Chapter 1

Roman water supply

1.1 THE AQUEDUCTS OF ROME

"The aqueducts were to him the most engrossing of all Roman antiquities"
May Ashby [1]

During the period of the Republic and the Principate eleven aqueducts were built for Rome, which each conveyed water to the city for centuries. They will briefly be presented in chronological order in the first part of this chapter. The emphasis will be on their construction, on adjustments and repairs, on the people who paid for their creation, and on those who took credit for them. The quality of the water that was led into the city by the aqueducts will be touched upon, as well as the people's appreciation of it. Furthermore, figures will be given for the aqueducts' total length, for stretches running underground or above ground, on substructures and arches. These figures will show that some aqueducts had hardly any stretches above ground outside the city, while others ran on arches for a considerable distance, and therefore were relatively vulnerable. What happened after an aqueduct entered the city - the distribution of the water by means of branches, mains and fistulae - is not explored in any depth in this chapter. As the present study aims at an evaluation of the role played by the water supply system in the city's history of social conditions and its historical demography, it is evident that the vicissitudes of the aqueducts, rather than their archaeological remains, will be stressed here. References to specific archaeological publications are offered in the footnote inserted after each heading. Technical aspects are mainly discussed in part 1.2. The discussion of the water distribution in the city's *regiones* relies to a large extent on Frontinus' reports, although it will be clear that his *regiones* do not

[1] Ashby 1935, v. May Ashby was the widow of Thomas Ashby who died 1931 after he had finished the manuscript of his book *The Aqueducts of Ancient Rome* which he considered to be his crowning work as an archaeologist and director of the British School at Rome.

necessarily completely match those mapped out by modern scholars.[2] The quantity of water delivered will come up for discussion in the next chapter and is therefore not mentioned here.

1.1.1 Aqua Appia [3]

The year 312 BC saw the earliest execution of plans for building an aqueduct to bring water to the city of Rome, by the censors C. Plautius Venox and Appius Claudius. Plautius found the water 'veins' to be tapped as sources for this aqueduct, hence his cognomen. Appius Claudius was the only one, however, who got credit for its construction; he deliberately stayed on as censor after his year-and-a-half term, and thus he was the one who finished the aqueduct. (*Aq.* 5.1-3).[4] The project was paid from public funds, according to Diodorus Siculus, without a decree of the senate (Diod. Sic. 20.36.1). In 144 BC, the aqueduct was leaking because of old age, and because it had been unlawfully punctured by private people. Q. Marcius Rex, *praetor inter cives* that year, was instructed by the senate to repair the aqueduct and reclaim the water (*Aq.* 7.1). Agrippa had the aqua Appia repaired again in 33 BC. The aqueduct probably formed part of the major repair of all *rivi aquarum* ordered by Augustus (RGDA 20.2), which he had promised to pay for in 11 BC (*Aq.* 125). This work was finished by 5 or 4 BC (CIL 6.1244).[5] In addition to his interest in the aqueduct, Augustus supplemented the Aqua Appia by means of a new branch, the *ramus Augustae* (*Aq.* 5.6).[6] Augustus probably paid for both the repair and the new branch.[7]

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[2] For a more critical discussion of the extent of the *regiones* and Frontinus' city-concept see section 2.4.

[3] PA, 21; Van Deman 1934, 23-28, 368, 385; Ashby 1935, 49-54; Hainzmann 1975, 78-82; Richardson 1992, 15-16; Evans 1993a, 65-74; LTUR I, 61-62; Aicher 1995, 34-35.

[4] Livy's story to explain the name of the aqueduct was slightly different: Plautius did not agree with the way in which Appius Claudius had revised the list of senators, and resigned during office (Livy 9.29.5-9).

[5] CIL 6.1244, part of ILS 98, can be seen on the Porta Tiburtina, above the arches over ancient Via Tiburtina. Nash 1961-1962 I, 49 fig. 44.

[6] It is not impossible that Agrippa built this branch, since Augustus did not mention it in his *Res Gestae* (20.2), unlike his addition to the aqua Marcia. However, Grimal 1961, 68; and Ashby 1935, 50 are of the opinion that the *ramus Augustae* must have been built between 11 and 4 BC.

[7] Bruun 1997a, 150-151.

The original aqua Appia had its source on a crossroad 780 *passus* (ca. 1.2 km) to the left of the Via Praenestina, between the seventh and eighth milestone, from Rome (*Aq.* 5.4).[8] The *ramus Augustae* had its intake on another crossroad of the Via Praenestina, at the sixth milestone, 980 *passus* (ca. 1.5 km) to the left (*Aq.* 5.7), near the Via Collatina. Both sources must have been situated near to each other, but have never been found. The two supply channels were united *Ad Spem Veterem*, a spot that Frontinus called *Gemelli* for that reason (*Aq.* 5.6). The end of the supply line was situated at the Clivus Publicus near the Porta Trigemina, at a place named *Salinae* (*Aq.* 5.9). Distribution started therefore at the northwest side of the Aventine hill, close by the river Tiber.

The total length of the original aqua Appia from *caput* to end was 11.190 *passus* (ca. 16.56 km), of which some 60 *passus* (ca. 0.09 km) were above ground on substructures and arches near the Porta Capena, between the Caelius and the lower Aventine (*Aq.* 5.5). The *ramus Augustae* ran completely underground (*Aq.* 5.8).[9] No settling tank was incorporated in the aqueduct. Possibilities for distribution of the Appia's water were rather limited because of the low level at which the water line entered the city. The advantage of the depth of the *caput* - 50 feet (ca. 14.8 m) below the surface of the earth - and the low positions of the channels outside the city was that they were less vulnerable to injuries from outside (*Aq.* 65.7). In the city, on the other hand, there were leaks and illicit punctures diminishing the total amount of water (*Aq.* 65.5-6).

At the end of the first century AD, the water from the aqua Appia that had entered the city was divided, by means of twenty *castella*, among the *regiones* II (Caelimontium), VIII (Forum Romanum), IX (Circus Flaminius), XI (Circus Maximus), XII (Piscina Publica), XIII (Aventinus), and XIV (Transtiberim) (*Aq.* 79.2). It was therefore used in the *regiones* where the *rivus* came through (II, XII and XIII) and the low-lying districts near the river. It is astonishing that *regio* I is not included in this series, since only in this *regio,* and in *regio* XII, does the channel seem to have run on substructures and arches.[10] Or maybe the boundaries of the fourteen Augustan *regiones* as indicated on our modern maps do not correspond to reality in the time Frontinus wrote these lines.[11] Water

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[8] 1 *passus* = 5 Roman feet = 5 x 29.6 cm = 148 cm
1 Roman mile = 1000 *passus* = 1.48 km.

[9] Van Deman 1934, 385 mentioned some remains of the aqua Appia under the Aventine hill; nothing has been found of the *ramus Augustae* (Van Deman 1934, 26).

[10] Evans 1993a, 66 + n. 6.

