AN INVESTIGATION OF WATER SUPPLY IN ROMAN ANKARA

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ABSTRACT

AN INVESTIGATION OF WATER SUPPLY IN ROMAN ANKARA

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The existence of two baths, if not more, in Roman Ankara reveals that a considerable amount of water was needed at least for the working of these baths. However, how and from where this water was supplied is not so clear because of the lack of both archaeological and historical evidence. In this regard, by bringing together all the archaeological data so far discovered and the available published information regarding the water supply scheme in order to see all this data collectively in a single picture, this thesis tries to investigate how and from where the water was supplied to Roman Ankara. In addition, this thesis reviews the available water potential of Ankara considering geography and hydrology of the site and also contains an analysis of how water was supplied in the more recent history of the city which is believed to contain invaluable information regarding the ancient water supply scheme of the city especially when the archaeological data is very scarce.

Keywords: Aqueduct, Water Supply, Roman Ankara

ÖZ

ROMA DÖNEMİ ANKARA'SINDA SU TEMİNİ ÜZERİNE BİR ARAŞTIRMA

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Roma dönemi Ankara'sında iki hamamın bulunması, en azından bu hamamda kullanılmak üzere ciddi miktarda suya ihtiyaç olduğunu ortaya koymaktadır. Fakat, suyun nasıl ve nereden temin edildiği konusu arkelojik ve tarisel verilerin azlığı nedeniyle henüz açıklık kazanabilmiş değildir. Bu anlamda, bu tez şu ana kadar keşfedilmiş bütün arkeolojik veriler ile su temini üzerine yayımlanmış bütün bilgileri bir araya getirerek suyun Roma dönemi Ankara'sına nasıl ve nereden temin edildiğini araştırmaya çalışmaktadır. Buna ek olarak, bu tez coğrafik ve hidrolojik olarak Ankara çevresindeki mevcut su kaynaklarını gözden geçirmekte ve şehrin yakın tarihinde suyun nasıl temin edildiğini de analiz etmektedir, ki bunun özellikle arkeolojik verinin kıt olduğu durumlarda daha eski zamanlardaki su temin sistemine ait değerli bilgiler içerdiği düşünülmektedir.

Anahtar Kelimeler: Aküdükt, Su Temini, Roma Dönemi Ankara'sı

To the memory of my father,

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The existence of two baths, if not more, in Roman Ankara reveals that not only a certain but also a considerable amount of water was needed at least for the working of these baths. But how and from where this water was supplied is not so clear because of the lack of both archaeological and historical evidence. Public baths were sometimes supplied from wells or cisterns but as far as the size[1] of the bath complex at the Çankırıkapı district of Ankara is considered – it is one of the largest of its kind in the Roman world – it certainly seems more plausible to think that it must have been supplied with continuous running water by an aqueduct. Reinforcing this way of thinking, numerous pierced stone blocks re-used on the fortification walls of the citadel together with some others coincidentally encountered during miscellaneous public excavations for public works are all thought to be the remains of an aqueduct system supplying water for the bath and maybe for the other parts of the ancient city as well[2]. Since there is no information or evidence regarding the

[1] Inge Nielsen states that early established baths were supplied with water from wells or cisterns but this limited the amount of water used and thus the size of the baths and of the pools (Nielsen 1993:23). She also asserts that as the aqueducts had been cut-off in the Late Roman and Byzantine times, the baths were again started to be supplied from cisterns and wells and eventually the sizes of baths and especially pools are reduced (Nielsen 1993:24). Similarly according to Hodge, "it is not unknown for a bath to function, on a small scale, without any connection to an aqueduct, but for a serious enterprise water was needed in quantities that only an aqueduct could supply" (Hodge 1992:6). He adds that "usually, then, the construction of a large bath complex was the chief reason for a building an aqueduct; sometimed the only one" (Hodge 1992:6). Also, Yegül points out that for the larger baths and the *thermae*, it became a necessity to supply water from the city aqueducts which was the most effective and reliable method (Yegül 1992:391).

[2] Also, an "aqueduct" is mentioned on a late antique inscription (Bosch 1967:369 no. 306).

existence of any overground[3] structure supporting the aqueduct, these pierced blocks forming a watertight pipe with their female and male connections at both ends, appear to be the members of an underground pipe system.

So far this water supply system has not been studied in detail[4]. More than 50 years ago, Nezih Fıratlı (1951) made an attempt to bring together all the available information/evidence acquired during the various excavations undertaken in conjunction with public works of the state in order to understand the general characteristics of the ancient Roman water supply system in Ankara. To this end, he has drawn some conclusions regarding the route within the city, the intermediate and final destinations, as well as the source of the aqueduct by making use of the *in-situ* directions of the pierced blocks found. Concentrating on the topography of the site of the bath complex, he also comments on the direction from which the bath was fed by water. In general, he agrees with Ernest Mamboury's conviction that the water was brought by an aqueduct from the springs of Elmadağ. This conviction seems plausible since, firstly, the *in-situ* discovery of the pierced blocks were on the direction to Elmadağ, secondly, the elevation of Elmadağ springs is higher than Ankara[5]; and thirdly, there exist no historical or archeological data regarding the existence of any other ancient artificial reservoir[6]. In 1967, Eşref Özand, the General Director of Ankara Sular İdaresi (Ankara Water Board),

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[3] Although Bosch's translation of the inscription mentioning the aqueduct contains such words as "arches of the aqueduct", Foss asserts that "his translation contains several misunderstandings", and adds that "the word *holkos* does not mean 'arcade', but 'aqueduct' or 'water channel' and is so used in Late Antiquity" (Foss 1977:63 and footnote 146).

[4] Even Afif Erzen does not touch upon the subject of water supply in ancient Ankara while betraying the importance of the city in early ages both from the historical and architectural point of view in his very important book, *İlkçağda Ankara*.

[5] Farrington states that "the basic prerequisite of an aqueduct is, of course, that the source of water be higher than the place to be watered" (Farrington 1995:106).

[6] As pointed out by Nezih Fıratlı (1951) also.

devotes the first chapter of his book titled "Ankara Şehri Su Tesisleri" to the subject of the history of the water supply in Ankara. Although he admits that the Romans brought water to the city from Elmadağ springs for the parts of the city at higher elevations, he believes that the bath was fed by the water coming from the Roman infiltration gallery at Kayaş together with Hanımpınar spring. On the other hand, however, there is one different opinion, which belongs to Julian Bennett, regarding the water source of the aqueduct. Bennett states that the extensive re-use of the pierced blocks in the south-east side of the walls of the citadel suggests that the aqueduct passed nearby and that its source was the headwaters of Ankara Çayı on the slopes of Küre Dağı (Bennett 2003:8). In this context, it is obvious that there exist contradictory ideas regarding the source, route, and final destination of the aqueduct(s) which reveal clearly that due to the lack of reliable archeological evidence, such details of the system are so far not sufficiently understood and its general characteristics are not yet established.

In general, a complete understanding of ancient water supply systems is not easy. The case for Ankara is much more difficult since the available archaeological data regarding the aqueduct is mainly based on coincidental findings at salvage excavations rather than full-scale excavation projects, thus not reported properly. Even though pierced blocks and terracotta pipes were found during the excavation of the bath complex, no information is given about these findings in the published excavation report. Yet, today it is possible to see these findings at the site of the bath complex (Figures 1 and 2). As mentioned at the beginning, the Roman baths must have been an important destination as water is the true lifeline of the bath. Hence its plan, location, and the topography of its site may reveal a good deal of information regarding the aqueduct. In this context, putting the bath complex at the centre, this study aims to bring together all the known information, former ideas and archeological and historical data about the water supply system of ancient Ankara to re-evaluate and re-assess them in order to make some more informed guesses about the general characteristics of the aqueduct. While doing this, modern hydraulic engineering principles will also be consulted. As Dora P. Crouch points out, insights from modern hydraulic engineering can have “chronology-free” validity since water still behaves as it always has and is to be managed as it always was (Crouch 1993:3). Apart from the findings/hypotheses about the water supply system of Ankara, it is hoped that this study will contribute to the more general ongoing discussions regarding the bath complexes and other structures thought to have existed in the ancient city. In addition, a rough quantity estimation of supplied water will certainly help generate further ideas regarding the other unknowns of the city such as population, scale of the city etc.

Structuring the aforementioned aims, this brief introduction is next followed by the chapter titled “Water Source of the Aqueduct”. In this second chapter, the available water potential of the city of Ankara is reviewed considering only the geography and hydrology of the site without considering archaeological evidence. In addition, there is also an analysis of how water was supplied in the more recent history of the city because this subject is believed to contain invaluable information regarding the ancient water supply scheme of the city. In the third chapter, “the knowns” regarding the outline will be re-considered. These knowns, which are the archaeological remains, or places where these remains were discovered or formerly existed, are traced, re-visited and some data regarding the geographical point of the “knowns” are listed. And finally, in the fourth and the last chapter, an overall assessment is made of the knowns together with the data collected; in order to make informed guesses regarding the general characteristics of the aqueduct such as the source, destination and route.

Figure 1: Terracotta pipes visible at the Roman Bath site today (Photo: Emre Kaytan).

Figure 2: Pierced stone blocks visible at the Roman Bath site today (Photo: Emre Kaytan).

CHAPTER II

WATER SOURCE OF THE AQUEDUCT

Natural water sources can be simply classified into two groups as surface and ground waters. Lakes, streams and rivers are the examples of surface waters. On the other hand, ground water is found under ground and it becomes available for use in wells, by the installation of infiltration galleries and by natural springs. Ancient people used both sources to supply water according their needs[7]. For our case, we know that water was needed and supplied in Ankara at least for the working of baths. In this chapter, it will be tried to be understood from where and from which sources the water for such a need might have been supplied in and around Ankara by concentrating on the geography and hydrology of the site rather than the archaeological evidence[8].

"… The quickest way toward an understanding of ancient water problems at a given site is simply to look around to see how water is obtained today and to look closely at available detailed maps to see if there are streams, springs and wells today" (Thomas 2000:13). It is obvious that a few thousand years is a very short time for the topographical characteristics of the site to change considerably[9]. In addition, the climate for the past few thousand years is also

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[7] Hodge states that "one way or another, whether by wells, local springs, or by distant springs tapped and brought to town by aqueducts, it was this ground water that filled by far the greatest part of the ancients' needs" and he adds "surface waters, whether from lakes or rivers, was used less often than might be expected" (Hodge 1992:69).

[8] Consideration of archaeological evidence will be the core subject of next chapter.

[9] According to Mitchell, "the basic geography of inland Anatolia changed little throughout Antiquity" (Mitchell 1995, I:5). There was no drastic geomorphological change in the interior, as occurred along the west and south coasts of Turkey, where the aggradation of river silt and changes in the sea level radically altered the fortunes of some coastal cities" (Mitchell 1995, I:5).

similar to the modern climate, varying within limits with rare events[10] (Thomas 2000:4). Thus, possible sources for an aqueduct such as springs, streams and underground sources should have been at the same place and should have flown with approximately same discharges[11] some few thousand years ago. Then, it can be concluded that especially for the sites like Ankara where both the modern and ancient city had been founded approximately at the same place[12], the people responsible for the water supply of the city must have brought more or less the same solutions to water supply problems throughout the history since their available sources were of nearly the same characteristics. In this context, in order to comment on the possible sources of the ancient water supply of Ankara, we will firstly look at today's physical maps to understand the availability of possible water sources and geological conditions of the site and then secondly examine how the city supplied its water in the near history and today in the manner also suggested by Thomas (Thomas 2000:13) (Figures 3, 4 and 5).

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[10] Dennis Murphy states that "the work by Bottema, Zeist and the Groningen group in studying polen samples obtained through core samples shows that the climate has not changed much in the last 3000 years" (Murphy 2006:160). He adds that "Richard Hodges and David Whitehouse have studied samples from the late Roman and early medieval periods with basically the same result" (Murphy 2006:160). He also asserts that "in time, the current work of Peter Kunihom and the Aegean Dendrochronology Project will be able to provide a beter picture of climate changes on the Anatolian Plateau and the Taurus Mountains where tree-rings spanning long periods of time can be recorded" (Murphy 2006:160).

[11] Discharges may change as vegetation and soil are altered by human intervention and erosion respectively. However, Mitchell states that, "the vegetation cover of the interior (Anatolia) also remained broadly similar from the early Hellenistic period until the end of Antiquity (Mitchell 1995, I:5-7). "Doubtless intensive agricultural exploitation and widespread timber cutting in the Roman imperial period brought previously untilled land under cultivation and eroded the forest cover in specific locations, but not to the extent of fundamentally altering the landscape's appearance" (Mitchell 1995, I:7). "The central Anatolian plateau was as treeless in Antiquity as it is today; despite the heavy exploitation of timber forests of Bithynia, Paphlagonia, and Pontus in the north; Mysia in the north-west; and Lycia and Cilicia in the south, the tree cover was not destroyed or significantly reduced" (Mitchell 1995, I:7).

[12] Mitchell points out that most of the Roman city lies hidden under modern Ankara (Mitchell 1995, I:104).

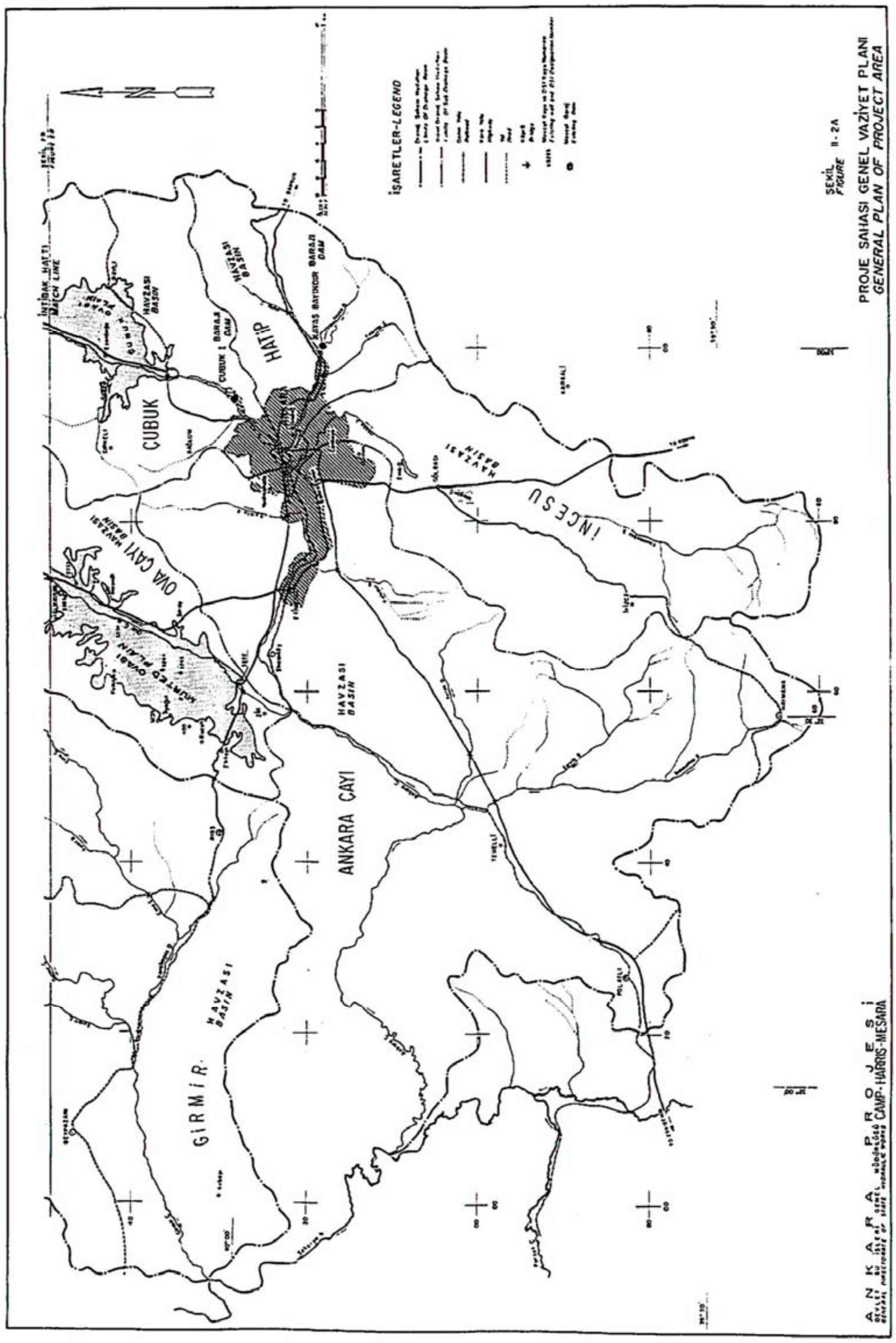

Figure 3: Surface water potential around Ankara, the southern part (Source: Camp-Harris-Mesara:1969).

