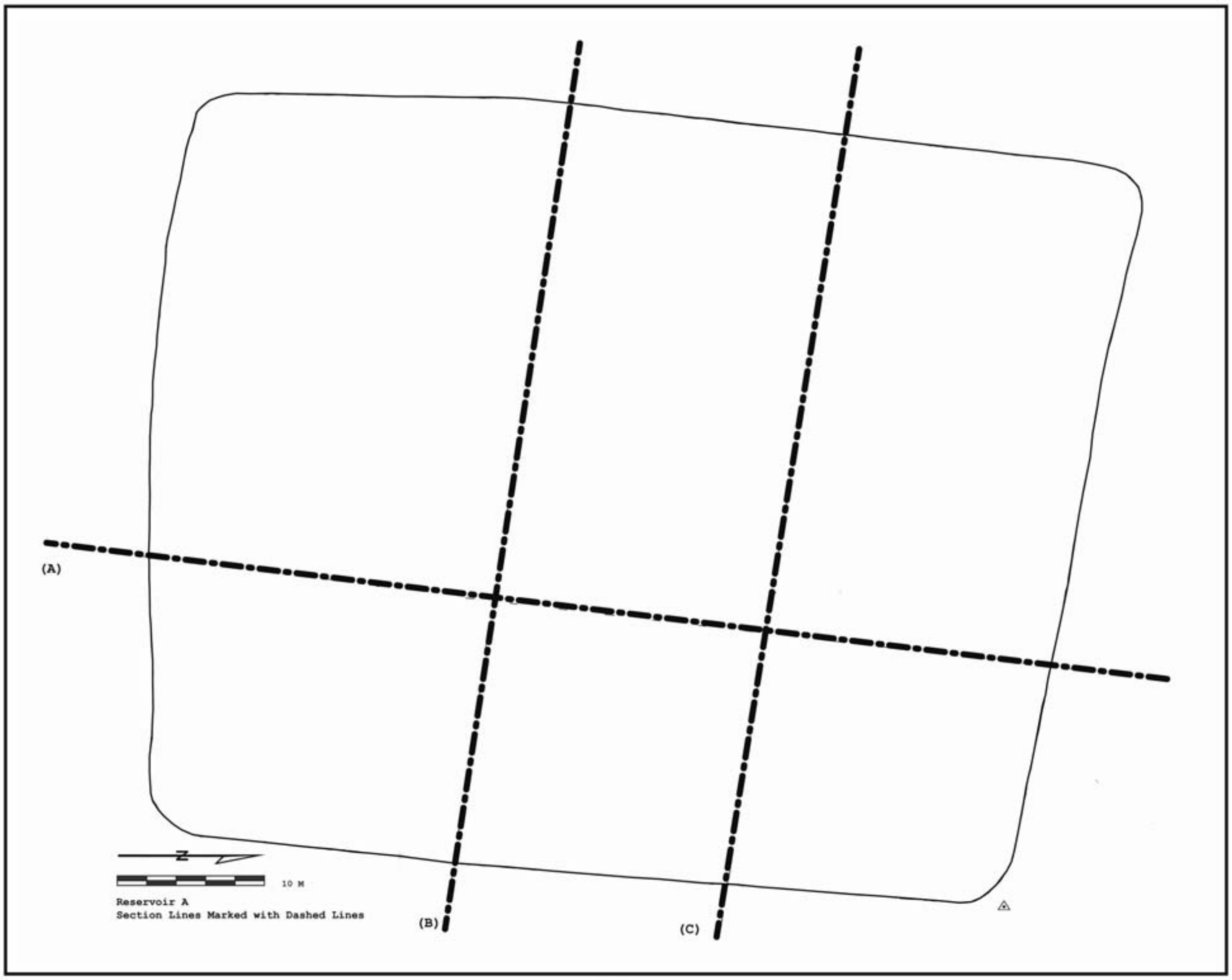

Figure 21: Plan of Reservoir A

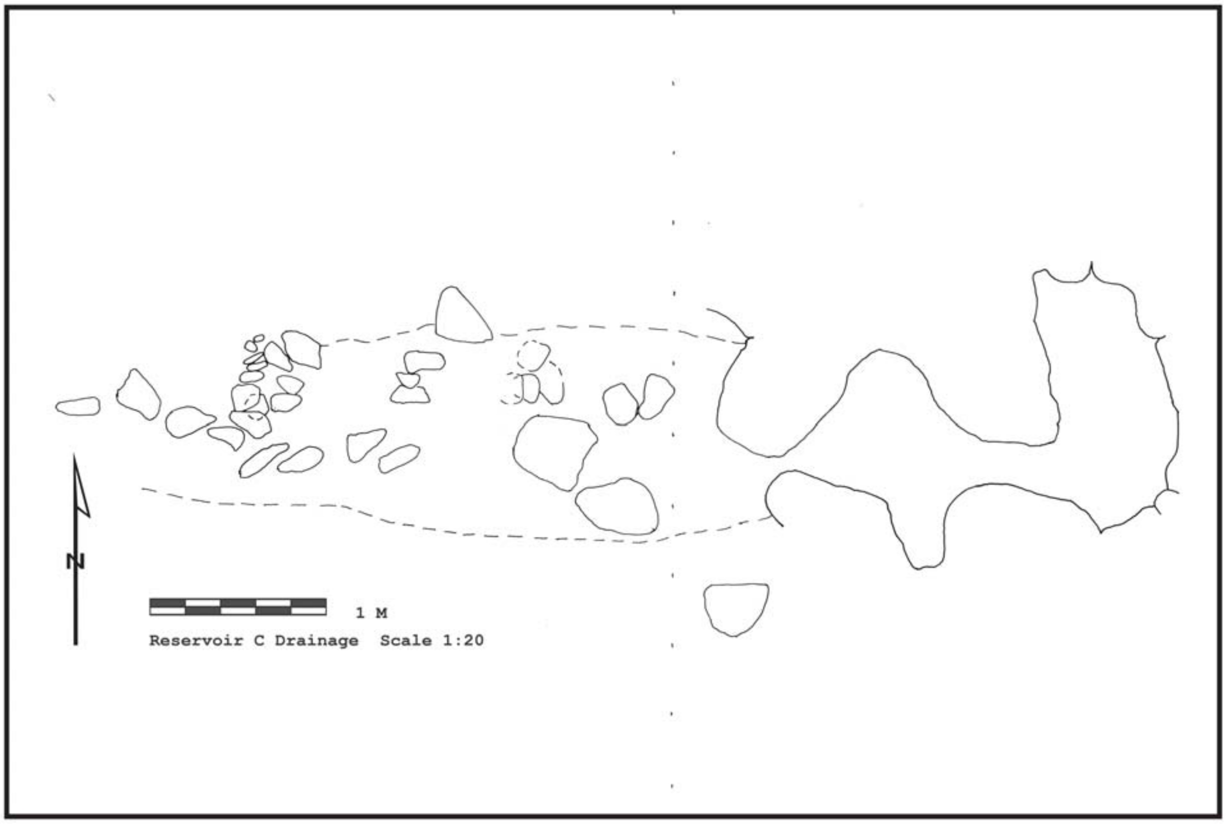

Figure 22: "Reservoir C" drainage plan