[11] Von Gerkan 1959, 393-430 disputed, unsuccessfully, the consensus on the boundaries of the fourteen Augustan *regiones.* The principal adjustment he promoted

from the aqua Appia was conveyed to the other side of the Tiber by means of a bridge, probably the Pons Aemilius. It is quite likely that when this bridge for normal traffic was reconstructed in 12 BC, provisions were made, for the first time, to transport water from the Appia to Transtiberim.[12]

1.1.2 Aqua Anio Vetus [13]

Forty years after the construction of the aqua Appia, in 272 BC, one of the censors in office, M' Curius Dentatus, contracted out the building of a second aqueduct. It was to be financed with the booty captured from Pyrrhus (*Aq.* 6.1). After Curius' term in office, construction apparently dragged. In 270 BC, the senate decided to appoint Curius together with Fulvius Flaccus as *duumviri aquae perducendae* to complete the waterline (*Aq.* 6.2-3). Owing to the premature death of Curius, Flaccus finished the aqueduct alone and claimed the credit (*Aq.* 6.4). His name, however, was not attached to it. The waterline brought surface water, sometimes of poor quality, from the river Anio to the city, and was named aqua Anio. When, in the first century AD, a second aqueduct, which drew its water from the same river, was built, the name of the former was extended with the adjective *vetus* to differentiate this aqueduct from the latter (*Aq.* 13.5). Along with the aqua Appia, the Anio Vetus was repaired several times: by Q. Marcius Rex in 144 BC (*Aq.* 7.1), by Agrippa in 33 BC (*Aq.* 9.9), and by Augustus between 11 and 4 BC (*Aq.* 125; CIL 6.1244 = ILS 98). The remains, moreover, suggest that Agrippa and Augustus made major adjustments. They also bear traces of Flavian, Hadrianic, and third century repairs.[14]

The length of the aqua Anio Vetus, from its *caput* near modern Vicovaro to its *terminus* inside in the Republican city wall close to the Porta Esquilina, totalled up to 43,000 *passus* (approx. 63.64 km), of which only 221 *passus* (approx. 0.33 km) ran above ground (*Aq.* 6.7). The waterline was this long because, among other reasons, its route followed the slopes of the hills as much as

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was that Meta Sudans should no longer be considered as the spot where five *regiones* (I, II, III, IV, X) met. As a consequence, his regio I was situated completely outside the Republican city wall (Von Gerkan 1959, 409 fig. 2; 418).

[12] Taylor 1995, 78-80.

[13] PA, 12-13; Van Deman 1934, 29-66, 369, 385-390; Ashby 1935, 54-87; Hainzmann 1975, 83-90; Richardson 1992, 11; Evans 1993a, 75-82; LTUR I, 44-45; Aicher 1995, 35-36.

[14] Van Deman 1934, 62-65.

possible and only by way of exception crossed a valley, to the ill effect that height was lost (*Aq.* 18.6).[15] The intake not only served the aqua Anio Vetus, but also an aqueduct for Tibur (*Aq.* 66.2).[16] Frontinus described a supplement from the aqua Marcia into the aqua Anio (*Aq.* 67.3) that might be confirmed by archaeological evidence.[17]

The Anio Vetus had its own settling tank, probably just before the fourth milestone on the Via Latina (*Aq.* 21.1).[18] From there, the water line ran underground along Spes Vetus, then in a roundabout way in the direction of the Porta Viminalis in the Republican wall to its *terminus* inside that wall near the Porta Esquilina. From there, the water was spread over the city (*Aq.* 21.3).[19] There must have been a shunt from the main line, near the second milestone on the Via Labicana, named Specus Octavianus, bringing some of the water to another place, near the gardens of Asinius and the Via Nova, from where it was distributed to a neighbouring region (*Aq.* 21.2).[20] The name of this shunt, Specus Octavianus, strongly suggests a date shortly before 27 BC. Remains were found near the Amphitheatrum Castrense, under the Aurelianic wall and east of the Porta Metrovia, that is to say at the south-eastern side of the city,

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[15] Some stretches above ground: Van Deman 1934, 385 ff. no. 47: bridge, no.50: bridge (Augustan), no. 70: substructure and channel 100 m long (Augustan), no. 72: substructure with channel (Marcian?)

[16] The exact location of the aqueduct for Tibur is much debated, but remains unknown. See Evans 1993b, especially pp. 450-452. Both *Aq.* 6.5 (Concipitur Anio Vetus supra Tibur vicesimo miliario extra portam . . . RRa . . . nam, ubi partem <dat> in Tiburtium usum) and *Aq.* 66.2 on the water quantity (Ad caput inveni quattuor milia trecentas nonaginta octo praeter eum modum qui in proprium ductum Tiburtium derivatur,...) talk about this line supplying Tibur. In order to locate the intake and the derivation of the branch for Tibur from the main aqueduct, discussion concentrated on the corrupted passage *Aq.* 6.5, in particular on the twenty miles above Tibur and the identification of the porta, but paid less attention to *Aq.* 66.2, which seems to imply that both aqueducts, the Anio Vetus as well as the Tibur line, started at the same *caput*, apart.

[17] Van Deman 1934, 387 no. 28; Grimal 1961, 85 and Ashby 1935, 65 suggest dating this supplement as Augustan.

[18] According to Frontinus (*Aq.* 19.1) the aqua Anio Vetus was one aqueduct out of six with a *piscina* within the seventh milestone on the Via Latina.

[19] See Bruun 1991, 119 for the suggestion that here free-flow channels were used for distribution.

[20] Grimal 1984, 159 situated the gardens of Asinius at the place where, in the early third century, the Baths of Caracalla were laid out. The Via Nova, as is to be seen on modern maps of Imperial Rome, was built at the same time as these baths. Maybe Frontinus meant another road, existing at the end of the first century. We may also be dealing with a later interpolation of the text; see also Evans 1993, 78-79.

under and outside the later third-century city wall. Lanciani has identified these as fragments of the Specus Octavianus. Van Deman dated them Augustan.[21] Like the aqua Appia, the aqua Anio Vetus did not have enough height to supply the entire city with water (*Aq.* 18.2-3.6).
At the end of the first century AD, the water from the aqua Anio Vetus was distributed via 35 *castella* in the *regiones* I (Porta Capena), III (Isis and Serapis), IV (Templum Pacis), V (Esquiliae), VI (Alta Semita), VII (Via Lata), VIII (Forum Romanum), IX (Circus Flaminius), XII (Piscina Publica), and XIV (Transtiberim) (*Aq.* 80.2). It is noteworthy is that *regio* II (Caelimontium) is not mentioned on Frontinus' list. Hence it appears that the water from the aqua Anio Vetus was distributed, by means of the Specus Octavianus, to the southern *regiones* I and XII, from a place near the gardens of Asinius.[22] Water could have been distributed to the other *regiones* mentioned above from a place near the Porta Esquilina. The aqua Anio Vetus was extended from the Forum Holitorium in *regio* XI towards *regio* XIV (Transtiberim) either via the pons Agrippae or via the Tiber Island using the pons Fabricius and the pons Cestius. This extension was probably carried out by Agrippa.[23]