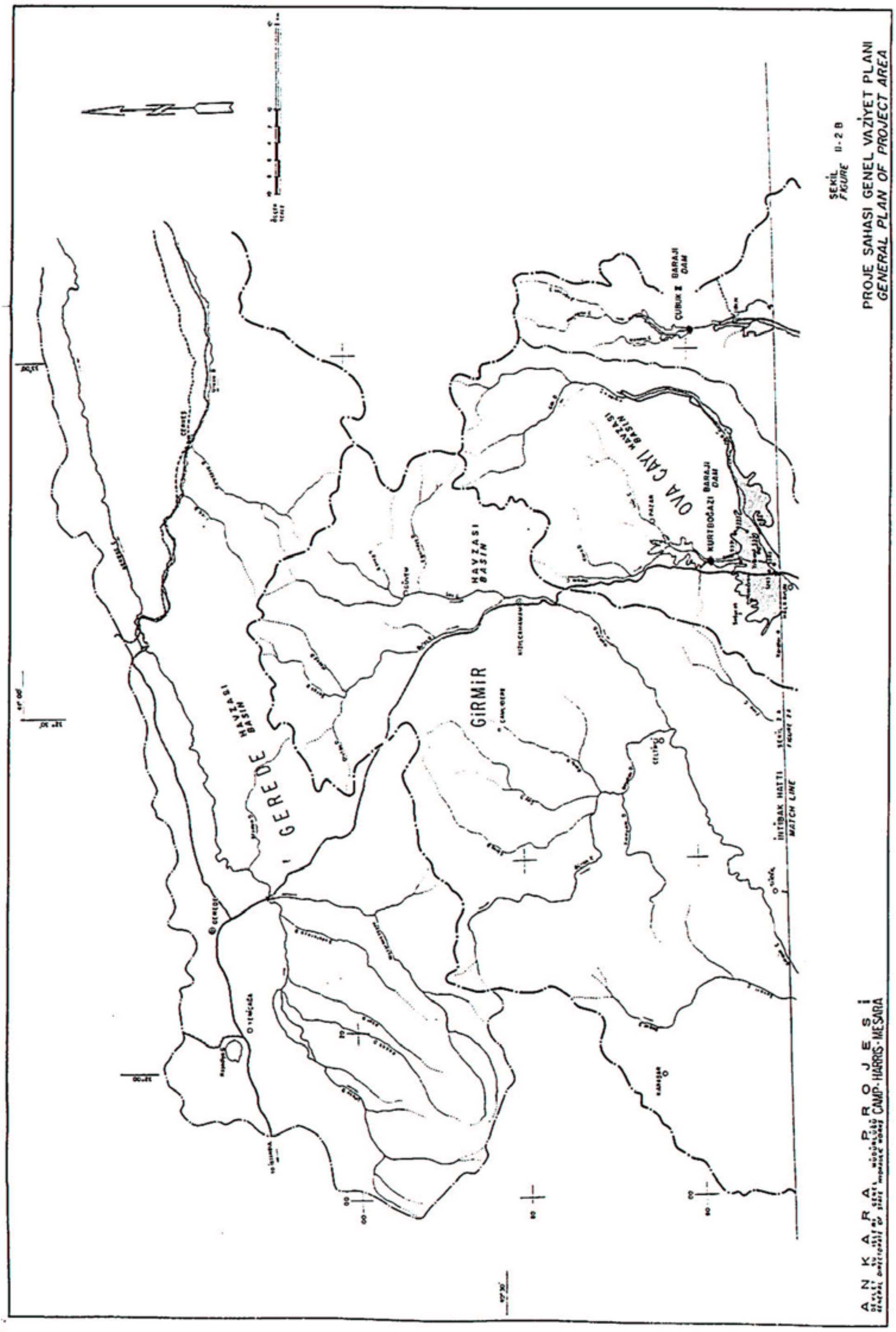

Figure 4: Surface water Potential around Ankara, the northern part (Source: Camp-Harris-Mesara:1969).

When examined within the context of the region to which it belongs, Ankara appears to have been established on a relatively well-watered territory (Aydın et al. 2005:20). This situation is a consequence of a special geography existing around the city (Figure 5). The city's far-north is bounded with Köroğlu Mountains, a part of the Karadeniz (Pontic) Mountain range. This mountain range acts as a barrier for the winds carrying rainy clouds making the region turn to a steppe (Aydın et al. 2005:21). However, these mountains are rich in water sources which balance the steppe drought (Aydın et al. 2005:19). The closer vicinity of Ankara is shaped by the mountains which protrude from the Köroğlu range towards the city (Aydın et al. 2005:21). These mountains are Ayaş and Mire on the west, Karyağdı[13] in the middle and İdris-Elmadağ range on the east (Aydın et al. 2005:21).

Figure 5: Physical map of the region (Source: MTA web page).

[13] Karbasan Mountain at the map? (Figure 5).

At the bottom of the valleys between these mountains flow the most important surface waters of the city which are the main tributaries of Ankara Çayı[14] (Engürü Suyu). Among these surface waters, naturally flowing toward the city are Çubuk Çayı, Hatip Çayı (Bentderesi) and İncesu Deresi. Such surface waters[15] which flowed through the city were used by ancient people as water supply sources but not that frequently as expected (Hodge 1992:69). Hodge states that the more seldom use of river water was due to a couple of reasons. Firstly, it is too polluted and secondly, the water has to come from a higher source since most cities were founded on high ground (Hodge 1992:70-71). In addition, as also pointed out in the introductory chapter, running water to the large scale baths must have been supplied by an aqueduct, not by a well or cistern, whose most common source was a spring[16], underground water naturally or sometimes artificially[17] meeting the surface. Thus, it would be more convenient to direct our attention to the springs at the elevations higher than the city which finally fed these creeks running at valley bottoms.

The existences of such perennial streams as Çubuk Çayı and Hatip Çayı which flow very close to city in the valleys between Elmadağ, Mire and Karyağdı mountains remind us of the abundance of their tributaries which are fed by gushing springs and streams on higher elevations of these mountains. Among these mountains, as also pointed out by Fıratlı[18], the most possible place for

[14] Mitchell mentions Ankara Çayı as a perennial stream running through the Roman city (Mitchell 1995, V1:105).

[15] Also there are two lakes at a very close vicinity to the city. However, these lakes will not be considered as a water source for aqueduct in this study because according to Hodge, lakes were, surprisingly, almost never used as a source for Roman aqueducts (Hodge 1992:79).

[16] As pointed out by Hodge (Hodge 1992:72).

[17] Underground water was sometimes made available artificially by use of collection structures or galleries drilled below the groundwater table.

[18] Nezih Fıratlı states that water in good quantity and quality could have been brought to the city only from Elmadağ as there exists no ancient installation like modern Çubuk Dam (Fıratlı

water supply seems to be Elmadağ due to a couple of reasons. Firstly, Elmadağ is rich in a reliable quantity of water sources in the form of groundwater, springs, and surface streams. It is known that the most important tributaries of perennial streams Hatip Çayı and İncesu Deresi are received from Elmadağ (Figure 6). According to Dewdney, these streams drain the northward slopes of Elmadağ (Dewdney 1971:190) (Figure 6). In addition, Özand states that because of its high but not so steep structure, Elmadağ is the most important one among the high mountains around Ankara as far as the underground water potential is concerned (Özand 1967:29). As Elmadağ receives more precipitation in the form of snow than Ankara, which sometimes occurs very heavily, most of the melting snow on the slopes seeps down to the ground through the cracked formation and contributes to the long groundwater flows (Calvi 1936:18)[19]. It is obvious that the mentioned groundwater flow will not only feed the streams flowing in valley bottoms, but more importantly it will also be the source for the springs. Secondly, its altitude is higher than the city to provide enough level and as important as this, it is the closest one among the aforementioned mountains to the city. For ancient man, apart from the reliability of the quantity and the quality, the construction ease and consequently cost of the water supply must have been an important concern in the selection of the water source. It then follows that when the desired quantity of water is available at a closer distance, it should have been utilized first since it would be easier and less costly to construct an

1951: 350). - However there exists an ancient dam constructed by Romans on Hatip Çayı (Bentderesi) according to Eşref Özand (Özand 1967:2). In addition, Fıratlı asserts that it is not possible to bring water to Ankara from any place other than Elmadağ as far as the altitudes and the capacity of the springs are considered (Fıratlı 1951: 355).

[19] According to Calvi, much of the precipitation amount in Ankara contributes to the groundwater due to the cracked formation which is suitable for seepage (Calvi 1936:29). He adds that permeable and impermeable layers in lower elevations formed due to the river sedimentation keep the seeping water from the mountains. Thus it can be said that Ankara is rich in underground water sources (Calvi 1936:29). Use of plenty of wells for different purposes and existence of swamps and marshes within the city supports this belief (Calvi 1936:13).

aqueduct. Thus, supplying water from Elmadağ with less distance for water to be transported and thus having less probability of the existence of natural obstacles or hindrances such as hills on the route of aqueduct to be passed by siphons, arches etc., would require less labor and material, consequently less cost. Therefore, for ancient men, this alternative seems to have been more feasible than others to utilize.

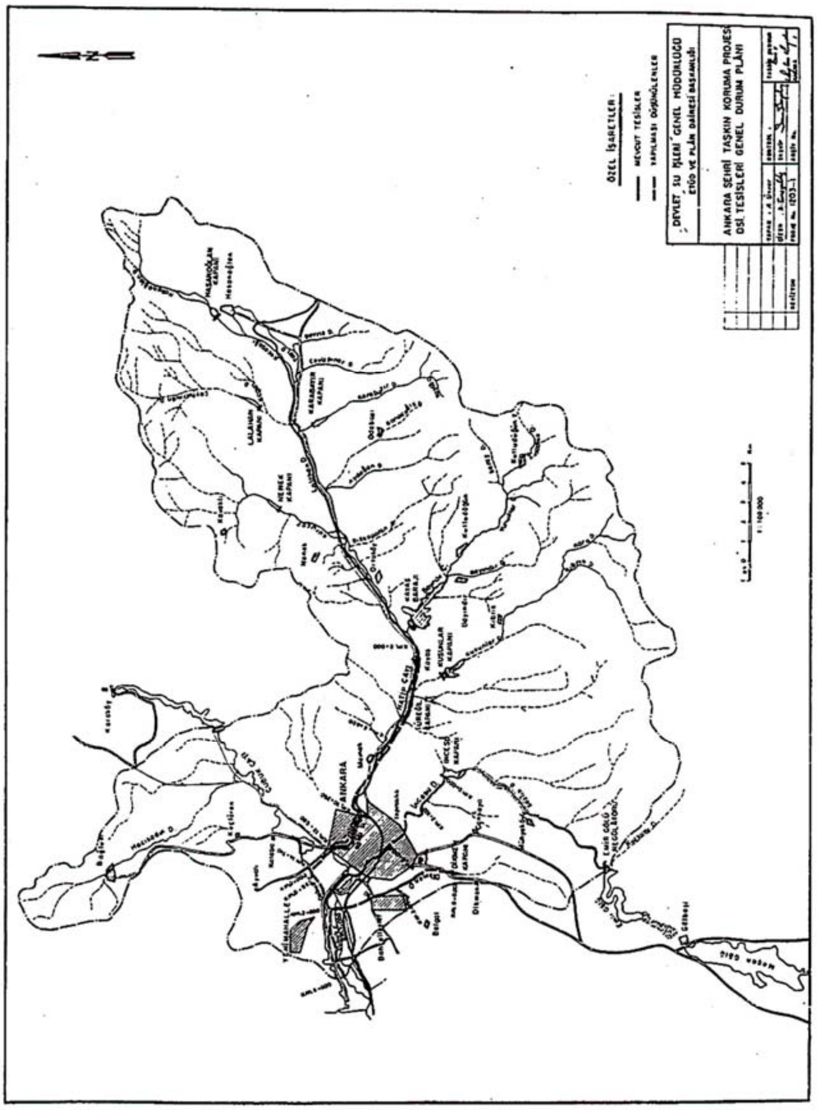

Figure 6: Tributaries of Hatip Çayı and existing structures (Source: DSI 1963:26).

On the other hand, when looking at the recent history of the city, it is interesting to see that underground sources and springs of Elmadağ were also used as a water source before when the city was not as populated as today as also pointed out by Fıratlı[20]. In 1890[21], the water of Elmadağ Kehriz Pınarı and Kayaş Hanım Pınarı springs was utilized by Mayor Abidin Paşa for drinking purpose (DSI 1963:26). We know that during these years, spring water capacity in Elmadağ was re-examined seriously and by re-constructing old installations, water was transported to a storage tank located at Abidinpaşa, Cebeci which was at the elevation of 1000 m. (Özand 1967:3). From this tank, it was possible to transmit water to Ankara Castle, up to the elevation of 960 m., by the means of a newly laid pressure-stand metallic pipeline (Özand 1967:3). Later, Kusunlar underground water collection unit and a 10 km. long aqueduct from Kusunlar were built, together with two pumping stations at Hanımpınar and Şahne in 1925 (DSI 1963:26)[22].

Up to here, all these installations were intended to collect and transmit basically either underground or spring water of the basins of Hatip Çayı and İncesu Deresi which drain the northward slopes of Elmadağ. Afterwards, in response to the rapid increase in population and hence in need for water of Ankara during the early Republic times, the first modern reservoir for water

[20] Nezih Fıratlı states that until the construction of Çubuk Dam, water was supplied to the city from Elmadağ (Fıratlı 1951:355). Even today (1951) water for some districts is brought from Elmadağ (Fıratlı 1951:355). This district must have been Çankaya as seen in Figure 8.

[21] This date is given as 1840 in the source (DSI 1963:26) but it might be a printing error because Eşref Özand (Özand 1967:3) states that our first literary information regarding water supply of Ankara dates back to 1890. According to Aydın et al., it was in 1893 that Hanımpınarı water came to the city (Aydın et al. 2005:253). On the other hand, according to ASKI web page, Elmadağ and Hanım Pınarı springs' water was brought to the city in 1890 by Abidin Paşa (Aski web page).

[22] This structure was initially planned as an underground dam; however it could not be completed. For the interesting history of this planning see Özand (1967) 'Ankara Şehri Su Tesisleri', pp 5-7.

supply from surface flow, Çubuk-I dam, was put in operation on Çubuk Çayı in 1936. And finally, until the year 2000, the construction of other water supply dams followed. Looking at Figure 7, it can easily be seen that as the population and consequently water need increased, the water supply scheme changed its destination from the Hatip and İncesu Basins (springs and underground sources of Elmadağ), to Çubuk Basin (Çubuk-I and Çubuk-II surface dams on Çubuk Çayı), and then towards far-north (other surface dams at Girmir and Gerede Basins), Köroğlu mountains, where the water sources are rich enough for a city of more than four million population. In this context, it can be concluded that before the construction of modern dams whose sources are richer but more distant, the city initially used such moderate but easily utilizable sources as underground sources at Hatip Çayı Valley on the slopes of Elmadağ by means of underground water collection galleries and Elmadağ springs. The water supply planning of Ankara in year 1936 shows how springs and underground water sources of Elmadağ were utilized as a part of water supply scheme of the populated city (Figure 8).

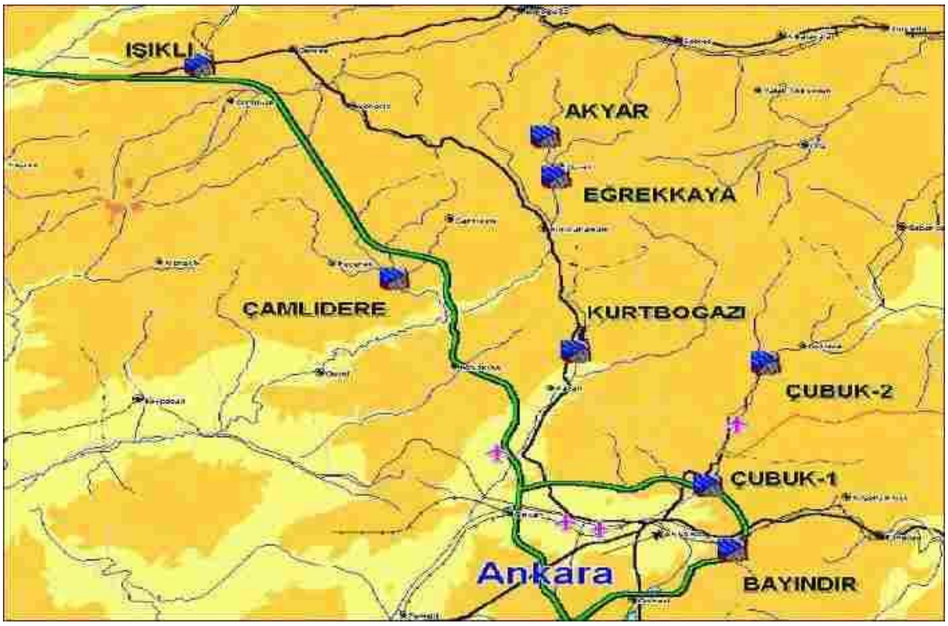

Figure 7: Modern dams for water supply in Ankara (Source: ASKİ web page).