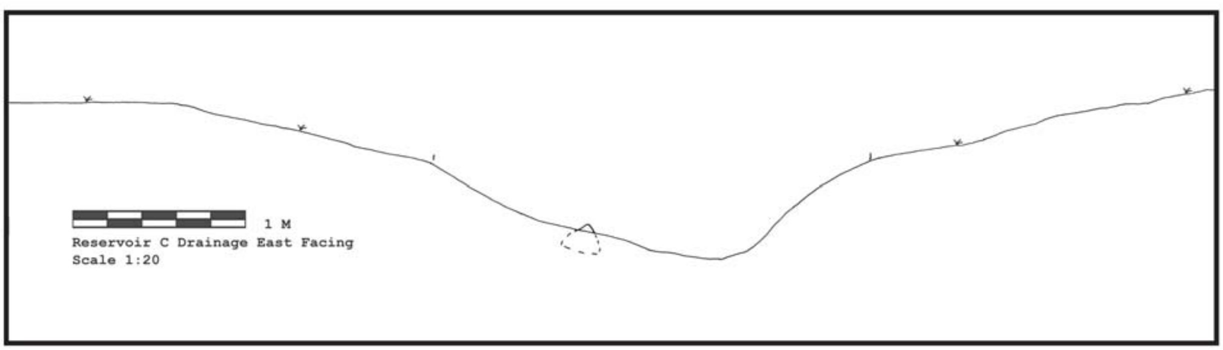

Figure 23: "Reservoir C" drainage section

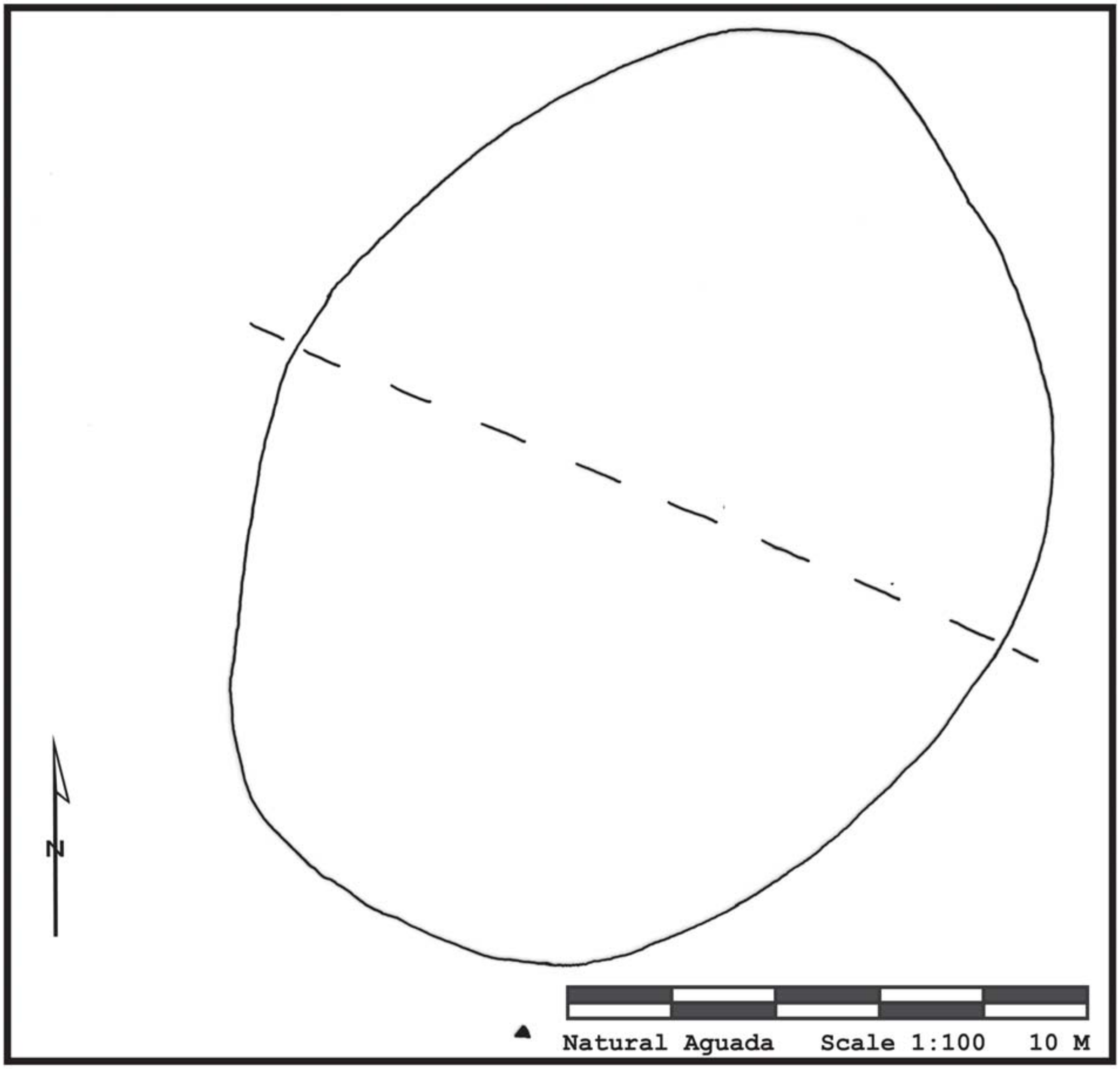

Figure 24: Plan of natural epicentral aguada