1.1.3 Aqua Marcia [24]

The censors of 179 BC, M. Aemilius Lepidus and M. Fulvius Nobilior, tried to build a third aqueduct serving Rome, an attempt that was blocked by M. Licinius Crassus, who did not allow the waterline to pass through his lands (Liv. 40.51.7). Yet thirty-five years later, according to Frontinus, the senate considered it wise, in view of the growth of the city, to repair the two existent aqueducts leaking from old age, and to reclaim the water illicitly diverted by private people. Q. Marcius Rex, praetor *inter cives* that year, was appointed to both tasks (*Aq.* 7.1.3), and accomplished them. He was also charged with the task of enlarging the water quantity, if possible, by bringing *alias aquas* into the city (*Aq.* 7.2). Whether the senators ordered him to supplement the existing

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[21] Van Deman 1934, 66 and 390 nos. 81-83; She did not mark off Agrippa's activities from those of Augustus on the basis of remains (Van Deman 1934, 60).
[22] Evans 1993a, 78-79 discusses the problems.
[23] Taylor 1995, 78-81.
[24] PA, 24-27; Van Deman 1934, 67-146, 370-371, 390-402; Ashby 1935, 88-158; Nash 1961-1962 I, 48-51; Hainzmann 1975, 91-106; Bieber 1976; Richardson 1992, 17-18; Evans 1993a, 83-93; LTUR I, 67-69; Aicher1995, 36-37; Astin 1961, Morgan 1978, Tortorici 1993, Volpe 1996.

two aqueducts with new sources or to construct a new water line, Marcius succeeded in building a new aqueduct too (*Aq.* 7.3).[25] Whereas censors had contracted out the earlier aqueducts, Marcius obtained HS 180 million this time, probably for his three assignments (*Aq.* 7.4).[26] The relatively sudden population increase in the city, when in 146-145 BC three victorious armies had returned to Italy, and many veterans wanted to try their luck in Rome, may indeed have been the reason why the senators chose not to wait another two years when censorship would be filled again.[27] Where the money came from, Frontinus does not say. It is obvious, however, that the victories over Carthage and in Greece in 146 BC, had enlarged the funds of the Roman Republic to such an extent that this large sum of money could be spent. Again the builder's term of office did not suffice to finish the job, so Marcius' praetorship was prorogued for a year.[28]

From its *caput*, at a place to be reached when coming from Rome on the Via Valeria up to the thirty-sixth milestone, then going 3,000 *passus* (ca. 4.44 km) along a crossroad to the right, up to the city, the aqua Marcia had a length of 61,710.5 *passus* (ca. 91.33 km) of which 54,247.5 *passus* (ca. 80.28 km) were underground and 7,463 *passus* (ca. 11.05 km) above ground (*Aq.* 7.6.8). The sources have been found in an elevated valley of the river Anio, and the route of the water line is rather well known.[29]

From the settling tank (*piscina*) at the city side of the seventh milestone on the Via Latina, the aqueduct continued above ground: 528 *passus* (ca 0.78 km) on

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[25] Evans 1993a, 84; Morgan 1978, 47 suggested that the senatorial debate in 143 BC (*Aq.* 7.5) turned on the issue of the new aqueduct.

[26] See Brunt 1971, 13 for a list of censors.

[27] Evans 1993a, 84 n. 7; Morgan 1978, 29-33 and 54 argued convincingly that the senators, aware of the problems related to the sudden influx of Roman citizens they could not send away, and confronted with proposals for a redistribution of the *ager publicus*, decided in favour of improvement of living conditions in the city.

[28] Plin. *HN* 36.121, telling that Q. Marcius Rex finished the aqueduct within his term, omitted to say that the term was prolonged. The debate in the senate about a branch to Capitol Hill was carried on in the years after 144 BC (see Astin 1961, 540-548 for a discussion arisen from *Aq.* 7.4). In *HN* 31.41, contrary to his *HN* 36.121 and Frontinus' words, Pliny attributed the construction of the aqua Marcia to one of the Roman kings, Ancus Marcius, and held Q. Marcius Rex responsible for repairs only. Morgan 1978, 37 thought that Pliny, in attributing the aqueduct to Ancus Martius, "reflected a conceit originated by the Marcii themselves, to invest their aqueduct with an impressive pedigree".

[29] The later *aquae* Claudia and Anio Novus, following approximately the same course, were not as long as the aqua Marcia, since curves in their upper courses were cut short (Grimal 1961, 71).

substructures and 6,472 *passus* (ca. 9.58 km) on arches.[30] After this stretch the water line disappeared from sight again, it went underneath the Viminal Hill, only to re-emerge at the Porta Viminalis (*Aq*. 19.5-6). The exact location of the original main distribution point is not known, but it must have been near the Porta Viminalis. When entering the city, the most prized water of all had enough height to be distributed in all *regiones* (*Aq*. 18.3-4).

The aqua Marcia was put under repair by Agrippa in 33 BC (*Aq*. 9.9), by Augustus (*Aq*. 125 and CIL 6.1244), and by Titus (CIL 6.1246).[31] Moreover, archaeological remains also show Hadrianic, Severan and later improvements.[32]

In order to supplement the aqua Marcia if it ran dry, Augustus ordered water to be added from another spring, a little further on in the Anio valley than the first, by means of an underground channel into Marcia's original *rivus* (RGDA 20.2; *Aq*.12.1-3, 72.8). This extra supply channel was named Augusta after its builder. Under normal conditions, however, the aqua Marcia was not in need of such a supplement, and therefore, at some point in the first century AD, Marcia's surplus was conducted into the aqua Claudia (built in Claudius' reign, see below) (*Aq*. 14.3, 72.8). Somewhere between the sources and the *piscina* near the seventh milestone on the Via Latina, part of the water of the aqua Marcia was given to the Anio Vetus and the aqua Tepula (see below) (*Aq*. 67.3). Agrippa, constructing the aqua Iulia in 33 BC and transforming the aqua Tepula, built the channels of both these water lines, from the sixth milestone on the Via Latina onwards, on top of the aqua Marcia (*Aq*. 19.3-4). In the second century AD, probably, reservoirs were built south of Porta Collina in the Republican city wall, to take in the water of these three aqueducts.[33]

In Frontinus' time, three branches conveyed water to major distribution points: The first was a branch to the Capitol, the construction of which caused sensation for years. For political reasons, probably, religious objections were made to prevent Q. Marcius Rex from being honoured as the first who did bring water to the Capitol. In senatorial debates in 143 and 140 BC, objections

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[30] For the puzzling interpretation of these numbers, see Grimal 1961, 76-77.

[31] Both CIL 6.1244 and 1246 are included in ILS 98. The inscriptions were attached on an arch of the aqua Marcia over the Via Tiburtina, that was incorporated in the Aurelian wall. However see Grimal 1961, 77 who is of the opinion that the arches of the Marcia-Tepula-Iulia between the Porta Maggiore and the Porta Tiburtina were never incorparated in that wall; Nash 1961-1961 I, 49 fig. 44.