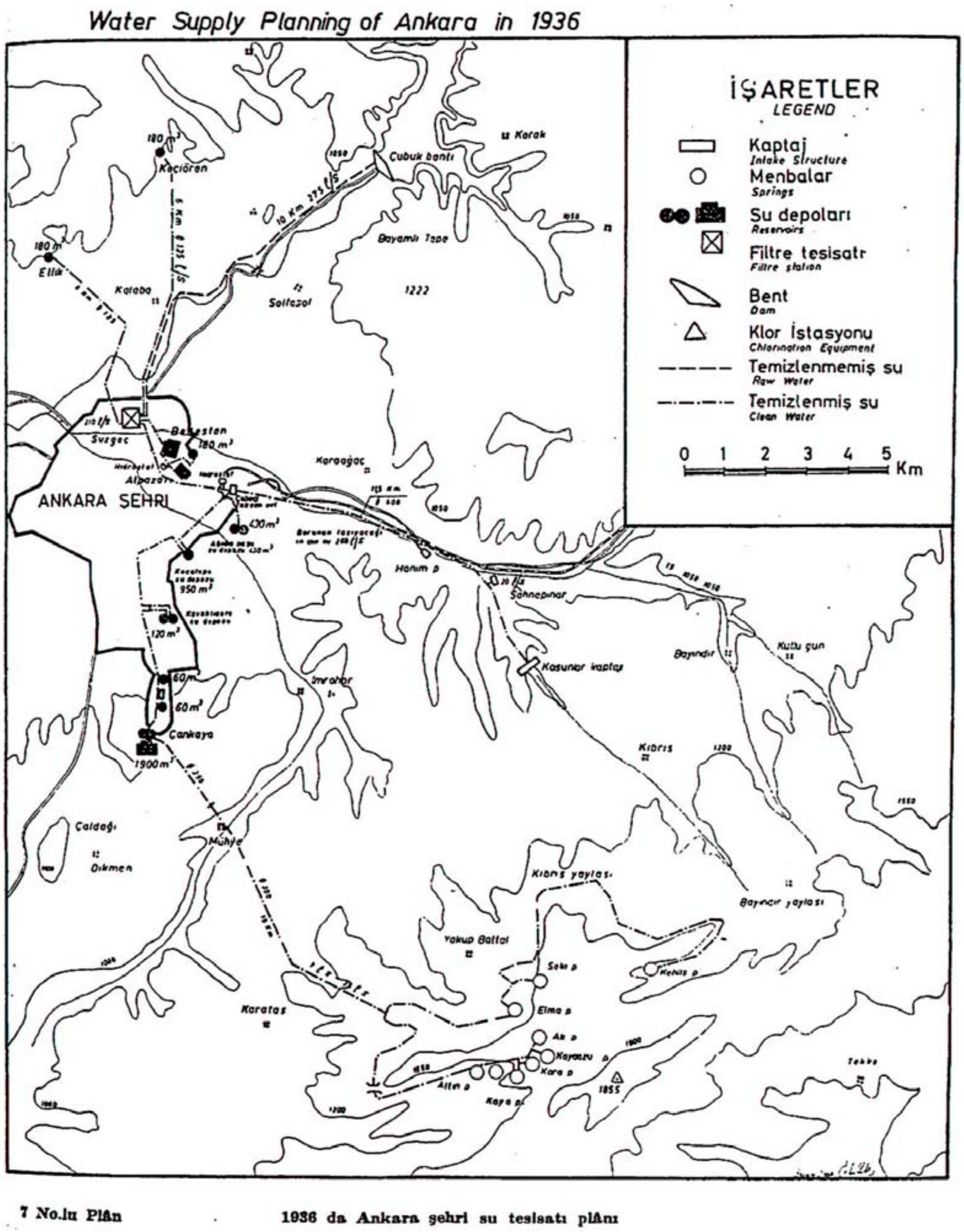

Figure 8: Water supply planning of Ankara in 1936 (Source: Özand 1967:9).

These utilized sources were not only relatively closer to the city than other possibilities, but also rich enough to provide water –supplemented by some additional sources[23]- for a city with a population of approximately 30,000[24]. Accordingly, it can be reasonably concluded that the springs and underground sources of Elmadağ would have been also enough in quantity at least for the baths of the Roman city, the population of which was above 25,000[25]. So why should ancient people have chosen a harder and more expensive way to bring water from somewhere else (headwaters of Ankara Çay on the slopes of Küre Dağı as suggested by Bennett[26]) when water in desired quantity is available very close to the city on Elmadağ and Hatip Çayı Valley? In addition, considering the location of Küre Dağı, it can be seen that it is beyond the Karadeniz Mountain range and belongs to a different drainage area which not related with Ankara Çayı. Thus, such an assumption appears as questionable and unlikely, most probably due to a mixing of Turkish names.

To conclude, being abundant enough and utilizable, both geographically and historically, Elmadağ springs and underground sources appear as the most possible source for the aqueduct which was supplying water to the baths. In the next chapter, the problem of source will be again turned to assessing the archaeological remains to investigate how far the material evidence supports these suggestions.

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[23] These other sources are Lake Eymir, Roman infiltration gallery at Kayaş to collect underground water, and the wells and cisterns (Aydın et al. 2005:252-253).

[24] In the very early 20th century, the population of Ankara was around 30,000 (Aydın et al. 2005:214, Table X-5).

[25] Although ancient population figures are difficult to ascertain, Mitchell mentions Ankara among the Roman cities with a population of more than 25,000 (Mitchell 1995, I:244).

[26] Bennett 2003:8

CHAPTER III

REVIEW OF THE "KNOWNS" REGARDING THE AQUEDUCT

As it was pointed out in the first chapter, the water supply system of ancient Ankara, unfortunately, has not been studied in detail so far, probably due to the scarcity of archaeological and historical evidence. We have almost a unique article "Ankara'nın İlk Çağdaki Su Tesisatı" written by Nezih Fıratlı in 1951, which is completely devoted to the aforementioned subject. Considering the very few archaeological findings and depending on the field surveys he made, Fıratlı tries to determine the course of the aqueduct within the city. In addition to this article, the first chapter of Eşref Özand's book "Ankara Şehri Su Tesisleri" is also allocated to the subject of history of water supply in Ankara, covering a very wide timescale from the Roman era to the early Republican times. Being the General Director of Ankara Sular İdaresi (Ankara Water Board) and a water supply expert, Özand's chapter has a more technical tone which, to my opinion, might sometimes be as useful as archaeological findings (if not more) to comment on ancient water supply systems especially when the archaeological remains are very scarce. The items, enumerated under the "knowns", listed below are mainly extracted from these two articles and also from some other scattered published sources where the water supply system or the aqueduct of ancient Ankara has been mentioned. In this regard, this chapter aims to bring together all the archaeological data so far discovered and the available published information regarding the aqueduct. Also, and more important, several of the places mentioned in the published testimony were re-visited. In addition, approximate geographical data such as simple elevations and distances was collected in order to re-map all the "knowns". Although our knowledge regarding the aqueduct is very limited and sometimes contains contradictory ideas and facts, it is believed that seeing all this data collectively in a single picture might enable us both to reassess former ideas and also to make some more informed guesses about the water supply system of ancient Ankara in the following chapter.

For the purpose of clarity, it is believed that it will be more convenient to start the listing of the "knowns" with the coincidentally discovered remains of the pipeline during the public excavations. Secondly, the Roman bath itself is analyzed as an important terminal point of the aqueduct. And finally, miscellaneous elements related with the water works which are known to have existed in or around the city, such as the Roman infiltration gallery and the Roman dam, are covered in this chapter.

3.1. Course of Pierced Blocks at Atpazarı and Discovered Remains during the Railway Excavation at Cebeci Station

According to Nezih Fıratlı (1951), Ernest Mamboury is the first researcher to discuss the aqueduct of Ankara. In his book "Ankara, Guide Touristique", Mamboury asserts that the water might have been supplied from Elmadağ since the course of the pierced blocks seen opposite Saraçsinan Mescidi was laid on the direction to Elmadağ (Fıratlı 1951:350) (Figures 9 and 10). Reaffirming this point of view, Fıratlı reports that remains of the two stone pipelines[27] discovered parallel to the asphalt road bridge[28] during the railway excavation at Cebeci Station was also laid on the direction to Elmadağ (Fıratlı

[27] Discovered pipelines were traced at a depth of 5 m. below the natural ground in 1945 and were composed of 22 cm. diameter pierced blocks (Fıratlı 1951:354).

[28] As far as the map of Nezih Fıratlı is concerned, this motorway bridge should have been Cebeci Railway Bridge on Talat Paşa Bulvarı.

1951:350) (Figure 11). Then, he concludes that this course of seven[29] pierced blocks located on Atpazarı Sokak No: 109, directly opposite Saraçsinan Mescidi, must have been the continuation of the pipe remains discovered at Cebeci Railway Station (Fıratlı 1951:350) (Figures 9 and 10). According to him, not only the *in-situ* laying direction of both pipes, but also the presence of scattered blocks on Başmil[30] Sokak, Ulucanlar Sokak, and Atpazarı Sokak between Cebeci Railway Station and Saraçsinan Mescidi support this conclusion[31] (Fıratlı 1951:350).

From Saraçsinan Mescidi on, Fıratlı asserts that the pipeline continued to the south-east of the citadel, towards Atpazarı depending on the laying direction of the seven-block course and two-meter wide ditch on the other side of Atpazarı Sokak, carved in a soft stone to place the pierced blocks (Fıratlı 1951:350). In Atpazarı, he believes there existed a storage tank/reservoir around Hisarkapısı, where the water was distributed to Roman Ankara which was located on the west of the citadel (Fıratlı 1951:350-351). However, he does not give any information about how he inferred that a storage tank existed at Hisarkapısı[32]. In this regard, he only refers to the visible scattered pierced blocks on Aslanhane and Safa Streets between Hisarkapısı and Saraçsinan Mescidi to show that the pipeline passed between these two places (Fıratlı 1951:350-351).

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[29] Although it is reported as a course of seven blocks by Fıratlı (Fıratlı 1951:350), it contains six blocks (Figure 10).

[30] Başmil or Beşmil Sokak should have been the part of today's Ulucanlar Street towards Talat Paşa Bulvarı.

[31] The diameter of the course of blocks found opposite Saraçsinan Mescidi is also 22 cm.

[32] Maybe because the aqueduct reached the highest elevation within the city at Hisarkapısı, Fıratlı might have been led to conclude that a storage tank would be needed here to distribute water. Note that a modern storage tank also existed at Hisarkapısı to distribute water to Ankara during 1930s (See Figure 8). Note also that the district is today called Sutepe Mahallesi, which means "Waterhill District" and there exist a street ending at Hisarkapısı Meydanı called Depo Sokak which means "Tank Street" in Turkish.

Figure 9: Block course opposite Saraçsinan Mescidi at Atpazarı Sokak (Photo: Emre Kaytan).

Figure 10: Closer view of the same block course (Photo: Emre Kaytan).

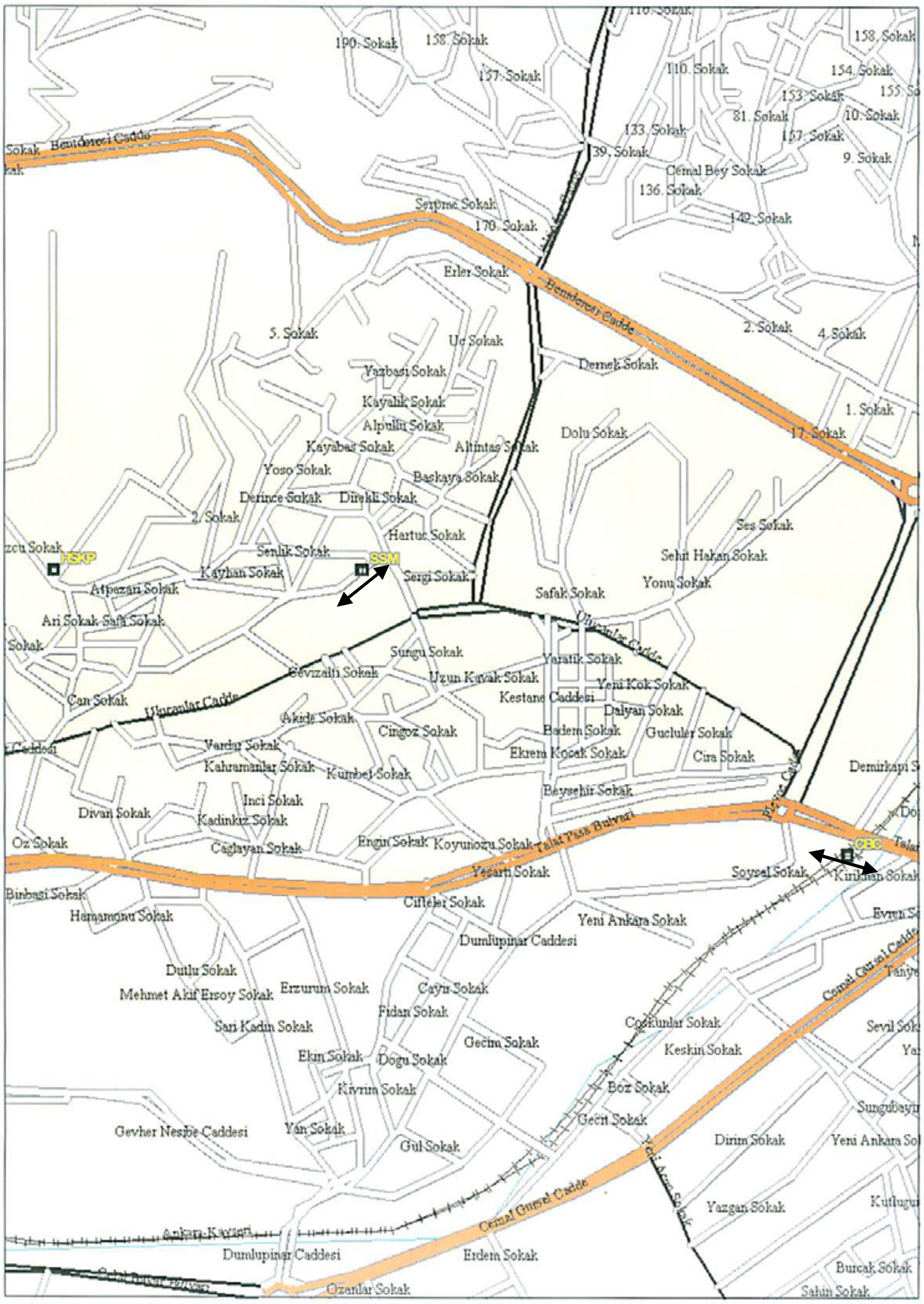

Figure 11: Locations of the aforementioned pierced blocks. CBC: Cebeci Railway Station, SSM : Saraçsinan Mescidi and HSKP: Hisarkapı. Double Arrows shows the laying directions of the found course of blocks.

Among the aforementioned remains, apart from scattered pierced blocks still present at Atpazarı Sokak, it is only possible to see the block course opposite Saraçsinan Mescidi in its place today (Figures 9, 10, 13, and 14). However, it appears that this course of blocks is not *in-situ* but has been re-used as a construction member for the masonry wall, just like the pierced blocks seen on the picture in the article of Nezih Fıratlı (Resim 2) or other architectural members re-used on the walls of other houses on the street (Figure 12). Thus, although it is somewhat doubtful to comment on the source of the aqueduct depending on the direction of the course of the pierced blocks[33], together with scattered ones on the street, these remains certainly show that the aqueduct was passing very nearby especially when the intactness of the mortar connecting the pierced blocks within the course is considered.

Figure 12: Another architectural member re-used for the wall construction at Atpazarı Sokak (Photo: Emre Kaytan).

[33] Also, the blocks were not laid on the direction to Elmadağ, but on the direction to north-east.

Figure 13: Scattered pierced blocks at Atpazarı Sokak (Photo: Emre Kaytan).

Figure 14: Scattered pierced blocks at Atpazarı Sokak (Photo: Emre Kaytan).

3.2. Other Coincidental Findings at Building Foundation Excavations

Apart from the railway station at Cebeci, remains of the aqueduct are encountered at two different places in the city which were revealed during the salvage excavations for modern construction (Fıratlı 1951:350) (Figure 15). Nezih Fıratlı reports that two stone pipelines[34] laid side by side were traced at the foundation excavation of Ankara Municipality Building in 1944 (Fıratlı 1951:351). Afterwards, during the foundation excavation of the new Trade Center next to the municipality building in 1947-1948, the continuation of these twin pipes was traced laid slightly on the direction to east, towards Anafartalar Street (Fıratlı 1951:351). According to Fıratlı, between this point and the storage tank at Atpazarı, the aqueduct should have passed Anafartalar Caddesi, Konya Sokak and in front of Eti Museum[35] (Fıratlı 1951:351). He further adds that the stone pipeline found at the foundation of the municipality building was continuing on the north-west direction, towards the Ministry of Finance – Çankırıkapı (Fıratlı 1951:351). The second of the remains was traced in 1948 during the foundation excavation of the apartment no: 51[36] adjacent to Mermerci Apartment on Posta Caddesi[37] (Fıratlı 1951:351). Fıratlı reports that here was found an installation like a tank/reservoir with a semi-circular plan which was in relation to a wall[38] which probably belonged to the fortification of Roman Ankara (Fıratlı 1951:351). The water was brought to

[34] The diameter of the blocks comprising this pipeline was again 22 cm. (Fıratlı 1951:354).

[35] Museum of Anatolian Civilisations today.

[36] Today, Mermerci Han is numbered as 19 at Posta Caddesi, thus, the excavated apartment number should be either 17 or 21.

[37] Today, this street is named as Şehit Teğmen Kalmaz Posta Caddesi

[38] According to Fıratlı, the construction technique of this wall was the same as that of the Bath at Çankırıkapı (Fıratlı 1951:352).

this tank/reservoir by the stone pipeline of 25 cm diameter pierced stone blocks laid parallel but at a distance of 15 m. to Posta Caddesi[39] (Fıratlı 1951:351).

Figure 15: Indication of locations where the remains of the pipeline were traced during public excavations. BLDY: Municipality Building, MRMC: Mermerci Apt. at Posta Caddesi (and for information, HMM: Roman Bath). Double Arrows show the laying directions of the found course of blocks.

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[39] Fıratlı reports that the aqueduct was laid touching the main ground (ana toprak) and it was 1m. higher than Posta Caddesi as fitting to the topography of the site which gets higher after the street (Fıratlı 1951:351).

According to Fıratlı, the tank/reservoir was providing a pressure head for the water to be distributed to the western part of the city through terra-cotta pipes connected to the tank with a stone pipe member[40] (Fıratlı 1951:351-352). He also asserts that the stone pipeline was probably a branch laid along Posta Caddesi[41], which separated from the pipeline distributing water to the city from the tank at Atpazarı (Fıratlı 1951:352). However, this conclusion seems questionable as far as the diameters of the branching and main pipelines are compared. It is normally expected that the diameter of the branching pipe should be smaller than the main pipeline. However, here the diameter of the main pipeline is 22 cm., whereas the branching pipe is 25 cm. in diameter.

In the light of these two archaeological findings, Fıratlı concludes that one of the main pipelines distributing water within the city was laid towards Posta Caddesi and the other two were laid on the direction from the municipality building to the center of Roman Ankara, where the Ministry of Finance is located today, to the temple and further to Çankırıkapı (Fıratlı 1951:352). The water was then distributed to the further terminal points such as houses and fountains through the network of terra-cotta pipes branching out from the main stone pipelines (Fıratlı 1951:352, 354). These terra-cotta pipes were traced, sometimes as connected to the contemporaneous stone blocks, especially at the foundation excavation of the municipality building and on the course of the aqueduct (Fıratlı 1951:354) (Figure 16). In addition, some of these terra-cotta pipes were traced during the excavations made by Türk Tarih Kurumu

[40] Fıratlı suggests that very less calcium carbonate incrustation was observed in these terra-cotta pipes, which shows that the water level in the pipeline was not high enough to fill the section (Fıratlı 1951:352).