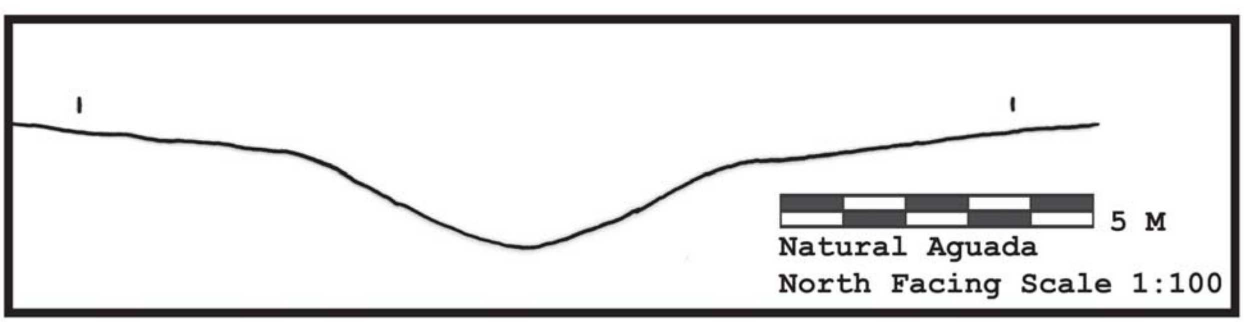

Figure 25: Profile of natural epicentral aguada

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