[32] Van Deman 1934, 390-401.

[33] Van Deman 1934, 401 no. 177, 403 no. 9, 404 no. 16; Ashby 1935, 151; Evans 1993a, 86.

were overruled at last (*Aq.* 7.5).[34] Nothing has ever been found of this branch. Nevertheless, Van Deman is of the opinion that it is possible to infer from the position of Marcius' statue behind the temple of Iupiter Capitolinus, that the *terminus* of the aqua Marcia must have been there.[35] And Ashby supposes that there had been a siphon from the Quirinal to the Capitol Hill.[36]

The second branch, the rivus Herculaneus, began before the aqueduct reached its main distribution point, behind the Horti Pallantiani on the Esquiline. From there it ran underground through the Caelius and ended above Porta Capena. For the Caelius itself this *rivus* was of no importance, since it was too low (*Aq.* 19.8-9).

The third branch supplied, according to Frontinus, together with the aqua Iulia (see below), water to Caelius and Aventine. It went out of use after Nero had built the Arcus Neroniani as a branch from the aqua Claudia (see below), and utilised the water from that aqueduct for both hills, employing the distribution devices of the aqua Marcia (*Aq.* 76.5-7). In Frontinus' time, the branch from the aqua Marcia from Spes Vetus to the Aventine was open again (*Aq.* 87.3-4).

At the end of the first century AD, water from the aqua Marcia was distributed in the *regiones* I (Porta Capena), III (Isis and Serapis), IV (Templum Pacis), V (Esquiliae), VI (Alta Semita), VII (Via Lata), VIII (Forum Romanum), IX (Circus Flaminius), X (Palatium) and XIV (Transtiberim), by means of 51 *castella* (*Aq.* 81.2). It is striking, that in this inventory, the *regiones* II (Caelimontium), XII (Piscina Publica), in which normally the lesser Aventine is located, and XIII (Aventinus) are missing, whereas they, especially, should have been supplied by the aqua Marcia. Since Van Deman noticed Trajanic repairs in the branch to the Aventine, Frontinus may have confused reality and intentions.[37] Besides, he may have been wrong in assuming that the second and the third branches ran separately.[38]

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[34] Astin 1961, 547-548; see Morgan 1978 for a rather extensive hypothesis of the problems in bringing water to the Capitol via the aqua Marcia.

[35] Van Deman 1934, 139 established the position of the statue on CIL 16.5 = CIL 3.2.846, a *diploma militaria* found in Bavaria, Germany.

[36] Ashby 1935, 152. Both Cicero (*Rab. Post.* 31) and Florus (II. 4), describing how Marius had had the water line to Capitol Hill cut off in 100 BC, used the word fistula, which is usually understood as lead pipe by modern authors. Ashby did not adduce these passages as evidence for his assertion.

[37] Van Deman 1934, 402 nos. 184c and 185; Ashby 1935, 156, however, wrote "Of Trajan's *amplum opus* nothing appears to be left." See Evans 1993a, 87-89 discussing both the rivus Herculaneus and the second branch to the southern parts of the city.

[38] Volpe 1996, 75-80 counter to the consensus of earlier students, thought that Trajan extended the rivus Herculaneus from Porta Capena to the Aventine.

Maybe there was another branch from the Marcia, the evidence for which dates from Hadrian's reign. Lanciani has already identified some very big fistulae as elements of a water main from the Porta Viminalis to the Forum Traiani.[39] Rather recently, it has once more been suggested that this main was the branch constructed by Q. Marcus Rex that supplied the Capitol.[40] If so, the lead pipes must have replaced earlier ones.[41]
Archaeological evidence, dated as Caracallan, indicates a branch from a reservoir near the third milestone on the Via Latina to a reservoir behind the Baths of Caracalla.[42] As Caracalla made clear in an inscription (CIL 6.1245, to be seen on the Porta Tiburtina) that he had restored the aqua Marcia and added a new source, it is plausible that the aqua Marcia supplied his baths. The aqua Marcia likewise supplied the later Baths of Diocletian, via a short stretch from the Porta Viminalis to a reservoir at the south east side of these baths.

1.1.4 Aqua Tepula [43]

In 125 BC, the censors Cn. Servilius Caepio and L. Cassius Longinus built the aqua Tepula, bringing water from Lucullus' lands at Tusculum to Rome and the Capitol (*Aq.* 8.1-3). Neither of them attached his name to the aqueduct, possibly because they did not take any pride in its construction, as the water it delivered was tepid and therefore unappreciated. The water line started at a distance of 2,000 *passus* (ca. 2.96 km) on a crossroad to the right - seen from

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[39] Lanciani 1975, 432-433; His silloge no. 59 = CIL 15.7309 β, two items found near the center of the exedra of the Baths of Diocletian, bearing a stamp containing the names of Hadrian, procurator Petronius Sura and a plumber, the slave Martialis, and CIL 15.7309 α (= Lanciani's silloge no. 60), one item found at the west side of the Quirinal near the temple of Serapis, bearing a stamp containing the names of the same emperor and procurator, and a different plumber, Claudius Felix. Van Deman 1934, 402 nos. 186 and 187 mentioned an underground channel and a Hadrianic lead pipe at both find-spots.

[40] Tortorici 1993, 19-21 and fig. 22; Ashby 1935, 152 knew of such an hypothesis, in his time based on an underground channel found in Piazza Termini which is now called Piazza della Repubblica, in Antiquity the exedra of the Thermae Diocletianae, and a "small portion of a conduit found in front of Palazzo Rospigliosi" (FUR fol. 16). This portion of a conduit was probably CIL 15.7309 α. In his opinion, both attributions to the Marcia's branch to the Capitol were very doubtful.

[41] Volpe, accepting Tortorici's hypothesis: Volpe 1996, 80-81 and fig. 80.

[42] Van Deman 1934, 402 nos. 188-194.

[43] PA, 27-28; Van Deman 1934, 147-156, 372, 403; Ashby 1935, 159-160; Hainzmann 1975, 107-108; Richardson 1992, 18; Evans 1993a, 95-98; LTUR I, 70; Aicher 1995, 38.

Rome - at the tenth milestone on the Via Latina. Its sources were identified as close by Tusculum. Van Deman's measurement showed a water temperature of 16 to 17° C there, at an air temperature of 10° C. There are no known remains of this aqueduct as a separate construction.[44] In 33 BC Agrippa took measures to end the separate course of the tepid water: it was mixed with the fresh supply of a new aqueduct, the aqua Iulia, drawing its water from sources nearby those of the Tepula (*Aq.* 9.1).