[41] Kadıoğlu asserts that this line clearly reaches Ulus Trade Center, and therefore this branch of the aqueduct can be shown as a proof that the building remnants traced during the foundation excavation of Ulus Trade Center was a bath or a *palatium* containing a *hypocaust* underneath which was supplied with water through the aforementioned line (Kadıoğlu et al. 2007:67).

around the Temple, where two fountains were discovered as reported by Fıratlı[42] (Fıratlı 1951:352).

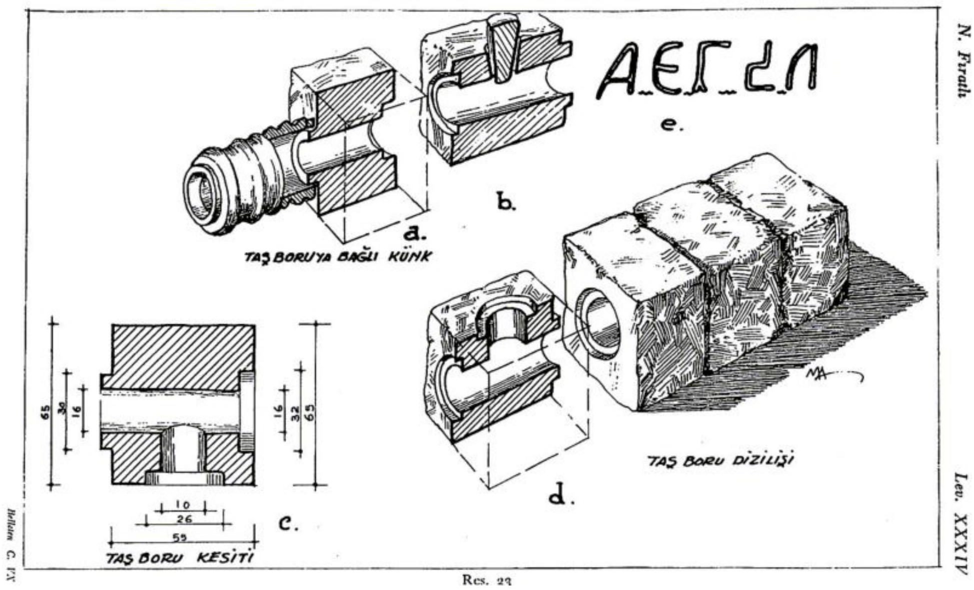

Figure 16: Pierced Stone Block members of the aqueduct and terra-cotta pipes as connected to these stone blocks (Source: Fıratlı 1951).

In addition to these findings, according to Kadıoğlu and Görkay, the andesite blocks traced together with the terracotta discs belonging to a *hypocaust* during the foundation excavation of Tandoğan Trade Center[43] in 1962 might also be thought to have been the remains of the aqueduct (Kadıoğlu et al. 2007:90). They assert that the presence of thick *opus mixtum* walls and the

[42] According to Kadıoğlu, the city also had a monumental fountain. He asserts that the building, remains of which were unearthed during the salvage excavation in 1954 by Mahmut Akok for the outbuilding of İş Bankası, should have been a *nymphaeum* as far as the features such as the presence of a well with staired entrance and an aeration shaft, and the location of the structure within the ancient city are concerned (Kadıoğlu et al. 2007:43). However, we do not know if this structure was depending for water only on the aforementioned well or also on any additional external source brought by the aqueduct.

[43] The exact place of Tandoğan Ticaret Merkezi can not be known. However, from the excavation photographs stored in Museum of Anatolian Civilisations archive, it is at least understood that the building was located to the south of Hallaç Mahmut Camisi, at the junction of Yurt Sokak, Susam Sokak, Kızılbey Sokak and south-east corner of D-Block building of Ulus Türk Telekom Directorate (Kadıoğlu et al. 2007:90, no.28 on the plan).

hypocaust suggest that this building might have been a bath and a pipeline composed of the found andesite blocks, if they were *in-situ*[44], might have supplied this building with water (Kadıoğlu et al. 2007:90). In this context, they suggest that this pipeline might have been a branch separated from the main pipeline found during the foundation excavation of the municipality building towards Hallaç Mahmut Camisi in the south-west (Kadıoğlu et al. 2007:90).

3.3. Roman Bath at Çankırıkapı

As stated in Chapter 1, being the major and continuous water consuming building, the Roman Bath at Çankırıkapı should have been one of the most important terminal points of the aqueduct. For this reason, analyzing this building from the water supply point of view may reveal invaluable information and evidence regarding the characteristics of the aqueduct. Unfortunately, as also pointed out by Fıratlı, no detailed information regarding the water supply and internal distribution system of the bath building was given in the excavation reports, probably due to the lack of physical evidence[45] (Fıratlı 1951:352). However, even the plan and the topographic arrangement of the building may help derive plausible guesses about the water supply of the building. In this context, considering the topography of the site, Fıratlı very reasonably concludes that the water should have arrived at the bath

[44] According to the authors, at least three andesite blocks seem to have been *in-situ* according to the excavation photographs (Kadıoğlu et al. 2007:90).

[45] Dolunay only mentions that the hot and cold water was carried by means of terra-cotta pipes and that the bath building had an excellent network of water channels running under the building (Dolunay 1948:216-217). According to Akok, located in the hypocaust and in the parts where necessary, these channels were designed to convey the waste water of the upper floors to the main drainage channel (Akok 1968:10).

building from the south-east, from the direction of the secondary school[46] (Fıratlı 1951:353). Reaffirming this conclusion, Fıratlı reports the presence of two stone blocks in front of the footings which are located behind the *piscina* (pool) to the south-east, each containing two 16 cm. diameter perforations (Fıratlı 1951:353) (Figure 17).

Figure 17: Pierced blocks in the foreground[47] (Photo: Emre Kaytan).

Fıratlı asserts that as far as the pierced shapes of these blocks are considered, it is understood that two of them belonged to the pipeline that brought water to the bath, and the other two belonged to the one that distributed water within the bath (Fıratlı 1951:353) (Figure 18). Other important evidence which shows that the water entered the bath from the same direction was the discovery of the course composed of two pierced stone blocks laid on the direction to the secondary school under the water bringing blocks standing in front of the

[46] Today's Atatürk Teknik Anadolu Kız Meslek ve Meslek Lisesi.

[47] It should be noted that these pierced blocks do not appear to be *in-situ*.

footings (Fıratlı 1951:353). In addition to this course of two blocks, Fıratlı reports that one more scattered pierced block was found in the close vicinity of the secondary school, which also supports the conclusion concerning the connection of the aqueduct to the bath building (Fıratlı 1951:353).

Figure 18: Pierced blocks in front of the footings (Photo: Emre Kaytan).

Figure 19: Pierced blocks between the footings (Photo: Emre Kaytan).

Fıratlı also asserts that there exist also pierced blocks between the aforementioned footings located behind the *piscina* showing that these footings are a part of a high water tank/reservoir (Fıratlı 1951:353) (Figure 19). He notes that the footings contained calcium carbonate incrustation due to the spill or seep of water which is again a sign pointing to the existence of a tank/reservoir there (Fıratlı 1951:353). According to Akok, this was a substitute water tank/reservoir with a base area of 10 x 6 = 60 square meters elevated on twelve footings between the *frigidarium* (cold bath) and the *caldarium* (hot bath) in order to provide the head needed for the water to be transferred to the desired bathing areas (Akok 1968:10) (no:12 on Figure 20).

Although the diameters of the pipe remains were different, Fıratlı proposes that the two pipelines traced side by side at the Municipality Building's foundation were continuing up at the tank/reservoir of the bath, in front of which were also found the remains of two pipelines[48] (Fıratlı 1951:353). According to him, the difference between diameters can be explained by this pipeline's additional supply of water to the city which was settled between these two aforementioned points (Fıratlı 1951:353). Fıratlı believes that terra-cotta pipe remains with diameters 16 cm. and 6 cm. found during the foundation excavation of the buildings erected at the intersection point of Çankırı Caddesi and Beşik Street[49] support his point of view (Fıratlı 1951:353-354).

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[48] The diameter of the stone pipe members traced at the Municipality Building's foundation was 22 cm., whereas the pipeline in front of the footings at the bath had a diameter of 16 cm.

[49] The name of Beşik Street must have changed because such a street name does not exist today.

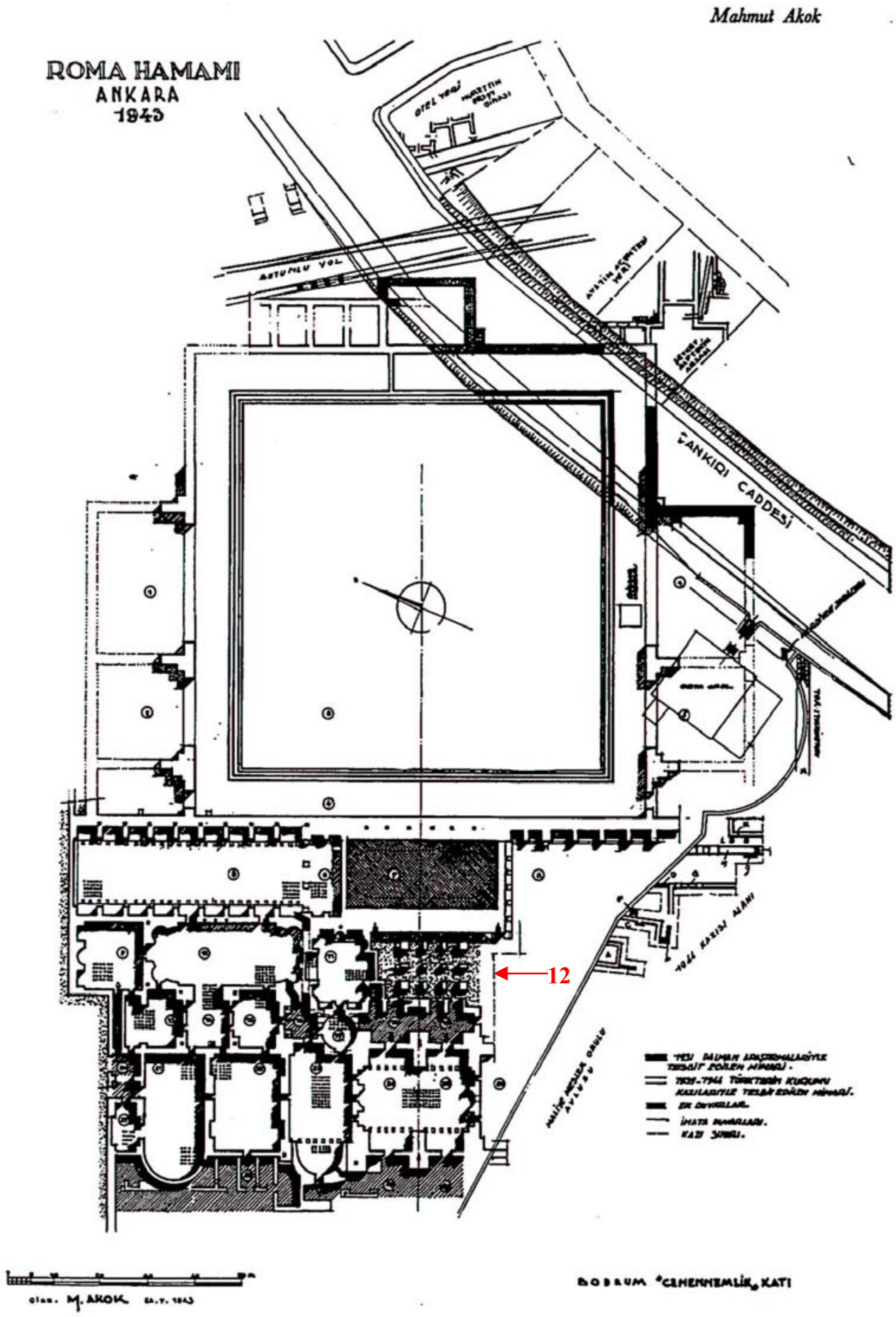

Figure 20: Foundation plan of the Roman Bath at Çankırıkapı, noting no:12 for the location of the suggested water tank/reservoir (Source: Akok 1968:25).

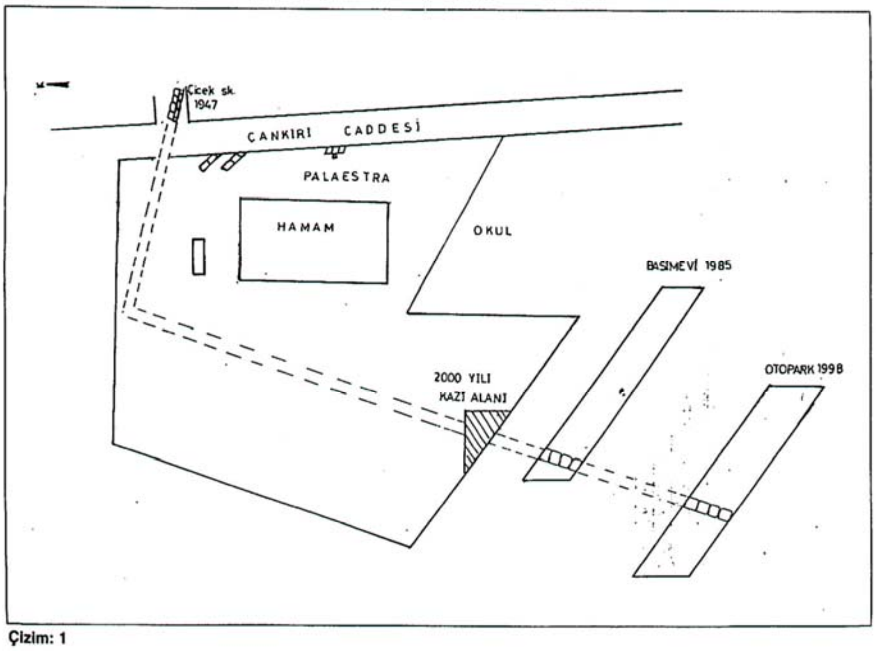

Figure 21: Location of the rescue excavations (Source: Temizsoy et al. 2002:146)

Our very limited knowledge on the water works around the bath site and its environs has been increasing since the year 2000, when the rescue excavation works restarted at the south-west of the bath site with the purpose of discovering the early medieval fortification wall which was understood to pass through the Roman Bath site after the excavations of 1947[50], 1985[51], and 1998[52] (Temizsoy et al. 2002:146) (Figure 21). During the rescue excavations in 2001, a 16 cm. diameter terra-cotta pipeline laid in the direction of south-east was traced (Temizsoy et al. 2002:147). Afterwards, approximately 1.5 m. below this level, four terra-cotta pipelines of 13 cm. diameter were discovered to the west of an area thought to be a *hypocaust* (Temizsoy et al. 2002:148-149) (Figure 22). Although not yet definite, it is believed that these terra-cotta

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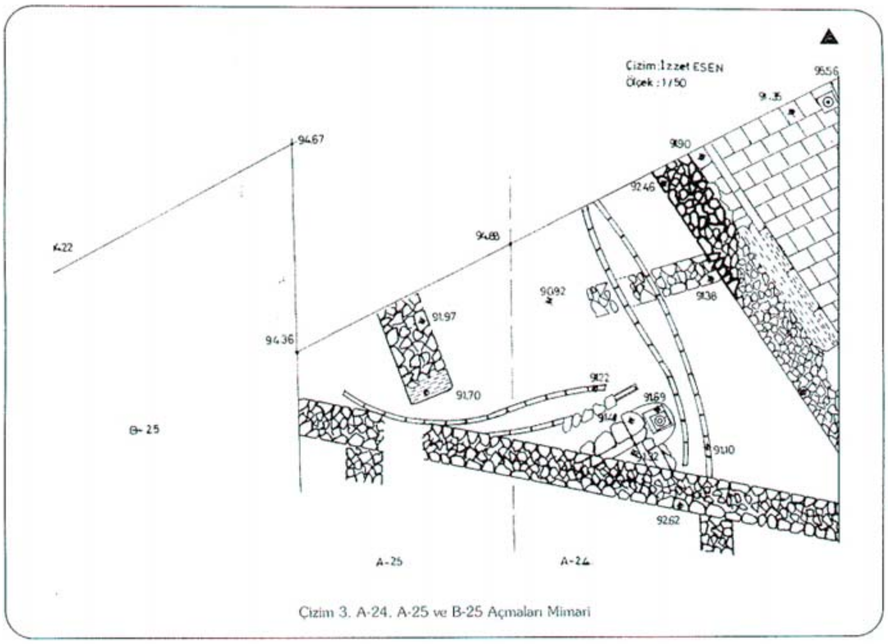
[50] Excavation by Mahmut Akok at Çankırı Caddesi, Çiçek Sokak (Temizsoy et al. 2002:146).

[51] Foundation excavation of Başbakanlık Basımevi Building (Temizsoy et al. 2002:146).

[52] Foundation excavation of the multi-storey car park building (Temizsoy et al. 2002:146).

pipes were carrying water to the private houses or baths around (Temizsoy et al. 2002:148). If so, these pipes can be thought to have been the connections of private houses to the public aqueduct[53].



Çizim 3. A-24. A-25 ve B-25 Açmaları Mimari

Figure 22: Plan of the excavated area, and the found terracotta pipes (Source: Temizsoy et al. 2002:154).

After the organizational arrangements made at the archaeological site of the Roman bath in order to turn it to an open air museum between 1995-2000, today it is possible to see the pierced stone members of the aqueduct at the northern part of the site (Esen 2001:286-287) (Figure 2 and Figure 23).