Frontinus considered the aqua Tepula a waterline without separate sources, entirely diverted from the aqua Iulia. Yet the name aqua Tepula had not vanished (*Aq.* 9.2). The *caput* of the Tepula was, after Agrippa's efforts, the *piscina* of the aqua Iulia at the sixth milestone on the Via Latina (*Aq.* 68.2-3). From there the Tepula had its own channel, between those of the aqua Marcia and the aqua Iulia. It received water from the aqua Marcia just beyond the *piscina*, and was, at some point in the first century AD, supplemented with water from the aqua Anio Novus at a place near the gardens of Epaphroditus (*Aq.* 68.4). As the channel of the Tepula ran, just like the channel of the aqua Iulia, on top of the substructures and arches of the aqua Marcia, the route of the latter aqueduct was followed up to Porta Viminalis (*Aq.* 19.3-5), and, probably since the second century, beyond to Porta Collina (see section 1.1.3). Augustus repaired the aqua Tepula between 11 and 4 BC, along with the Marcia (*Aq.* 125, CIL 6.1244).[45] Some later repairs have been attested to by means of archaeological evidence.[46]

As the channel of the aqua Tepula was built on top of the aqua Marcia, this line too had sufficient height to distribute water all over the city. Yet, according to Frontinus, water from the Tepula was only divided among the *regiones* IV (Templum Pacis), V (Esquilliae), VI (Alta Semita), and VII (Via Lata), which were all at the north and east sides of the city, by means of 14 *castella* (*Aq.* 82.2).

1.1.5 Aqua Iulia [47]

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[44] Van Deman 1934, 149; Evans 1993a, 96 suggested that from the beginning in 125 BC, the Tepula ran on top of the Marcia.

[45] It is evident that Plin. *HN* 36.121, mentioning a repair by Marcius in 144 BC, cannot be correct. How to repair a structure 19 years before its construction?

[46] Van Deman 1934, 403.

[47] PA, 23-24; Van Deman 1934, 157-166, 373, 403-404; Ashby 1935, 161-166; Nash 1961-1962 I, 47; Hainzmann 1975, 109-113; Richardson 1992, 17; Evans 1993 a, 99-103; LTUR I, 66-67 ; Aicher 1995, 38-39.

Agrippa was engaged in the water supply of the city as *aedilis curulis* in 33 BC, four years after he had held the office of consul.[48] Besides repairing the existent aqueducts, the aquae Appia, Anio, and Marcia, he rebuilt the aqua Tepula and constructed a new one, the aqua Iulia.[49] For that purpose he made available for Rome sources in the surroundings of Tusculum, some 3.4 km as the crow flies, from those of the Tepula.[50] How he financed these activities is not reported. It is not unlikely, however, that he paid for them out of his own fortune.[51] The aqua Tepula was intercepted, and its water mixed with that of the new aqua Iulia. As a single channel the water of both aqueducts arrived at the *piscina* near the sixth milestone on the Via Latina. Here the water was separated: a minor part continued on as aqua Tepula, while the remainder continued as aqua Iulia, the highest of three channels on the substructures and arches originally built for the aqua Marcia. The aqueduct followed its course to Porta Viminalis (*Aq.* 19.3-5, 69.2), and, probably from the second century onwards, beyond to Porta Collina (see section 1.1.3). Like the other aqueducts, the Iulia was under repair between 11 and 4 BC (*Aq.* 125; CIL 6.1244). Archaeological evidence suggests Severan and late repairs.[52]

The aqua Iulia has a length of 15,426.5 *passus* (ca. 22.83 km), of which 7,000 *passus* (ca. 10.39 km) are above ground in common with the aquae Marcia and Tepula (*Aq.* 9.3).[53]

Frontinus brought to an end a temporary supplement into the Iulia, for Rome neither necessary nor effective, from the Cabra. This source close by those of

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[48] Agrippa *aedilis curulis*: CIL 6.31270 = ILS 128; aedil after the office of consul: *Aq.* 9.1, Plin. *HN* 36.121, Dio Cass. 49.43.1-4.

[49] Plin. *HN* 36.121 expressing his admiration for Agrippa's activities as aedil in 33 BC, does not mention this aqueduct, but rather the aqua Virgo. According to Dio Cass. 48.32.3, Agrippa, *praetor urbanus* that year, had the aqua Iulia introduced into the city in 40 BC. In view of the political instability and the premature end of his term (MRR II 380), Frontinus'dating is more plausible.

[50] Grimal 1961, 72.

[51] Frank 1959, 370 was of the opinion that Agrippa enlarged the water supply of the city at his own expense, but it is not clear on which evidence his opinion was based. Dio Cass. 49.43.1-4, listing Agrippa's activities as *aedilis* in 33 BC, in some cases mentioned his financial efforts, for example in 49.43.1 writing about Agrippa's repair of public buildings and roads, and cleaning the *cloacae*, without breaking into public funds. He passed over the building of this aqueduct.

[52] Van Deman 1934, 403-404.

[53] The common course is confirmed by Augustan *cippi* (CIL 6.31559 = 6.1248 and CIL 6.31561 = 6.1249) and remains of that can be seen at Porta Tiburtina, Porta Maggiore and Romavecchia (Aicher1995, 56, 58, 98-102).

the Iulia supplied the landowners of Tusculum, irrigating their fields. The supplement had been made by *aquarii*, who took care that it never reached the city. When the emperor ordered Frontinus to end this abuse, he returned the water to the people of Tusculum (*Aq.* 9.5-7).[54] At some time in the first century AD, the Iulia accepted a supplement from the aqua Claudia (*Aq.* 69.3) behind the gardens of Pallas, close by the city. Like the aquae Marcia and Tepula, the Iulia had sufficient height to be distributed all over the city (*Aq.* 18.3-4). A branch starting at Spes Vetus supplied the Caelius (*Aq.* 19.7). Whether this line has ever existed, separate or on top of the Marcia is doubtful, since no traces of this branch have been found. Equally problematic is Frontinus' statement that the Iulia as well as the Marcia were neglected after Nero had built the Arcus Neroniani as a branch of the aqua Claudia (*Aq.*76.4-7).[55] A branch running from the channel of the Iulia somewhere between Porta Maggiore and Porta Tiburtina to a *nymphaeum Alexandri* also called Trofei di Mario at Piazza Vittorio Emanuele was traditionally supposed to have been built by Severus Alexander in the third century AD. Measurements from the last decade seem to have proven that the aqua Iulia cannot have supplied this nymphaeum.[56]

By Frontinus' time, the water from the aqua Iulia was distributed by means of 17 *castella* in the *regiones* II (Caelimontium), III (Isis and Serapis), V (Esquiliae), VI (Alta Semita), VIII (Forum Romanum), X (Palatium), XII (Piscina Publica) (*Aq.* 83.2).

1.1.6 Aqua Virgo [57]

After his third consulship, Agrippa once again constructed a new aqueduct (*Aq.* 10.1), at his own expense (Dio Cass. 54.11.7). The first day on which the aqueduct flowed into the city was June 9, 19 BC (*Aq.* 10.2).[58] Agrippa's name for it, aqua Augusta, was never accepted; a fancy name became the vogue.[59]

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[54] The attribution of CIL 6.1261, showing water division among landowners at fixed hours, to the Cabra is doubtful. See Grimal 1961, 72 n.26.

[55] See section 1.1.3 (aqua Marcia); Evans 1993a, 100-101.

[56] LTUR I, 67.

[57] PA, 28-29; Van Deman 1934, 167-178, 374-375, 404-405; Ashby 1935, 167-182; Nash 1961-1962 I, 55-56; Hainzmann 1975, 114-118; LLoyd 1979; Richardson 1992, 19; Evans 1993a, 105-109; LTUR I, 72-73; Aicher 1995, 39-41.

[58] Plin. *N.H.* 36.121 dated the aqua Virgo during Agrippa's term as aedil, that is to say in 33 BC.

[59] Aqua Augusta: Dio Cass. 54.11.7; *Aq.* 10.3-4 and Plin. *HN* 31.42 each explained the name by which it was generally known.

The *caput* was situated in the marshland near the eighth milestone on the Via Collatina, not far from the sources of the aqua Appia. The enclosure of the source was lined with impenetrable *opus signinum* in order to screen the spring water from that of the marsh (*Aq.* 10.5).[60] An unspecified number of extra sources were added to the main channel before the seventh milestone (*Aq.* 10.6, 70.2-3). Like the aqua Appia, the Virgo had, by the time of Frontinus, no *piscina* to settle impurities before entering the city (*Aq.* 22.1). That device was built during Hadrian's reign.[61]

The route of the aqua Virgo had a length of 14,105 *passus* (ca. 20.88 km), of which 12,865 *passus* (ca.19.04 km) ran underground, 540 *passus* (ca. 0,80 km) on substructures at several places, and the remaining 700 *passus* (ca. 1.04 km) on arches (*Aq.* 10.7). These arches started under the gardens of Lucullus and ended in the Campus Martius near the front of the Saepta (*Aq.* 22.2).[62] It seems plausible that Frontinus in his treatise described the arches of the aqueduct, which Claudius had rebuilt after Gaius had removed the original. Their route seems not to have been altered.[63] Repairs by Augustus are neither likely nor proven. However, the aqueduct has been under repair time and again as it still serves the city of Rome. Apart from Claudius, *cippi* point at interference from Tiberius (CIL 6.31565 = 6.1253 and 1254). Another inscription shows that Constantine II was concerned with this aqueduct in the fourth century (CIL 6.31564).

The aqua Virgo, like the Appia, had insufficient height to be distributed all over the city, since both their *capites* were too low (*Aq.* 18.7). Water from the Virgo was distributed by means of 18 *castella* in the low-lying *regiones* VII (Via Lata), IX (Circus Flaminius), both at the north side of the city. It was

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[60] Grimal 1961, 73 n. 30 and 32.

[61] Van Deman 1934, 405 no. 6; Aicher 1995, 40.

[62] The gardens of Lucullus were situated near modern villa Medici and the Spanish steps.

[63] CIL 6.1252 = ILS 205:
TI CLAVDIVS DRVSI CAESAR AVGVSTVS GERMANICVS
PONTIFEX MAXIM TRIB POTEST V IMP XI P P COS DESIG IIII
ARCVS DVCTVS AQVAE VIRGINIS DISTVRBATOS PER C CAESAREM
A FVNDAMENTIS NOVOS FECIT AC RESTITVIT;
Nash 1961-1962 I, 56 fig. 52. Had Caligula, assuming that the new aqueduct he had begun near Tibur would take over the Virgo's supply, pulled down the arches to give way to the amphitheater he planned to build beside the Saepta (Suet. *Calig.* 21)? Van Deman 1934, 404-405 dated the greater part of the remains of the Virgo as Claudian.

conveyed to *regio* XIV (Transtiberim) (*Aq.* 84.2), probably by means of the Pons Agrippae.[64]

1.1.7 Aqua Alsietina [65]

Augustus had an aqueduct constructed simultaneously with his *naumachia* (open to the public in 2 BC), which was built on the right-hand side of the Tiber. It was named aqua Augusta after its builder, but became known as aqua Alsietina. Its water had poor quality. The sole rational explanation for the construction of this water line that Frontinus was capable of thinking up, was that Augustus needed a separate aqueduct in order not to use drinking water for the Naumachia Augusti (*Aq.* 11.1, 22.4).

Through the *specus* of the aqua Alsietina flowed surface water from the Lacus Alsietinus (modern Lago di Martignano) (*Aq.*11.3), supplemented by surface water from the Lacus Sabatinus (modern Lago di Bracciano) (*Aq.* 71.1), which were both situated northwest of the city.

The length of the aqueduct from its *caput* at Lacus Alsietinus to its *terminus* near the Naumachia Augusti in Transtiberim totalled up to 22,172 *passus* (ca. 32.81 km), of which 358 *passus* (ca. 0.53 km) ran on arches (*Aq.*11.3). Like the aqua Appia and the aqua Virgo up to Hadrian's reign, the Alsietina had no settling tank (*Aq.* 22.1). According to Frontinus this aqueduct was lowest of all.[66] Under normal conditions, and when there was no *naumachia* held, the total amount of its water was utilised outside the city (*Aq.* 85.2).[67] But, although the water was pronounced unfit for human consumption, in a pinch it was conveyed to the public fountains in Transtiberim. This occurred all the time when the bridges over which water from the other side of the river was

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[64] Lloyd 1979, 200-201; Evans 1993a, 107; Taylor 1995, 78-83.

[65] PA, 20-21; Van Deman 1934, 179-186, 376-377, 405; Ashby 1935, 183-189; Nash 1961-1962 I, 35-36; Hainzmann 1975, 119-120; Richardson 1992, 15; Evans 1993a, 111-113; LTUR I, 61; Aicher 1995, 41; Taylor 1997.

[66] However see PA, 20; Richardson 1992, 15; Taylor 1997, 484-485 postulating a principal *castellum* in the vicinity of the city before the remains found high on the Ianiculum.

[67] Against Mommsen in CIL, Ashby 1935, 183-184 and Grimal 1961, 73 n. 33 thought that the *forma Mentis* (CIL 6.31566 = 11.3772a) showed irrigation to landed estates, rather than an influx into the aqua Alsietina. Taylor 1997, 485 thought that Alsietina's delivery *extra urbem* was effected to a large extent not before its water entered the regionary city, but rather after it left, beyond the Naumachia Augusti.

conveyed were under repair, and the water supply to this region came to a standstill.
The vicissitudes of the aqua Alsietina after the end of the first century AD are within the realm of speculation, since hardly any traces of this aqueduct have been identified for sure.[68] It has been thought that its water served to operate the flourmills on the Ianiculum.[69] Recent excavations, however, seem to have proven that the aqua Traiana supplied the mills.[70]