[53] Quoting Jansen, Camardo states that "after a house is connected to the public aqueduct, the *impluvium* was often used as a basin and transformed into a fountain, and the cisterns were filled not with rainwater but with water from the aqueduct" (Camaro et al. 2006:184)

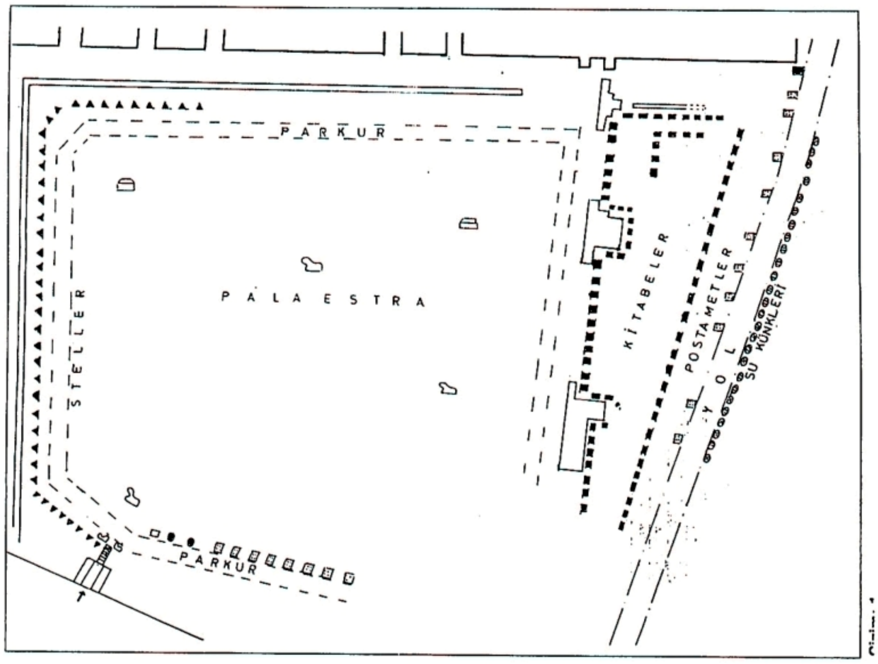


Figure 23: Plan of the open air museum and the location of the pierced stone blocks re-arranged on the north (Source: Esen 2001:289).

3.4. Tracks of the Aqueduct Beyond Cebeci Towards the Source

Without giving any detailed information regarding the archaeological evidence, Nezih Fıratlı reports that the remains of the aqueduct beyond Cebeci towards Elmadağ are traced on the line Cebeci Train Station – Gülhane Hospital[54] – Balkeriz Yards[55] – Samanlık Yards – Naldöken Tepe – Elmadağ Springs at the elevation of 1500 m. (Fıratlı 1951:355). According to him, the water collected from Elmapınarı[56] and other springs were brought to the

[54] Today's Ankara Üniversitesi Hospital at Cebeci.

[55] Today's Balkiraz district.

[56] According to Fıratlı, no Roman track as pointed out by Mamboury was traced at Seki Pınarı spring. In addition, he states that the discharge of Seki Pınarı Spring is very low (Fıratlı

Mamak – Aşağı İmrahor line through the channels made up of soft limestone and in some sections through terra-cotta pipes (Fıratlı 1951:355). The channel was composed of four limestone plates connected to each other by mortar to form a watertight tube nearly circular in section[57] (Fıratlı 1951:355) (Figure 24). According to him, this channel had the capability to withstand a pressure head of 6-7 m., thus this part of the aqueduct should have contained many intermediate tanks to decrease pressure (Fıratlı 1951:355).

Fıratlı states that no stone pipeline members were traced beyond Cebeci towards the source (Fıratlı 1951:355). However, he asserts that, as the aqueduct reached Hisarkapı, it must have worked under a pressure of 80 m. between the lines Mamak – Aşağı İmrahor and Solfasol Village – Köçek Ridge[58], and thus, stone pipes had to be used in this pressure section (Fıratlı 1951:355) (Figure 25).

1951:355). On the other hand, without giving the name of the spring, Özand mentions that during their research for spring water sources at Elmadağ in 1932, they have three water collection structures and pipe networks on three layers discovered at one spring which belonged to Roman, Byzantine and Seljukid times respectively (Özand 1967:3). In addition, Özand asserts that it was understood during their excavation works that the Romans used thick terra-cotta pipes reinforced from outside in a manner like a bracelet to transport water to the other side of the valley from the bottom (Özand 1967:3). Most probably, this must have been a siphon, and the pipes were reinforced to withstand the pressure.

[57] According to Özand, at some locations of the city, some hundred meters long drainage channels were used which were made between limestone plates in order to collect water (Özand 1967:2). He adds that such kind of limestone channels were traced during the foundation excavation of Hariciye Köşkü (Özand 1967:2). In addition to this, such a small gallery is still visible on the bank of the stream behind İngiliz Sefareti (Özand 1967:2). It must be noted here that the mentioned channel made of limestone plates might be and seem similar to the ones traced by Nezih Fıratlı.

[58] Maybe today's Keklik?, as assumed so while drawing the approximate line on Figure 25.

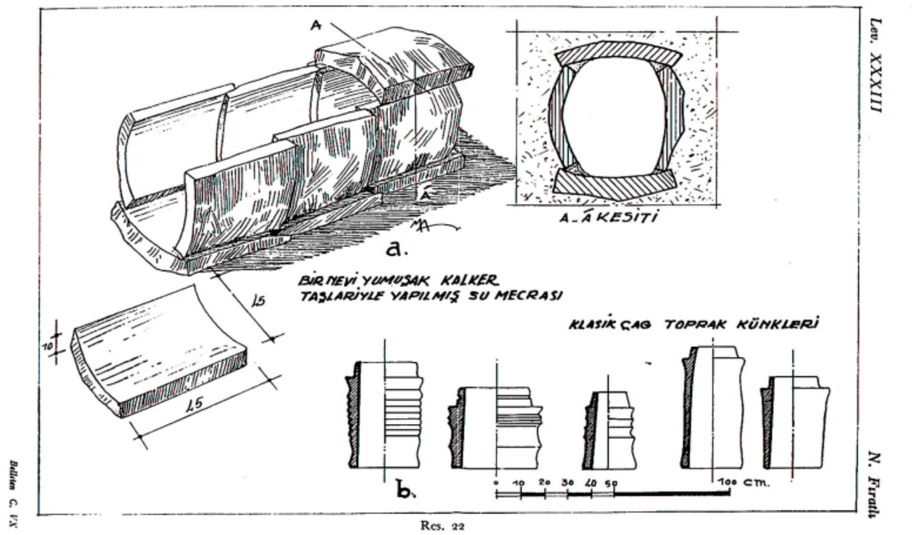


Figure 24: Limestone channel (Source: Fıratlı 1951).

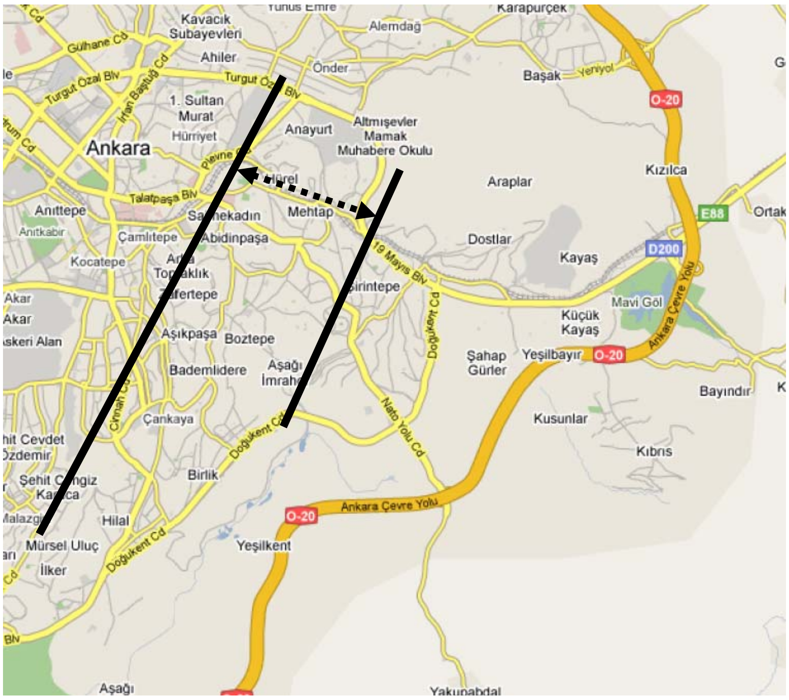


Figure 25: Pressure section beyond Cebeci according to Fıratlı

After considering all the findings, Nezih Fıratlı suggests a map showing the route and terminal points of the aqueduct within the city. According to him, the water was brought to Ankara with the stone blocks in diameters of 22 cm. and 30 cm., and then, it was distributed to city again with the stone blocks of the same diameters (Fıratlı 1951:354) (Figure 26).

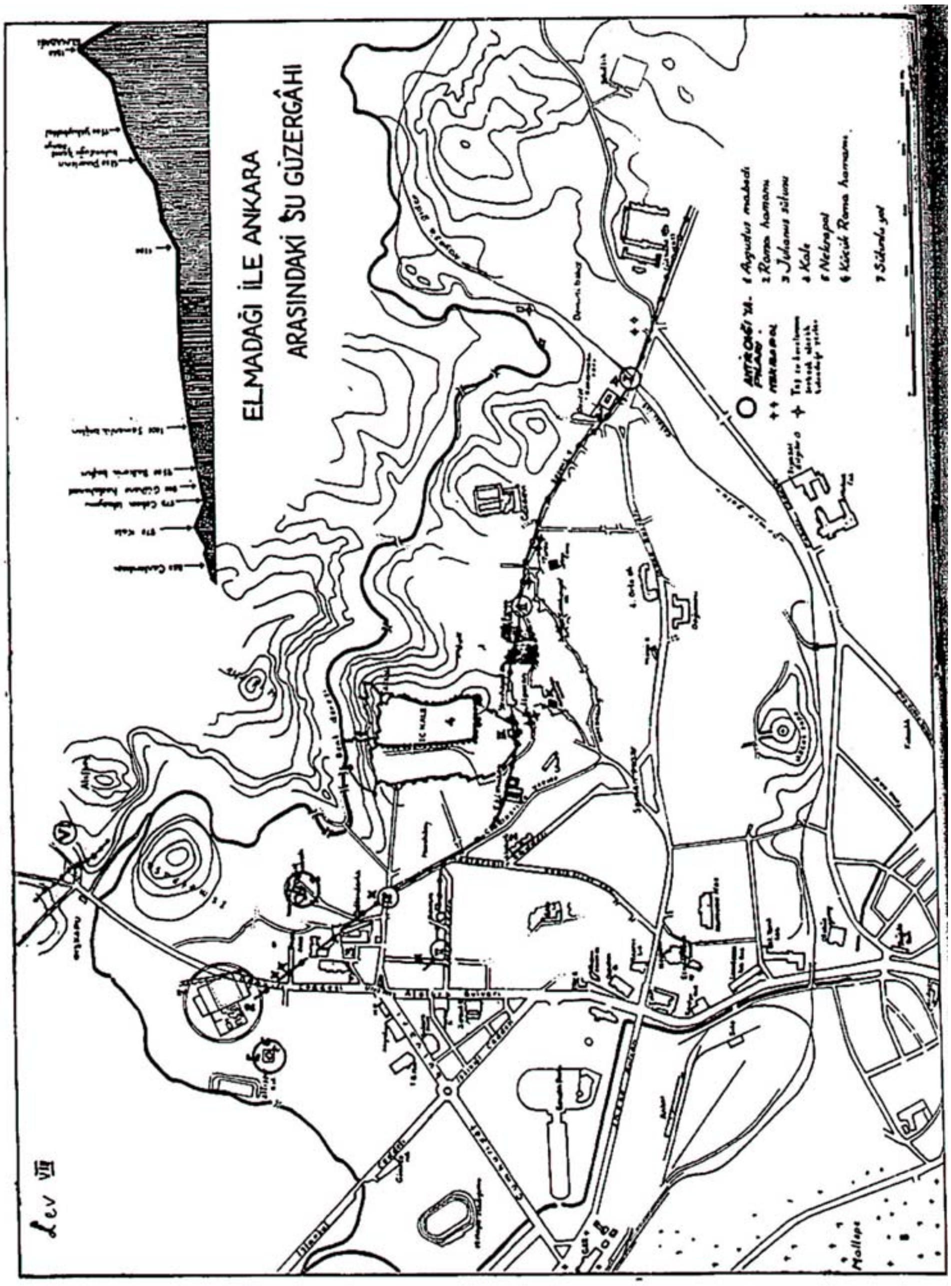


Figure 26: The route of the aqueduct within the city (Source: Fıratlı 1951)

3.5. Re-used Pierced Blocks on the Walls of the Citadel

Like the common fate of many parts of other ancient structures, the pierced stone blocks[59] of the aqueduct were also re-used as a construction member for the fortifications of the city citadel in Ankara (Figure 27). It is possible to see these blocks on every side of the fortification both on higher or lower elevations. However, a higher number of pierced blocks was re-used on the interior walls, especially on the south-east and east sides[60], than the outer one (Fıratlı 1951:358). This situation has been considered by many writers as a clue to the information regarding the aqueduct. According to Bennett, the extensive re-use of the blocks on the east and south-east sections of the fortification suggests that the aqueduct passed nearby (Bennett 2003:8)[61] (Figure 28). In addition, Fıratlı explains that as the ground between Saraçsinan Mescidi and the fortification is of rocky formation, the passing aqueduct was laid very close to the ground level here and that it would have been more economical to re-use the blocks on the fortifications that are closer to the aqueduct (Fıratlı 1951:358). On the other hand, considering the similar argument that "the blocks were re-used in the east wall of the citadel, but not elsewhere"; Foss tries to determine the site of the aqueduct (Foss 1977:64). He asserts that "it led from the east to the steep back side of the citadel, where the water was conveyed uphill by means of a stone siphon composed of large pierced blocks" (Foss 1977:64).

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[59] Diameters of most of these blocks were 30 cm. (Fıratlı 1951:354).

[60] Nearly half of the re-used stones used for the construction of the walls between Akkale, Şarkkale and Zindankapı were the stone pipe members of the aqueduct (Fıratlı 1951:352).

[61] David French questions the suggestion of Bennett regarding the source in that depending on the same evidence, which was "based on the proximity and number of siphon blocks surviving in the SE sections of Kaledağ defenses", an alternative case could be made for a source in the Çubuk Plain (French 2003:36).

Figure 27: Re-used pierced blocks on the walls of the city citadel (Photo: Emre Kaytan).

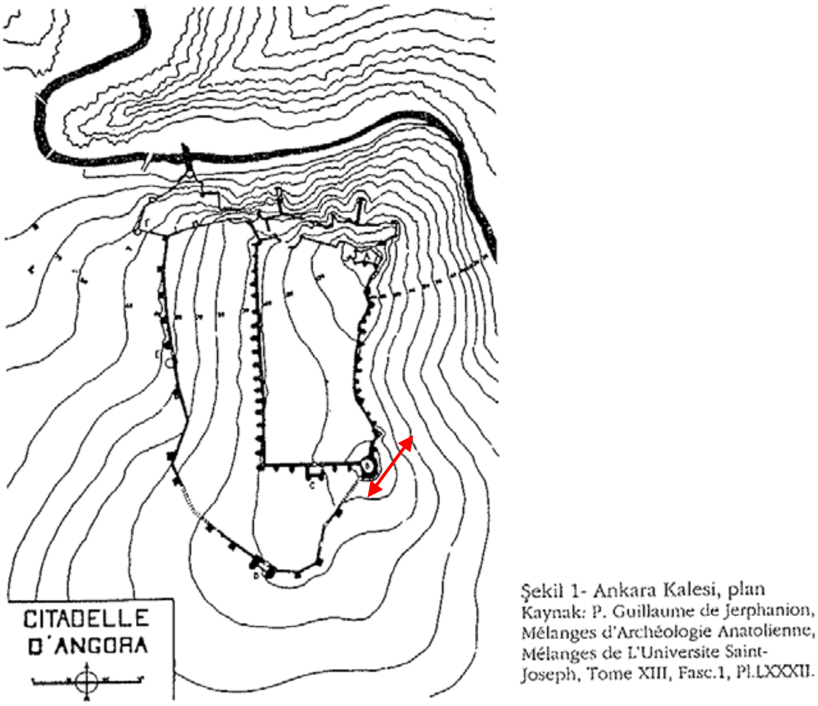

Figure 28: Plan of fortifications (Source: Bakırer 1998). Red double arrow shows the south-east concentration place of the pierced blocks on the walls.

3.6. Roman Water Infiltration Gallery at Kayaş

Depending on E. Chaput and İbrahim Hakkı[62], Nezih Fıratlı mentions the presence of a Roman infiltration gallery used to collect underground water at Kayaş valley at the elevation of 925 m. (Fıratlı 1951:356). He adds that today (1951) no gallery or stone pipe is seen in this valley (Fıratlı 1951:356).

According to Özand, the infiltration gallery was located at 400 m. distance to the right side of the Kayaş road prior to Kayaş district (Özand 1967:1). It was a 25-30 m. long tunnel at the depth of 7-8 m. below ground level constructed at the intersection point of Kusunlar and Kayaş Valleys in order to collect underground water from these two valleys (Özand 1967:1). Özand states that the collected water was transmitted with an underground pipeline to the left side of the valley by making use of the inclination of the Kayaş Valley, and taking also the water of Hanımpınar Spring after 2,5 km. at Üreğil Village, it was transported to Ankara through a masonry channel extending 10 km in total (Özand 1967:1) (Figure 29). He asserts that the tunnel section of this 10 km. long masonry channel is seen at the railway cut at Saimekadın[63] (Özand 1967:1). Özand also points out that for a long time this infiltration gallery was known as a spring called Şahne Pınarı since the collected water came out due to the demolishing of water transmission channels. However, this spring is no longer active as the well groups working in the region have decreased the underground water level (Özand 1967:1).