1.1.8 Aqua Claudia [71]

Early in his reign, emperor Caligula noticed that the existent seven aqueducts scarcely sufficed to meet the requirements of public use and private pleasure, and began the building of two new aqueducts (*Aq.* 13.1, Suet. *Calig.* 21). He did not live long enough to see their completion. Their inauguration took place fourteen years later in AD 52 under Claudius, who made it known among the people passing through the monumental arches over the viae Praenestina and Labicana, supporting the channels of both aqueducts, that he had had the water lines built at his own expense (CIL 6.1256).
The aqua Claudia drew its water from two copious springs, the Caeruleus and the Curtius. Its *caput* was situated 300 *passus* to the left on a crossroad of the Via Sublacensis at the thirty-eighth milestone (CIL 6.1256, *Aq.* 13.3, 14.1). The aqueduct had a length of 46,406 *passus* (ca. 68.68 km), of which 36,230 *passus* (ca. 53.62 km) ran underground, and 10,176 (ca. 15.06 km) *passus* above ground. At the upper course the *specus* ran on arches at several places, totaling up to 3,076 *passus* (ca. 4.55 km), and near the city beyond the seventh milestone on substructures 609 *passus* (ca. 0.90 km) and on arches 6,491 *passus* (ca. 9,61 km) (*Aq.* 14.4). Although the sources of the Claudia were situated nearby those of the Marcia, its channel was some 22.65 km shorter

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[68] Van Deman 1934, 405.
[69] Wikander 1979, 24-26 supposed that the very water of the Alsietina supplied the grain mills on the Janiculum. This supposition has been accepted by Evans 1993a, 112. Taylor 1995, 98 n. 74 thought it evident that both the Alsietina and the Traiana served the flour mills, while Taylor 1997, 486 gave preference to the Traiana; Taylor 1995, 97 n. 73 suggested that Alsietina's water was used by Domitian and Trajan for their *naumachiae.*
[70] Wilson 1998a, 2.
[71] PA, 22-23; Van Deman 1934, 187-270; Ashby 1935, 190-251; Nash 1961-1962 I, 37-46; Hainzmann 1975, 121-128; Richardson 1992, 16-17; Evans 1993 a, 115-128; LTUR I, 63-65; Aicher 1995, 42-43.

because of the more ample use of bridges in the upper course. Perhaps a network of channels and valves from various springs to Claudia's and Marcia's channels existed, since water from another source, the Albudinus supplying an aqua Augusta, was transmitted sometimes into the Claudia, and sometimes into the Marcia (*Aq.* 14.2-3, 72.8).[72]

The Claudia had its *piscina* inside the seventh milestone on the Via Latina, as had the Anio Vetus (section 1.1.9) (*Aq.* 19.1). Both channels met there and ran together, the Anio Novus on top, on arches to their common *terminus* (*Aq.* 72.6, 86.1) behind the gardens of Pallas. Their impressive remains still stretch into the countryside southeast of the city. As the *terminus* had enough height, the water of both aqueducts could be distributed all over the city (*Aq.* 86.3). This was done indeed, by means of fistulae (*Aq.* 20.2), making use of 92 *castella*. Vespasian (CIL 6.1257) and Titus (CIL 6.1258) executed repairs to the main aqueduct at their own expense. The remnants show mainly Hadrianic, Severan and later influences.[73]

During Nero's reign, a branch from the Claudia was built. That branch, the so-called Arcus Neroniani (*Aq.* 20.3, 87.3) or Arcus Caelimontani (CIL 6.1259), began shortly before the main channel arrived at the *terminus* and ended behind the temple of Claudius. It served the Caelius, Palatine, Aventine and regio Transtiberim (*Aq.* 20.5).[74] Whether the Arcus Neroniani was originally built by Nero for the purpose of supplying the Domus Aurea, or the Palatine and the centre of Rome, or was planned by Claudius as an integral part of the aqua Claudia right from the beginning, is hard to decide on the basis of Frontinus' evidence alone.[75] The Severi took care of the ageing branch and restored it at their own expense (CIL 6.1259).

1.1.9 Aqua Anio Novus [76]

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[72] Grimal 1961, 74 n.38; See section 1.1.3.

[73] Van Deman 1934, 405-416.

[74] Although no remains are left over, Taylor 1995, 78 thought it possible that Transtiberim was served via the bridges of the Tiber Island, and attributed the extension to Nero. Evans 1993a, 121-122 decided for the Pons Aemilius.

[75] For these hypotheses and relevant literature see Evans 1993a, 118-120.

[76] PA, 11-12; Van Deman 1934, 271-330, 380, 417-427; Ashby 1935, 252-298; Hainzmann 1975, 129-134; Richardson 1992, 11; Evans 1993a, 115-128; LTUR I, 42-44; Aicher 1995, 43-44.

The story of the construction of the Anio Novus resembled that of the Claudia so much that Frontinus treated them together. Built by Claudius, the Anio Novus drew surface water from the river Anio at the forty-second milestone on the Via Sublacensis (*Aq.* 15.1).[77] A little further on, the surface water was combined with water from a spring at the thirty-eighth milestone on the same way, by means of a *Rivus Herculaneus* (*Aq.* 15.4). In order to prevent confusion with the earlier aqueduct that drew its water from the same river, the former got the adjective Vetus, as the latter was called Anio Novus. By the time of Frontinus, the aqueduct had a length of 58,700 *passus* (ca. 86.87 km), of which 49,300 *passus* (ca. 72.96 km) ran underground and 9,400 *passus* (ca. 13.91 km) above ground. Most of the substructures and arches were located near the city beyond the seventh milestone, where the Anio Novus ran atop the aqua Claudia (see section 1.1.8). In the upper course, 2,300 *passus* (ca. 34.04 km) spread over several parts of the channel, ran on arches (*Aq.* 15.6).

Complaining about the behaviour of the personnel of the *cura aquarum*, Frontinus made a passing reference to the use of water from the aqua Anio Novus enlarging the quantity delivered by other aqueducts (*Aq.* 91,3), and archaeological evidence indeed argues for supplements. Van Deman recorded original diversions from the main channel of the Anio Novus into the lower aquae Marcia, Claudia and Anio Vetus, and Hadrianic diversions into the Marcia and the Claudia.[78]

As the aqueduct originally conveyed water from a river that ran through arable land and had loose banks, its water was always muddy and turbid. A settling tank installed beyond the captation did suffice in fine weather but fell short after showers (*Aq.* 15.2-3). As a consequence, the water in the other aqueducts was polluted. Trajan decided to reconstruct the intake at a different place (*Aq.* 93.3-4). The remains show Hadrianic, Severan and later adjustments and repairs, which are partially corroborated by a few inscriptions.[79]

As the aqua Anio Novus was highest of all, its water could be and was indeed distributed over the entire city (*Aq.* 86.3), making use of the same fistulae and 92 *castella* as did the aqua Claudia (*Aq.* 20.2).

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[77] Plin. *HN* 36.122, also taking together the aquae Claudia and Anio Novus, thought that both aqueducts had their intake at the fortieth milestone of an unnamed way.

[78] Original: Van Deman 1934, 422 no. 87 into the aqua Marcia before Tivoli, and p. 423 no. 98 into all three of them beyond Tivoli. Hadrianic: p. 423 nos. 99 and 100, just beyond no. 98. Mari in LTUR I, 43 mentioned some more in the upper course.

[79] Van Deman 1934, 417-427; CIL 6.31945 = 3865; CIL 9.4051 = ILS 795; see Bruun 1997a, 145 + n. 83.