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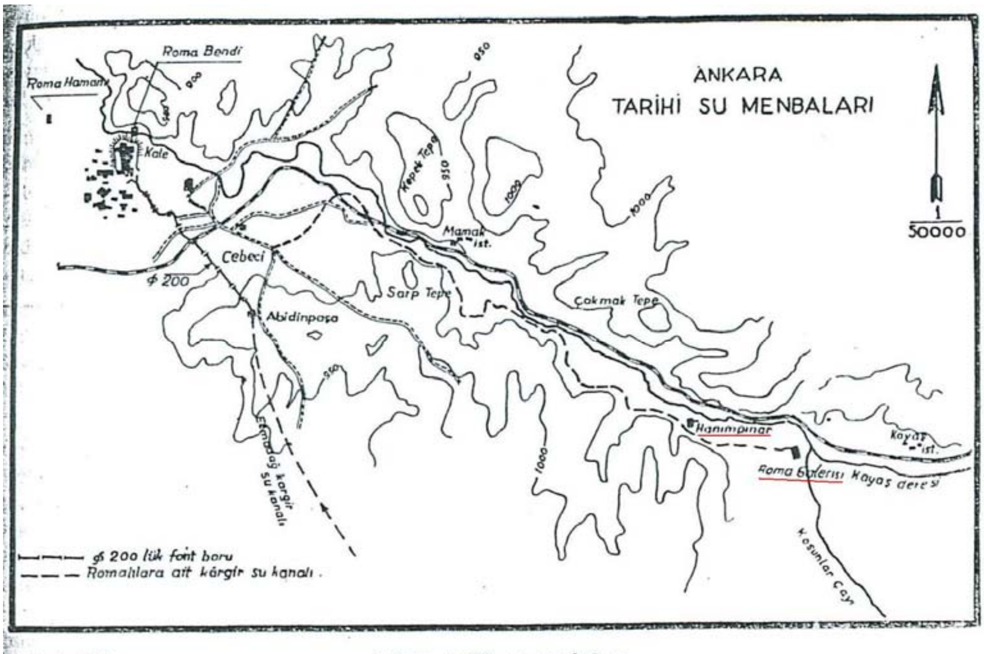
[62] See Chaput, E., İbrahim, H. (1930) 'Ankara Civarında Suların Cereyanına ve Onlardan İstifadeye Dair Mülahazalar', s.II.

[63] No remains of a tunnel in a railway cut was encountered during the field visits made for this study.



3 No.lu Plân Şehrin tarihî su menbaları

Figure 29: Historical water sources of Ankara (Source: Özand 1967:5).

Regarding the function of the gallery, the assertions of Fıratlı and Özand are more or less the same. Both authors state that the gallery supplied water for the parts of the city at lower elevations. Fıratlı adds that the gallery was acting as a complementary to the pipeline system supplying water from Elmadağ for the higher parts of the city (Fıratlı 1951:356). At the same time, in case of a repair at one of the systems, the other one prevented the city from staying waterless (Fıratlı 1951:356). On the other hand, according to Özand, water needed for the working of the bath must have been supplied from this infiltration gallery together with Hanımpınarı Spring water because it is easily possible to bring this water to the bath by laying the channel at suitable places around the city (Özand 1967:3). As far as the elevations of the source (infiltration gallery) and the destination (bath) are concerned, Özand might have been quite right. The infiltration gallery is at an elevation of approximately 925 m.[64], whereas the bath is located at around 870 m. above sea level, and they are 15 km.[65] away from each other. Thus, it can be also thought that the water through a masonry channel could easily reach the bath by following the topography, contour lines, maybe with the additional help of some pressurized sections if and where necessary.

3.7. Roman Dam on Hatip Çayı (Bentderesi)

Hatip Çayı is also known as Bentderesi which means "barraged creek" in Turkish. It is believed that this creek has taken its name "Bentderesi" from the barrage or dam constructed on it (Aydın et al. 2005:252). Unfortunately, there exist no traceable remains from this structure today. Özand states that the ruins of the dam were still visible until 1935 when a modern dam was constructed at the same place, and adds that the modern dam was also demolished in 1957 (Özand 1967:2) (Figures 30 and 31).

Depending on old photographs[66], writers conclude that the structure might have been built in Roman times[67]. According to French, "it resembles, almost identically, both in construction and in features (such as the sluice gate), a Roman dam or barrage such as the little known example at Örükaya in the province of Çorum" (French 2003: 38). On the other hand, Kadıoğlu shows

[64] See Fıratlı 1951:356.

[65] See Özand 1967:1.

[66] Kadıoğlu shows old photographs as important sources to be consulted in order to obtain information regarding the structure (Kadıoğlu et al. 2007:75).

[67] French asserts that this structure had the appearance of Roman workmanship (French 2003: 38). Kadıoğlu also states that although this structure was not mentioned on any Roman inscription, as far as the construction technique is concerned, it demonstrates the features of the Roman era (Kadıoğlu et al. 2007:78).

the dam at Aizanoi, which is dated to the Late Roman era, as a similar example to the one built on Hatip Çayı[68] (Kadıoğlu et al. 2007:78). However, the function of the dam is quite obscure. Özand considers this historical dam built by the Romans on Hatip Çayı as one of the three important installations related with water in Roman Ankara together with the infiltration gallery at Kayaş and the bath at Çankırıkapı Caddesi (Özand 1967:1-3) (Figure 29). On the other hand, he states that the water stored in the reservoir behind the dam could not have been used at the baths because firstly, the quality of the water from the point of cleanness is very low and secondly, both the bath and the reservoir were at the same elevation of 870 m. (Özand 1967:3). According to Jerphanion, the dam was constructed not only to supply water to the city, but also for the purpose of irrigation and flood protection (Kadıoğlu et al. 2007:76-77). Similarly, Pococke writes that the dam seems to have been constructed to supply water for the people living on the Kale Mountain and mentions the existence of a secret road from the top down to the dam (Kadıoğlu et al. 2007:77).

To understand the function of the Roman dam, it might be helpful to find out the construction purpose of the modern one built at the same place in 1935. The modern structure in Figure 31, with its prominent overflow spillway structures, seems to have been constructed for flood protection by creating a reservoir behind it for the routing of the flood. Therefore, as also pointed out by Kadıoğlu[69] by betraying the flood risk on Hatip Çayı with past events, it can be said that the dam might have been constructed for the purpose of flood

[68] It should be noted that the similar dam at Aizanoi was planned for flood protection (Kadıoğlu et al. 2007:77, note 413) whereas the Örükaya Dam was thought to have been constructed for irrigation purposes (Öziş 1999:32). For detailed information on historical dams in Turkey; see Öziş, Ü. (1999) 'Historical Dams in Turkey'.

[69] See Kadıoğlu et al. 2007:77, note 413.

control. As it was built, it might then have been also used for irrigation purposes.

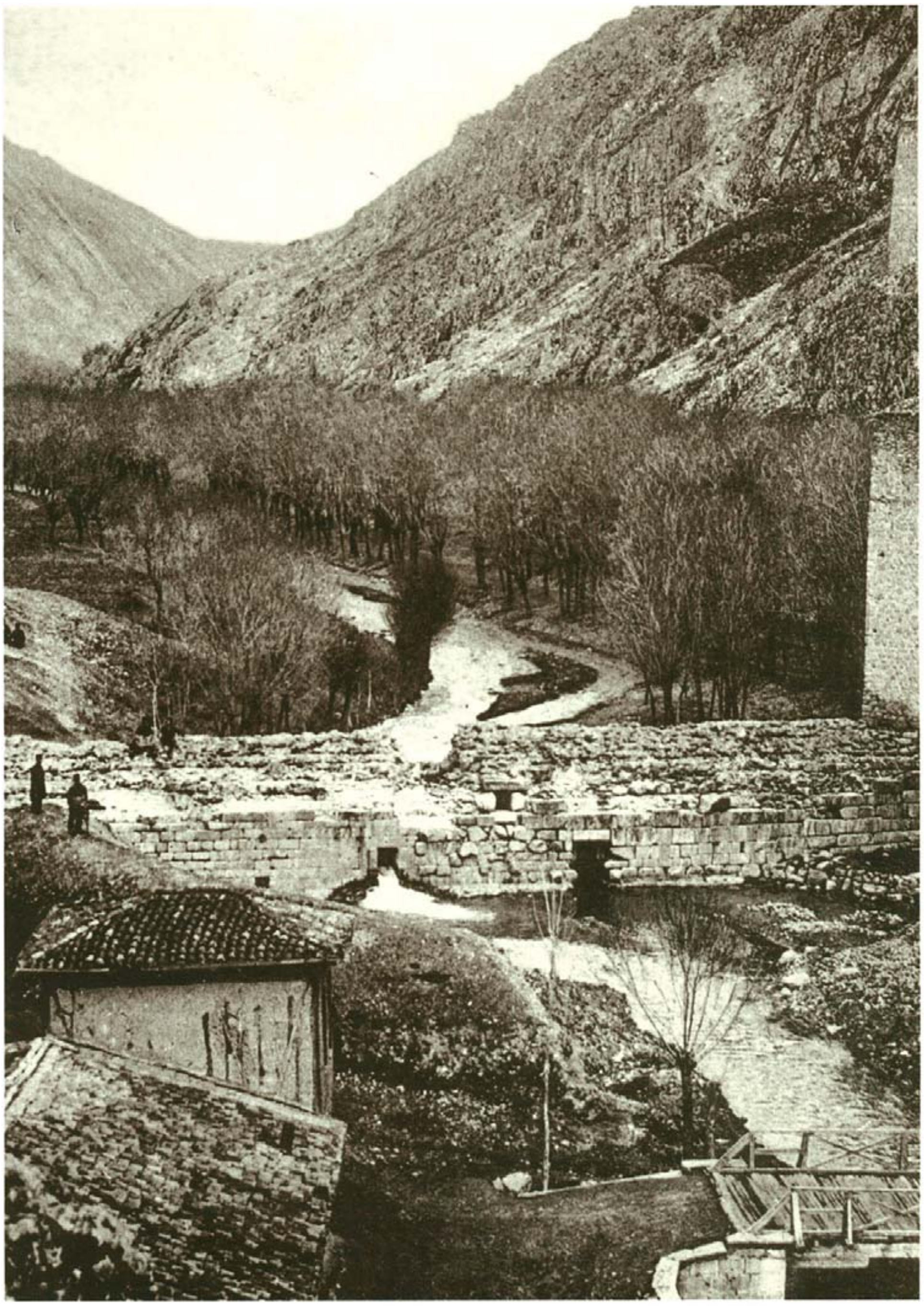


Figure 30: Roman Dam on Bentderesi (Source: Sağdıç 1993:77).

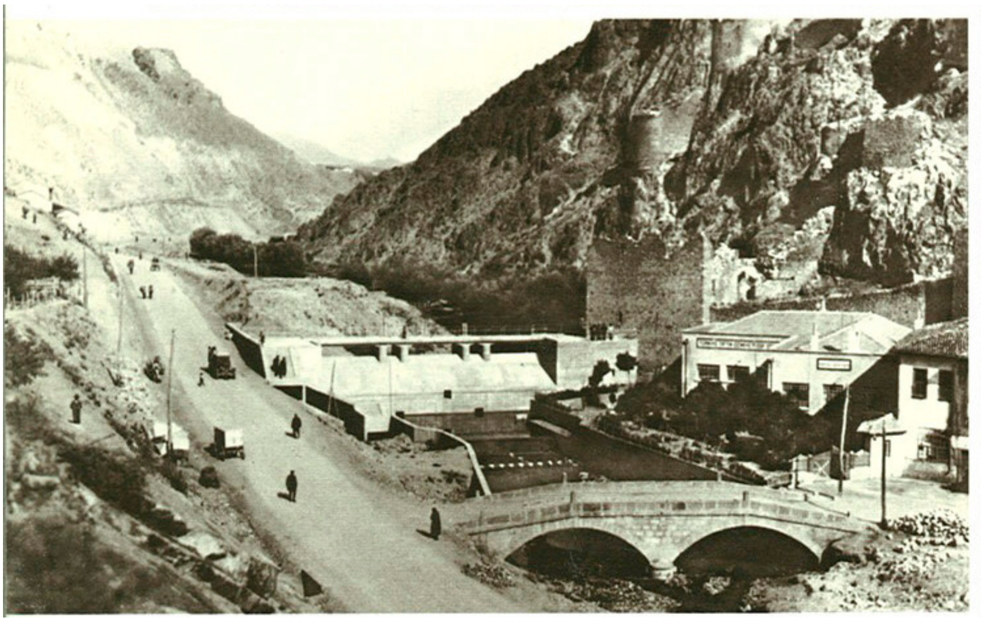


Figure 31: Dam constructed on Bentderesi (Source: Sağdıç 1993:76).

In his article, Fıratlı reports that a gallery partly completed by a stone pipe was traced during the foundation excavations at Dışkapı in 1948 and 1949 (Fıratlı 1951:356). According to him, this gallery was taking its water from Bentderesi and was supplying water to the parts of the city on both sides of Etlik Caddesi and to the parts settled on the ridge where the Askeri Serum Evi[70] is located (Fıratlı 1951:356). He adds that it is probable that this gallery also supplied water for the gardens in this part of the city (Fıratlı 1951:356). Although we do not possess any detail regarding the findings, as far as his assertions that the gallery was taking water from Bentderesi and that it might have supplied water for the gardens are concerned, it is probable that the Roman dam and the gallery-pipe system at Dışkapı might have been somehow interrelated.

[70] Askeri Serum Evi might be todays Dışkapı Hospital?.

CHAPTER IV

ASSESSMENT AND CONCLUSION

4.1. Assessment of the Water Supply Scheme

Taking into consideration the analysis of the facts covered in Chapter 2, Elmadağ underground resources seem the most possible water source for the aqueduct. In this context, as supported by the archaeological evidence outlined in Chapter 3, the infiltration gallery at Kayaş and the springs' area over Yakupabdal village at Elmadağ (Figure 32) gain prominence as specific locations for the source. These two distant source locations suggest the existence of more than one aqueduct, i.e. minimum two, which served the ancient city's water needs. In this way of thinking, Fıratlı concludes that these two aqueducts were working complementary to each other in that the aqueduct bringing water from springs at higher elevations of Elmadağ (hereafter referred to as Elmadağ Aqueduct) was supplying water for the higher parts of the city including the bath, whereas the other one which brought the underground water collected by the infiltration gallery[71] at Kayaş (hereafter referred to as Kayaş Aqueduct) fed the lower areas of the city (Fıratlı 1951:356). Although this conclusion is quite reasonable, it eventually results in the consideration of the Elmadağ Aqueduct being the primary one serving the important parts of city, and the other one, the Kayaş Aqueduct, as of

[71] This aqueduct was also conveying the spring water of Elmadağ, since the infiltration gallery must have been collecting the spring water in the aquifer at the north-western skirts of Elmadağ as the water seeps through the inside surface of the tunnel. The longer the tunnel length, the larger the exposed area will be, and thus, a greater amount of water will be collected (See also Hodge1992:78-79).

secondary importance or supplementary to the primary aqueduct. However, as far as the elevations are considered, it becomes clear that the Kayaş Aqueduct also had the capability to serve many important areas of the city, especially the ancient city centre where the public structures were located, such as the bath[72].

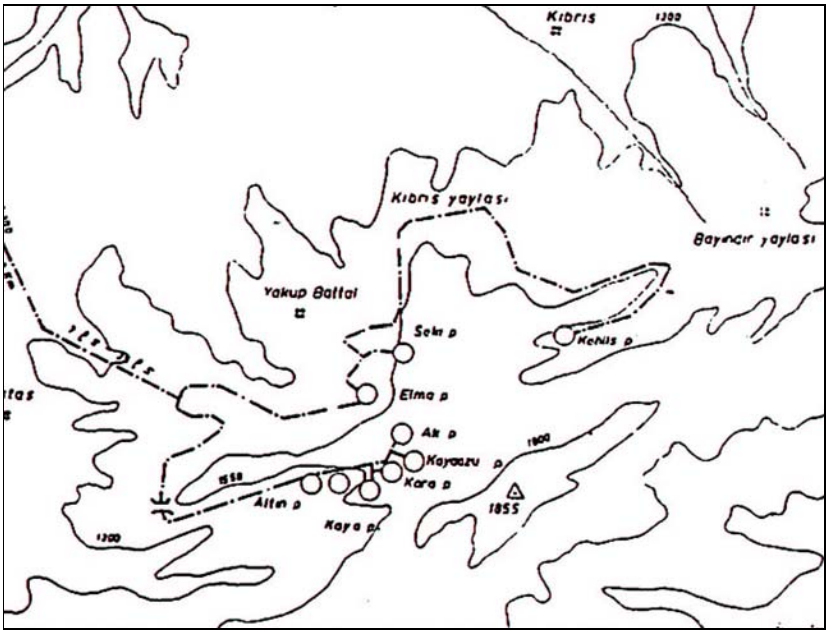


Figure 32: Utilizable springs at higher elevations of Elmadağ in 1930s (Source: Özand 1967:9).

Another point, which might also give some idea on the importance of the Kayaş Aqueduct for the ancient city, is the comparison of the discharges measured in the 1930s to determine the water potential of the sources available around Ankara. Considering the 'minimum output in normal years' column on

[72] The infiltration gallery was located at the elevation of around 925 m., which is higher than most parts of the ancient city including the bath and even the acropolis of the city where the temple was located. The elevations of the bath and the temple are approximately 870m. and 890 m. respectively. On the other hand, according to Afif Erzen, the early settlements were concentrated at the top, slopes, and the skirts of the mountain where the fortifications exist today (Erzen 1946:56). These settlements have the elevation around 930 m. and higher, thus can not be served by the Kayaş aqueduct since modern devices such as water pumps did not exist.

Table 1, it will be seen that the measured amount from Şahne Pınarı[73] was approximately equal to, even higher than, the measured total amount from all the utilizable springs of Elmadağ[74]. Hence, it can be safely concluded that the historical discharges of the aforementioned springs should also have been parallel to the measurements in 1930s[75]. Therefore, the Roman engineer or planner whose primary aim was to utilize as many different sources of water as were available[76] should have considered this source as important as the Elmadağ springs and thus might have utilized it together with the Elmadağ Springs for the water supply of the important parts of the city, especially for the parts where the public structures were erected, maybe also for the bath where huge amounts of water was needed.

Results of the water quantity measurements of available basins	**Km2**	**Maximum Output (lt/sec)**	**Minimum Output in Droughty Year 1933 (lt/sec)**	**Minimum Output in Normal Years (lt/sec)**
Kosunlar Underground Water Collection Structure	40.8	150	23	30
Hanımpınar Spring		30	12	20
Şahne Pınar Spring		25	15	20
Elmadağ Springs		36	12	15

Table 1: Water quantity measurement results at the sources available around Ankara in 1930s (Source: Özand 1967:13, partly).

[73] For a long time the infiltration gallery was known as a spring called Şahne Pınarı as the collected water flowed out due to the demolition of water transmission channels (Özand 1967:1).

[74] As also pointed out in Chapter 3, Özand suggested that the aqueduct was also taking the water of Hanım Pınar spring on the way to the city. If also the discharge of Hanımpınar Spring is added to the amount measured at Şahne Pınarı by considering his suggestion, than the total discharge would be much higher than the total amount measured at the springs of Elmadağ .

[75] See p. 6-7 and footnote 11.

[76] As pointed out by Crouch (Crouch 1993:22).

In this regard, as also pointed out by Özand (Özand 1967:3), the water from the infiltration gallery might have easily been carried to the ancient city maybe also to feed the bath and the other related structures by following the topography through a masonry channel under gravity flow conditions, with probable tunnel sections. Due to the facts that the only known regarding the Kayaş Aqueduct is the gallery itself and that there exists no archaeological evidence regarding the water channel laid from the gallery towards the city, unless Özand's published photograph of the tunnel part of the aqueduct which was traced during the railroad excavation at Saimekadın is considered[77], it is not easy to draw the route of this aqueduct from the infiltration gallery to the city. However, Özand's proposal for the route of Kayaş Aqueduct drawn between the infiltration gallery and slopes of Cebeci according to the contour lines seems quite reasonable (Figure 29). According to his drawing, the water should have been conveyed from the infiltration gallery, at an elevation of 925 m.[78] approximately, to the other side of the valley by means of a siphon[79], and then brought to the city by means of a masonry channel, up to the slopes of Cebeci at an elevation of approximately 900 m. under open channel flow conditions depending on the topography. It should also be noted that this was the typical Roman way of conveying water through the aqueducts (Hodge 1992:93). In fact, when the average gradient of Kayaş Aqueduct is computed as (925-900) / 10,000 = 0.25 %, it will clearly be seen that it is quite comparable to the usual gradients encountered in Roman aqueducts which are between 0.15 – 0.3 % (Hodge 1992:218).

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[77] See also p. 42 for the details.

[78] See Fıratlı 1951:356.

[79] Özand states that the collected water was transmitted with an underground pipeline to the left side of the valley by making use of the inclination of the Kayaş Valley (Özand 1967:1). This strongly suggests the implementation of a siphon in the valley.

Unfortunately, we do not know how Kayaş Aqueduct continued from the slopes of Cebeci towards the ancient city, but it is possible to make suggestions on this issue. As the aqueduct firstly had to pass across the Cebeci lower plain to reach its terminal points in the city, to maintain the water level in such a situation, arcades might have been a solution. Since we do not have any archaeological and historical evidence regarding the existence of an arcade[80], this alternative is of very little or no possibility. Another solution could have been the implementation of an inverted siphon. Fıratlı reports that some other pipeline remains have been traced at the Cebeci Railway Station excavation (Fıratlı 1951:350). Although he concludes that these pipes show the city was supplying water from that direction until recently, considering the fact that water supply elements are hard to date, these pipe remains might have belonged to the siphon conveying the water of the Kayaş Aqueduct. And a third possibility might have been that the Kayaş Aqueduct might have somehow joined one of the lines of the Elmadağ Aqueduct somewhere around the slopes of Cebeci at a junction tank as their routes towards the city centre seem to be overlapping.

For the Elmadağ Aqueduct, we cannot be precisely sure of which spring(s), Seki, Elma, Kehlis or another one, was tapped either individually or in combination by the aqueduct[81]. How the water was collected from these springs also remains unknown. Fıratlı reports that no remains of the collection structures were traced during field surveys as they must have been demolished by the later installations at the same spring for water supply (Fıratlı 1951:355-356). On the other hand, according to a recent survey by Melek Yıldızturan[82], it was observed that there exist some traces at one of the gushing springs at the

[80] See Footnote 3.

[81] For the suggestions on that issue, see p. 36-37 and also footnote 56.

[82] Archaeologist, Museum of Anatolian Civilizations.

high plateau of Kıbrıs Village (Figure 33). Since the studies are not finished yet, it does not seem possible for the time being to determine to which era these traces belong to. According to Yıldızturan, this source was also utilized for the water supply in 1930s for Çankaya District. Looking at Figure 8, it will be seen that several springs at Elmadağ were tapped and spilled in a single channel to convey it to Çankaya in the 1930s rather than transmitting separately (Özand 1967:12). A similar arrangement might have also been the case for the ancient Elmadağ Aqueduct. As far as the closeness of the two springs, Elma and Seki, is considered, it seems more reasonable from an engineering point of view to spill both, or more if any, of the springs into a single basin to which the main line, the Elmadağ Aqueduct was connected. Thus, with a little additional work when compared to such a long aqueduct of nearly 20 km., it would considerably increase the certain amount of water to be supplied with the same aqueduct.

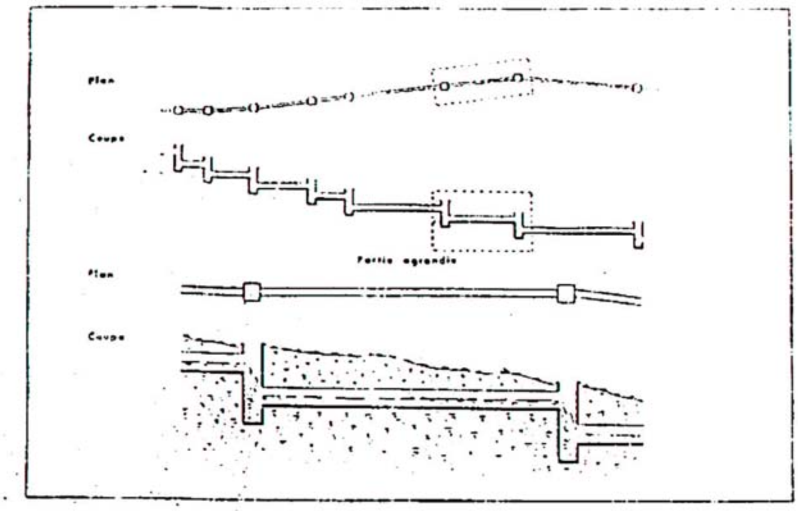
Figure 33: A spring and the collection channel, Kıbrıs Village (Photo: Melek Yıldızturan)

According to Fıratlı, the water collected from Elmapınarı and the other springs was brought to Mamak – Aşağı İmrahor line through terra-cotta pipes and soft limestone channels, maybe due to economical reasons (Fıratlı 1951:355) (Figures 24 and 25). He points out that some sections of this line were unearthed during the excavations made for the water supply line installation during the reign of Mayor Abidin Paşa and for this reason; the examination of the channel and the pipes became possible (Fıratlı 1951:355). Thus, it can be said that the routes of both aqueducts were overlapping at some sections. Fıratlı asserts that these channel members were capable to withstand a pressure of 6-7 m., and adds, therefore, that this part of the aqueduct should have contained many intermediate tanks to decrease pressure. If the pipeline was working under pressure[83], then he seems quite right in his conclusion. As there will be a pressure generation in such a pipeline not laid along the contour lines, but gently downhill, in order not to exceed the pressure which the pipe could withstand, there must have been intermediate tanks with several intervals to reduce the pressure to atmospheric[84]. Vitruvius also recommends building such kind of reservoir/tanks, so that if a break occurs anywhere, it will not completely ruin the whole work, and the place where it has occurred

[83] Hodge states that "unlike the normal masonry channel, pipes were intended to run full which in turn means that a pipeline would run under at least nominal pressure" (Hodge 1992:115). On the other hand, although the inclination is too steep for an open channel flow, these channels might have been designed for a half-full unpressurized flow. However, Fıratlı mentions that the examined channel remains contained 5 cm. thick calcium carbonate incrustation inside which decreased the flow section and thus the capacity of the system (Fıratlı 1951:355). If the incrustation had been circular and covering the whole inside perimeter of the channel, then it can be concluded that the pipe was working under pressure.

[84] Quoting Stenton and Coulton, Owens states that "the basins and small tanks are a common feature of water pipelines throughout the Graeco-Roman world" (Owens 2006:151). In addition, a very similar situation was the case for the aqueduct of the Ariassos, a notable feature of which, according to Owens, was a series of basins included along its course (Owens 2006:154). Owens observes that some of the tanks might also have been employed to reduce the momentum of water and so dissipate any internal pressure in the pipeline (Owens 2006:154).

can easily been found (Vitruvius VIII, 6.7). The use of intermediate tanks, in fact, is of somehow the similar mentality to use a cascade. Both methods decrease the generated pressure to atmospheric, but a cascade also decreases the elevation rapidly in way of pouring water into a deep vertical shaft. Similarly, Hodge points out that “if the source was originally too high that the problem was one of losing height,” which was also the similar case for Ankara[85], “then the solution was to use cascades” (Hodge 1992:160) (Figure 34).



115. Lyon: Craponne (Yzeron) aqueduct, cascades at Recret/Grézieu. There may have been up to fifty such steps in this 'hydraulic stairway' (A. Hernoud).

Figure 34: Use of cascade to let the aqueduct lose height rapidly (Source: Hodge 1992:162)

In this context, the Roman engineers must have selected the gentlest approach route for the laying of the aqueduct from the uphill of Elmadağ till down to the start of the inverted siphon which had delivered water to the other side of the lower plain. Such a laying out of the Elmadağ Aqueduct down to the start of the inverted siphon where a header tank should have been installed with the minimum slope possible might not only have prevented the generation of

[85] Springs’ area at Elmadağ is approximately at the elevation of 1500 m., and the elevation difference between Ankara and the springs is around 600m.

excessive pressure in the pipeline in short intervals, but would also have minimized, from the economical point of view, the number of intermediate tanks to decrease pressure. Based on this, an approach route for the Elmadağ Aqueduct to the ancient city and a corresponding longitudinal profile of the aqueduct, as drawn in Figures 35 and 36 respectively with the consideration of minimum slopes according to contour lines can reasonably be suggested[86].

It is believed that the inverted siphon had delivered the water to Hisarkapısı, to the elevation of 940 m., by crossing the lower plain through such a known point as Cebeci Railway Station where the traced twin pipelines were laid at the elevation of 885 m. approximately. Therefore, considering the topography of the inlet side and the elevation of the outlet side at Hisarkapısı, the inverted siphon section can be suggested to have started somewhere between the elevations of 1000 m. and 940 m. Then, assuming the traced pipeline at the railway station excavation as the lowest point for the siphon, it can be said with a help of a simple calculation on the map that the installed inverted siphon of a total length of approximately 2600 m. had been running under a maximum pressure head of between 55 m. and 115 m. depending on the start elevation of the siphon (Figure 36). Taking the diameter of the pierced stone pipe member as 0.22 m.[87], roughness height of the same as 0.003 m.[88] and assuming driving pressure head difference as 5 m.[89] between the inlet and the

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[86]It should be noted that the suggested route is roughly overlapping at some sections with the modern roads which are also aimed to be laid with the minimum slope possible towards the destination – Nato Yolu Caddesi and further its continuation Elmadağ Yolu passing through Yakupabdal village.

[87] The diameter of the twin pipeline traced at Cebeci Railway Station Excavation was 22 cm. (Fıratlı 1951:354).

[88] The same value was used for the discharge capacity calculation of the Karapınar Aqueduct in İzmir (Öziş 1999,48). It should be noted that especially the system in İzmir is very similar to the one installed in Ankara (Fıratlı 1951:359).

[89] Farrington points out that "the lower the outflow level, that is to say, the greater the fall of the effective gradient, the greater will be the water pressure at the outflow of the siphon"

outlet of the siphon, the discharge capacity of a single inverted siphon can be calculated to be roughly 16 lt./s., which is equal to the approximate delivery of 1300 cubic meters of water per day. If we consider twin pipelines as traced at Cebeci Railway excavation, then it makes 2,600 cubic meters of daily water delivery to the city.

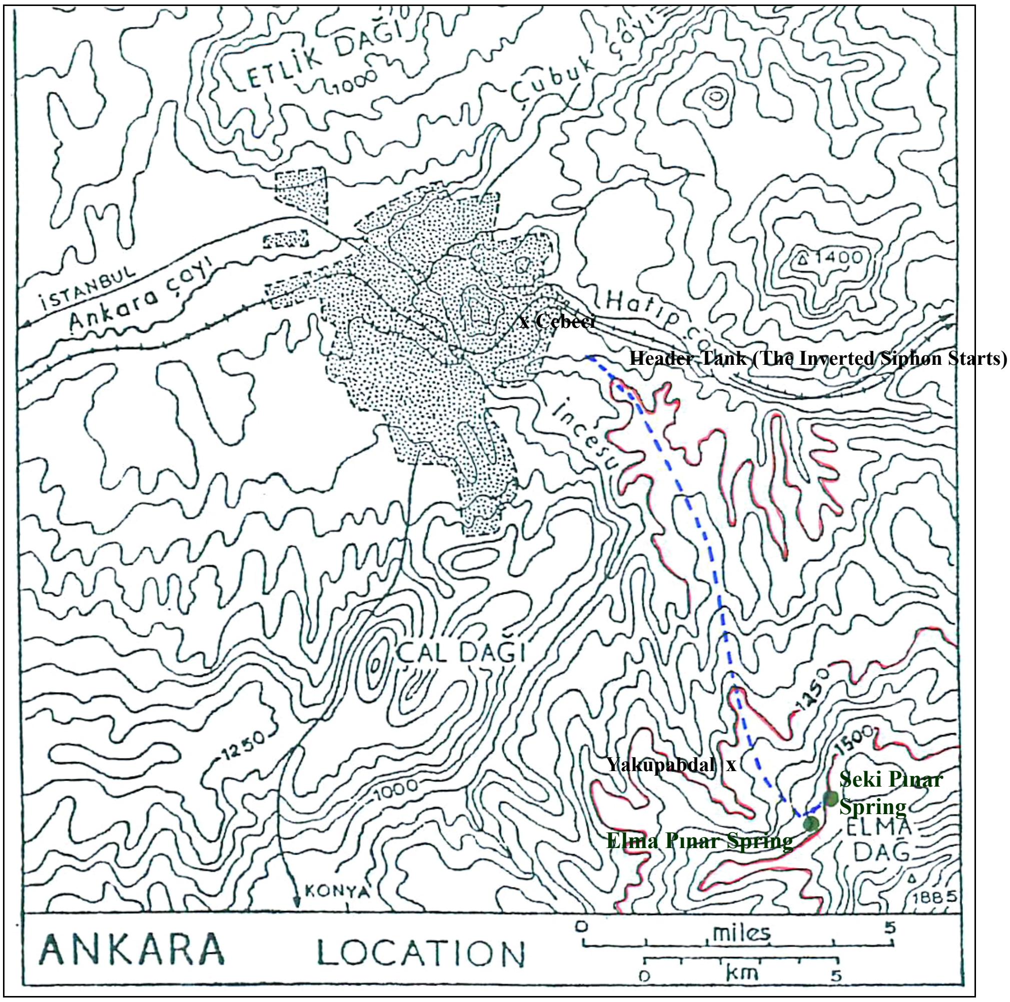

Figure 35: Possible layout of the Elmadağ Aqueduct (Topographic Map from Dewdney 1971, with some corrections on the elevations of the contour lines)

(Farrington 1995:107). Although, the siphon ends on a tank/reservoir at Hisarkapısı which will decrease any level of pressure to atmospheric at the outlet, due to the economical reasons, it might still be expected that the difference between inlet and outlet elevations would not be high.

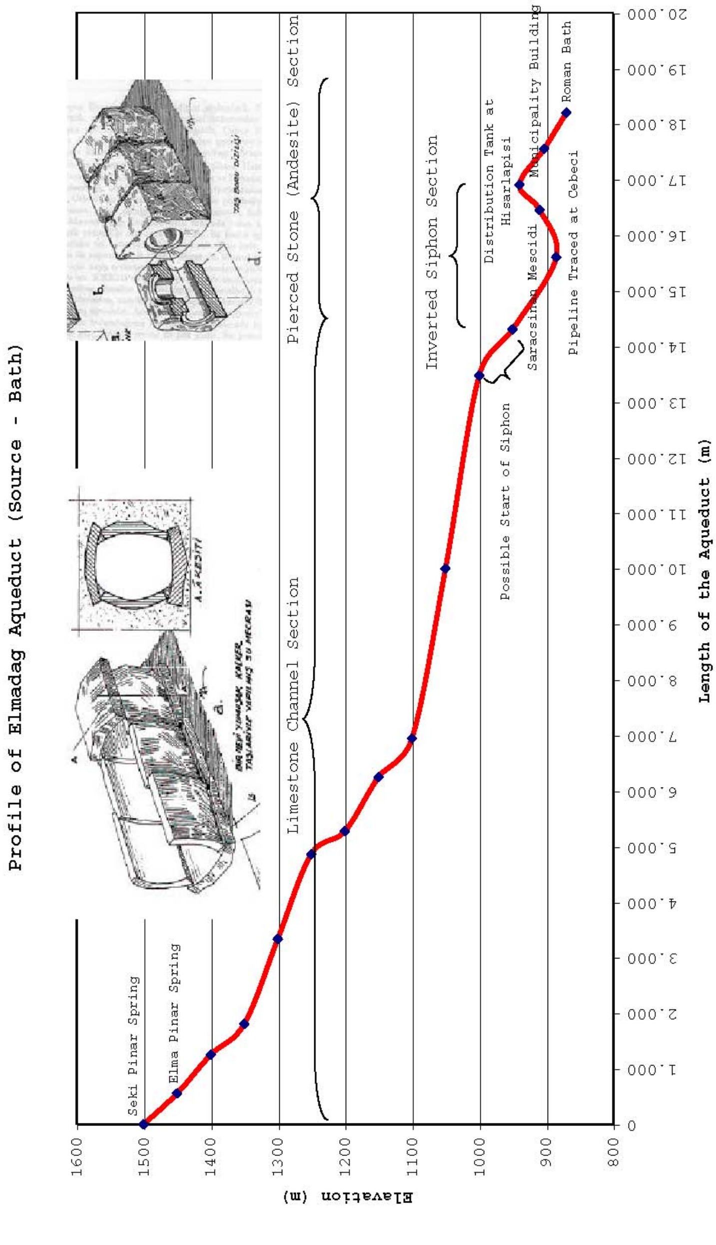

Figure 36: Suggested profile of the Elmadağ Aqueduct between the source and the terminal point, the bath.

When the water reached the city, Vitruvius recommends building a reservoir with a distribution tank, *castellum aquae*[90] (Vitruvius VIII, 6.1). Similarly, Fıratlı asserts that a storage tank/reservoir to distribute water to Roman Ankara should have been located at Hisarkapısı where the inverted siphon should have reached up (Fıratlı 1951:350-351). Unfortunately, due to the lack of archaeological evidence, we can not know if such a structure existed, and thus can not determine how the architectural and structural features were, and what the exact function was, if it ever really existed. However, as far as the location of Hisarkapısı is concerned, it seems a suitable place to locate a distribution tank[91]. In this context, it can be further commented that this structure might have been probably acting as a reservoir to provide pressure to feed the system for the urban distribution as located on a high point in the city. Further, it might also have enabled the settlement of the sediments in the brought water through a siphon before it was distributed to city.

The distribution scheme of water from the reservoir at Hisarkapısı within the city has been suggested by Fıratlı on the map depending on the traced remains at two places in the city (Fıratlı 1951:Resim 24, Figure 26 in this study). According to his proposal, after reaching the reservoir/tank located at Hisarkapısı, the pipeline passed in front of the Museum of Anatolian Civilizations, and continued towards the bath at Çankırıkapı along Konya Sokak and Anafartalar Caddesi (Fıratlı 1951:351). From this line, a branch is separated along Posta Caddesi[92] (Fıratlı 1951:351-352). Without any

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[90] For an interesting discussion on the *castellum aquae,* see Peleg, Yhuda (2006), '*Castella* are not Reservoirs'.

[91] See footnote 32.

[92] As also pointed out in Chapter III, this assertion seems questionable when the diameters of the main and the branching pipes are concerned. On the other hand, it should also be noted

additional discoveries, no further assertions regarding the distribution scheme of water within the city is possible. However, some guesses on the proposed scheme can be made. Looking at the profile of the Elmadağ Aqueduct between Hisarkapısı and the final destination, the bath, it will be seen that the elevation difference between these two points was quite high, approximately 70 m. (Figure 36). For lower parts of the city, this elevation would be much higher. Therefore, if the flow was pressurized[93], then, it is probable that high pressures would generate on the lower parts of the pipeline, which would be especially critical not only for the stone pipe members, but also for the branching network of terracotta pipes distributing water within the city. To overcome this undesirable situation and decrease the excessive pressures, secondary distribution tanks[94], as also found effectual by Vitruvius (Vitruvius VIII, 6.7) for maintenance purposes, or pressure dissipating devices, such as valves, (but of course not in the modern sense) should have been installed along the course of the aqueduct within the city. Similarly, Fıratlı mentions the existence of both a tank/reservoir and valves installed on the pipeline. However, the actual

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that according to Kadıoğlu, this line was feeding the bath thought to have existed at the place of Ulus Trade Center (Kadıoğlu et al. 2007:67).

[93] The presence of flow control valves is very important for a pressurized flow to occur within the pipe. If these control devices were not installed at outlet of the system or somewhere along the course of the pipeline, eventually suction will occur in the outlet of such a gravity pipeline system causing air entrainment into the system which renders the pressurized flow to free flow.

[94] A very similar situation to the case of Ankara has been encountered in Segobriga Aqueduct in Spain. The siphon section of this aqueduct also ended in a *castellum aquae* located in the highest part of the city (Cardigel et al. 2006:315). In addition, the writers assert that, "the most significant part of this aqueduct is the group of secondary *castella* built to avoid excess pressure in the pipes as the city was located on a steep slope, 75 m. above the bed of river Cigüela" (Cardigel et al. 2006:315).
Also similarly, Jansen points out that due to the steep sloped geography of Pompeii, especially in the lower parts, unacceptably high pressures generated in the main pipes distributing water from the main distribution centre which was located at the highest point of the town. She asserts that this high pressure was the reason for building towers up to 6 m. high as a minor distribution centre (Jansen 2000:113). Finally, she concludes that in most towns, from the main distribution at the edge at the town the water was led to minor distribution devices in several districts and from the minor distribution points water was led to its final destination: the street fountains, the baths, and the private consumers (Jansen 2000:124).

functions of these installations are not so clear. According to him, an installation like a tank/reservoir with a semi-circular plan found on Posta Caddesi provided a pressure head for the water to be distributed to the western part of the city through terra-cotta pipes connected to the tank with a stone pipe member (Fıratlı 1951:351-352). In this way, it can be considered as such a secondary distribution tank/reservoir which supports our opinion. However, the functions of the valve-like devices installed as a conic stone in the opening at the top of the pierced stone as shown (b) on Figure 16 remains a mystery. Fıratlı states that these valves were installed at the sections where the aqueduct passed lower elevations[95] and they were the same with the ones encountered in Laodikeia (Fıratlı 1951:354, note. 13) According to Şimşek and Büyükkolancı, these openings located at the top of the travertine block pipe members of the aqueduct of Laodikeia should have been installed for cleaning and maintaining purposes for the incrustation of calcium oxide which is rich in the waters of Lycos Valley, and also for the purpose of decreasing the pressure to stabilize the flow in the pipeline (Şimşek et al. 2006:87). The writers also add that these holes were acting also as safety valves to prevent the entire failure of the pipe member due to high internal pressure (Şimşek et al. 2006:87). Being parallel to the opinions of Şimşek and Büyükkolancı, these valves seem to have been employed in Ankara most probably for a function of energy dissipation in the pipeline especially for the ones distributing water to the lower[96] parts of the city, where the pressures would be more critical.

How the water was managed after reaching its one of the most important destinations, the bath, unfortunately remains obscure. However, it can be suggested that the coming water should have firstly collected in a reservoir

[95] He reports that these valves were traced at the foundation of the municipality building and the excavation of Cebeci Railway Station (Fıratlı 1951:354).

[96] It should be noted that Fıratlı also reports that these valves were installed at the sections where the aqueduct passed lower elevations (Fıratlı 1951:354)

before it was distributed to the individual water consuming facilities[97]. Apart from the function of collecting and distributing of water to various parts of the baths, this reservoirs might have also used for the purpose of water storage in order to the compensate for the fluctuations in the flow of water due to seasonal changes, breakdowns, or repairs on the aqueduct so that the bath could continue operating (Manderscheid 2000:491). It is obvious that such a reservoir might be expected to have been situated on a high level so that the water can easily circulate within the bath[98]. According to Fıratlı, the tank/reservoir at the Roman Bath at Çankırıkapı was located on twelve elevated footings behind the *piscina* (Fıratlı 1951:353) (Figure 17). Akok asserts that this tank/reservoir was a substitute one[99] and it was installed on a high elevation in order to provide the desirable head needed for the water to be transferred to the desired bathing areas (Akok 1968:10). We do not know if any additional water lifting devices were used in the bath.

The water was probably circulating inside the bath by means of terracotta and lead pipes invisibly laid inside the walls and the floors as was the general case

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97 According to Yegül, "even when a bathing establishment was served directly by a main line from a *castellum* or a branch from an aqueduct, a major reservoir was necessary for the collection and distribution of water to various parts of the baths" (Yegül 1992:394). Similarly, Manderscheid asserts that "no matter what type of provisioning was employed, all baths, small or large, public as well as private and military, were ordinarily equipped with water storage structures" (Manderscheid 2000:490). Nielsen also mentions the normal presence of an elevated storage tank in the baths supplied either by a well or by an aqueduct (Nielsen 1993:23).

98 Ordinarily, water supplies and storage installations are situated at a higher level than the bath itself, so that gravity might ensure an unobstructed flow of water (Manderscheid 2000:491).

99 By the word 'substitute' maybe he meant that the bath was depending on the running water from the aqueduct poured in a direct delivery tank and this tank/reservoir on the footings was used only when the flow of the water in the aqueduct was cut or reduced due to the reasons such as seasonal changes, breakdowns or repairs on the aqueduct. This suggests the existence of more than one, minimum two reservoirs.

for the Roman bath buildings[100]. Unfortunately, it seems almost impossible to determine how the water was transported from the tank/reservoir to the individual water consuming facilities and to understand the characteristics of the elaborate hot and cold water circulation system within the bath building because the last remnants from the superstructure of the bath building, the walls, were removed by blasting before the start of archaeological excavations at the bath site at Çankırıkapı[101] and the debris were dumped to the marshes near the Hatip Çayı.

Before the bed of Hatip Çayı was relocated in 1950s, it was flowing very close to the bath complex. Hodge points out “if the city was built on a river, as so many cities were, the drain simply emptied into it, and its contents were washed away downstream” (Hodge 1992:343). Considering this fact, Hatip Çayı can be shown as an important place for waste water drainage not only for the bath, but also for the city. In this context, it can fairly be suggested that the waste water collected through the excellent drainage channels network running under the building should have been successfully removed by draining to Hatip Çayı.

4.2. Conclusion

To sum up, it can be said that the city seems to have been supplied with spring/underground water of Elmadağ conveyed by minimum of two aqueducts, namely Kayaş and Elmadağ with approximate lengths of 15 and 18 km. respectively, although these water supply systems contain several

[100] See Farrington 1995:110, Manderscheid 2000:491.

[101] See Dolunay 1948:213, Akok 1968:11.

unknowns and their complete scheme has not yet been archaeologically proven. The former aqueduct should have conveyed the spring water within the aquifer on the northern slopes of Elmadağ tapped by an infiltration gallery through a masonry channel conduit under open channel, unpressurized, flow conditions in most parts, maybe also with some intermediate tunnel and inverted siphon sections. Although the conveying of water with this method has such difficulties as establishing the level, and such disadvantages as increased costs and vulnerability to attacks[102], as far as the geography and the topography of the site are concerned, it seems the only way of bringing water from that source. In this context, the Kayaş Aqueduct shows the features of typical Roman water supply systems. On the other hand, the latter should have tapped one or more springs on the higher elevations of the west side of Elmadağ by a spring house or by another similar tapping structure. Its completely underground course[103] was composed of limestone channel and pierced stone (andesite) block sections working under pressure. The difficulty of monitoring and maintenance, and the risks of splits and fracture in the pipeline due to high pressure generation[104] in such a pipeline system should have probably been overcome by the use of intermediate tanks. It is believed that pierced stones were belonging to an inverted siphon system with a maximum pressure of more than 55 m., which conveyed the water to a

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[102] Landels 1978:38-39, Şimşek et al.2006:91, footnote.71. Cost increase was mainly due to the necessity of constructing the masonry channel on a rock formation or on a firm ground against the risk of channel damage in case of a heavy precipitation or a landslide, which required extensive workmanship and material use (Landels 1978:38). Another reason for the cost increase could have been the elongated route of the channel.

[103] Coulton states that "sometimes, the pipe-blocks were simply laid on a firm foundation at ground level, as at Jeruselam or Laodicea" (Coulton 1987:78-79). As far as the clear-cut shapes of the blocks re-used on the city citadel are concerned, it seems that they might have been laid not underground but on a firm foundation at ground level. Fıratlı also explains that as the ground between Saraçsinan Mescidi and the fortification is of rocky formation, the passing aqueduct was laid very close to the ground level here and that it would have been more economical to re-use the blocks on the fortifications that are closer to the aqueduct (Fıratlı 1951:358).

[104] Landels 1978:43, Şimşek et al.2006:91, footnote.71.

distribution tank/reservoir situated at Hisarkapısı to be distributed to the city. With its stone pressure pipeline section, the Elmadağ Aqueduct reflects the general characteristic features of the water supply systems in Asia Minor[105] (Figure 37).

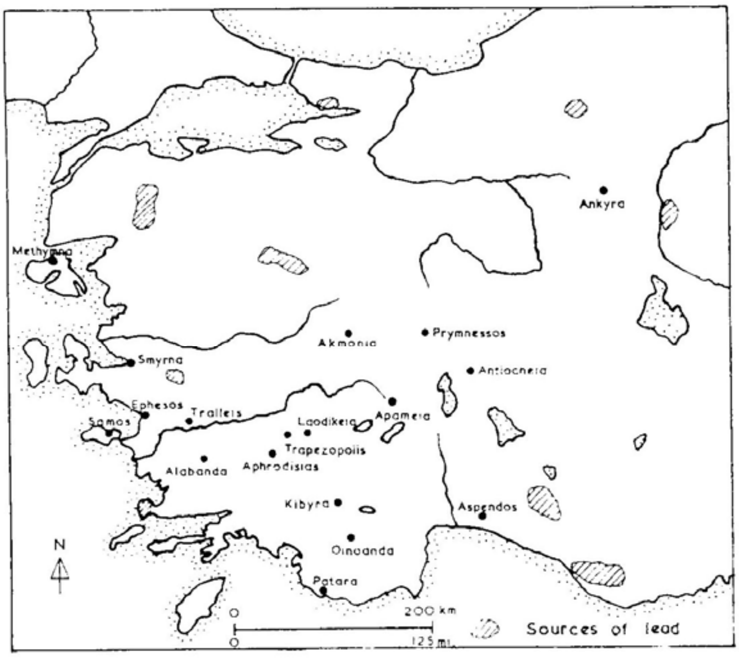

FIG. 22. Distribution map of stone siphon pipes

Figure 37: Aqueducts containing siphon pressure sections in Asia Minor (Source: Coulton 1987:79)

We do not know if these two aqueducts had worked simultaneously as complementary to each other or in different times individually, but both seem to have had the capability to serve the Roman Bath at Çankırıkapı. However,

[105] According to Coulton, the use of stone pressure pipelines is one of the characteristic features of the water supply systems of Asia Minor (Coulton 1987:76-78). He asserts that dating of these stone pressure pipelines is notoriously hard, and thus, without direct evidence, the argument for dating turns to an inconclusive dispute: “On the one side are those who believe that the cities concerned, established or already flourishing in the Hellenistic period, must have required a sophisticated water supply early on; on the other are those who argue that since most cities did not reach their acme until the second century A.D., it is only under the Roman empire that they would need such systems” (Coulton 1987:80-81).

districts having a level of more than 900 m., such as Kale Mountain where it is believed to be settled also in Roman times[106], or elsewhere, should have only been supplied by the Elmadağ Aqueduct, or by other means such as local wells and cisterns.

Finally, as an outcome of studying ancient water supply systems, Büyükyıldırım points out that it is possible to calculate the population of ancient towns, which is normally very hard to ascertain according to Mitchell[107], by making use of the daily water delivery to the town with a couple of assumptions:

1- All the water supplied to the city was consumed on the same day,
2- Daily water consumption of an ancient man is 100 lt. (today this amount is accepted as 200 lt. average in modern Turkey) (Büyükyıldırım 1994:16).

As it was calculated above, the daily discharge capacity of the inverted siphon section of the Elmadağ Aqueduct is 2,600 cubic meters[108]. Although the capacity of the masonry channel is much higher than the capacity of a pipeline[109], considering Table 1, it can be concluded safely that the Kayaş Aqueduct could have also supplied minimum such a similar daily amount. Assuming both aqueducts worked simultaneously, then the total daily water delivery comes out to be 5,200 cubic meters, say 5,000 cubic meters to be on the safer side due to leakage, etc. In this context, the population of ancient

[106] See Erzen 1946:56.

[107] See Mitchell 1995, I:244.

[108] This amount based on an assumption that the elevation difference between inlet and the outlet of the inverted siphon was 5m.

[109] See Hodge 1992:115.

Ankara would be: 5,000,000 lt. / 100 lt. = 50,000, which seems to be comparable with Mitchell's mentioning Ankara among the Roman cities with a population of more than 25,000 (Mitchell 1995, I:244).

Although the total water daily delivery of 5,000 cubic meters to ancient Ankara by two aqueducts is a very rough amount and depends on several assumptions which considerably affect the final figure, it gives us the opportunity of assessing the size of water supply establishment by comparing it with other cities. In this context, when compared with the daily amount of 26,000 cubic meters which was supplied to prosperous Pergamon with a population of 160,000[110] in the second and third centuries A.D., Ankara, as a metropolitan Roman town, also seems to have quite successful in solving the problems of water supply, and to have had a sophisticated water supply system to feed its two baths and amenities.

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[110] See Radt 1999:154.

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