1.1.10 Aqua Traiana [80]

Since the aqua Traiana was built after Frontinus had written his treatise, the presentation of this aqueduct must be done without him. And because other contemporary authors likewise have failed to mention this waterline, we have to rely on the scanty epigraphic, numismatic, and archaeological evidence.[81] Why Trajan had this aqueduct built at his own expense (CIL 6.1260), we do not know for sure. As it ran on, and conducted water to, the right Tiber bank, one might suppose a need for water in that part of the city, but the water supply of the Baths of Trajan at the other side of the river might have formed an incentive as well, as both aqueduct and baths were dedicated shortly after each other in AD 109. That these baths were supplied by an aqua Traiana is confirmed by some huge lead pipes found in 1935 near the Baths of Trajan, on which several stamps had been applied during the casting process, among which a stamp reading THERM TRAIAN, and on which the letters AQTR had been scratched afterwards.[82] And that this aqua Traiana was indeed a branch of the aqua Traiana mentioned in CIL 6.1260, found some 10 miles north west of Rome near the road to Bracciano, is hard to deny.[83] Archaeological evidence permits us to roughly reconstruct the course of the aqueduct. Water from springs was gathered northwest of Rome, at the west side of the Lacus Sabatinus (modern Lago di Bracciano). From there, the channel passed north and east of the Lacus Sabatinus, and ran to its *terminus*, which seems to have been situated on the Janiculum Hill. The water of the aqua Traiana was distributed throughout the entire city.[84] The plausibility of that distribution was corroborated by an interpretation of piers of aqueducts and river crossings as

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[80] PA, 28; Van Deman 1934, 331-340, 427-428; Ashby 1935, 299-307; Bloch 1944, 347-34; Nash 1961-1962 I, 52-54; Hainzmann 1975, 138-140; Richardson 1992, 18-19; Evans 1993a, 129-132; LTUR I, 70-72; Aicher 1995, 44.

[81] CIL 6.1260 = 31567 = 11.3793; BCAR 1938, 244-245; Inscr. Ital. XIII, I, 5 no. 22; RIC II, Trajan 463-464, 607-609; Van Deman 1934, 427-428.

[82] BCAR 1938, 245 = AE 1940, 40. See Hansen 1990, 111-124; Nash 1961-1962 I, 53 fig. 49.

[83] Bloch 1944, 337; Bruun 1991, 135-136 + n. 78; RIC II, 240 is of the opinion that the wording aqua Traiana on *aes* coins nos. 463 and 607-609 referred to a branch of the aqua Anio Novus. As no references to literature are mentioned, the origin of this assertion cannot be checked. Nor do I understand why no. 464 is omitted.

[84] Inscr. Ital. XIII, I, 5 no. 22.

shown on maps from the sixteenth century onwards, partially reproduced in Lanciani's FUR.[85]
From the end of the second century onwards, it was used to operate the grain mills of the Ianiculum.[86]

1.1.11 Aqua Alexandrina [87]

The last independent imperial aqueduct was constructed by Alexander Severus and was named aqua Alexandri(a)na. Its water was especially meant to supply the baths Severus Alexander built, substituting for the Thermae Neroniani on the Campus Martius (S.H.A. *Alex. Sev.* 25.3).
Fabretti studied the course of this aqueduct, and sketched its remains.[88] It started east of Rome, south of the Via Praenestina at the foot of the Alban hills. Van Deman saw some groups of springs in marshy grounds. The intake is now lost, but some traces of a *piscina limaria* nearby did survive. Remains allow us to follow the course of the aqueduct until it arrived underground near Porta Maggiore. There are no traces left beyond that point, neither of its course nor of its distribution. Repairs were executed afterwards.

Summarizing: The eleven aqueducts, which were built between 312 BC and the reign of Severus Alexander in the first half of the third century AD, were major enterprises undertaken by people at the top of Roman society. The building of a new aqueduct was often accompanied by adjustments and repairs to older ones. In this way, the system was scrutinised at intervals. Until Agrippa's intervention, funds for building and upkeep were made available by senate decision. Later on, emperors performed that duty. Credit for a new water supply line was only taken if its water was up to standard and appreciated by its consumers. So neither the Republican aquae Anio Vetus and Tepula, nor the imperial aquae Alsietina and Anio Novus were named after their builders. Agrippa's efforts in between did not result in an aqueduct bearing his name

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[85] Taylor 1995, 91-98; Maps: Buffalino 1551, Nolli 1748 fol. 13, Lanciani FUR fol. 34.
[86] Van Buren & Stevens 1917, 59-61; Bell 1993; Wilson 1998a, 2-3.
[87] PA, 20; Van Deman 1934, 341-360; Ashby 1935, 308-315; Hainzmann 1975, 141-142; Richardson 1992, 15; Evans 1993a, 132-133; LTUR I, 60-61; Aicher 1995, 45.
[88] Fabretti 1680; his map between pp. 4-5 was prized by Ashby 1935, 308 as very accurate.

either. On the contrary, the very name of the aqua Iulia shows his secondary position, and the fancy name of the aqua Virgo his loyalty.

Over time, as belligerent threats from the outside diminished, it seemed safe to build stretches above ground. As engineering improved, short cuts through valleys, if possible, were preferred to detours making use of side-hill channels. Therefore, underground stretches decreased proportionally. The aqua Claudia, for example, was over twenty kilometres shorter than the aqua Marcia, although its springs were slightly farther away from Rome, and both aqueducts followed roughly the same route.

In the course of time, the waterlines that began east of Rome became ever more interconnected and developed into a coherent system. The same applies to the mains inside the city. Already in 33 BC, Agrippa took care that the water of the aquae Marcia, Tepula and Iulia had enough height to be distributed all over the city, although this seems not to have been carried out, since the *regiones* XI and XIII are missing in Frontinus' listing of these aqueducts' distribution. Anyhow, water from the two great first century AD aqueducts was led into all the city's *regiones* to the effect that, at the end of the first century AD, at least two aqueducts could supply each *regio*. And if we do believe Frontinus, even the majority of the public fountains were connected to more than one aqueduct (*Aq*. 87.4-5). The advantages were clear: if necessary, shortage in one channel could be met by supplements from another, and closing down a water main for maintenance was only a nuisance for a confined area.

1.2 TECHNICAL ASPECTS: the city's water supply system at work

Large-scale Roman waterworks studies have been so amply made as to allow for some general remarks about the aqueducts serving the city of Rome. The same does not apply to the distribution network inside the cities. Both the absence of results from systematic archaeological research up to now, and of sufficient chance archaeological data should warn us against jumping to conclusions in that particular field.[89] Consequently, what is written on that subject here and elsewhere cannot but be tentative. This constraint, however, should not result in totally giving up the subject. Being mindful of the defective archaeological evidence, in the following sections an idea will be given of how, in a technical sense, the water supply system of the city of Rome might have worked during Republican times and in the first centuries of our era.

1.2.1 From source to city: large-scale aqueducts[90]

Eight out of the eleven aqueducts serving the city drew their subsoil water at springs welling up from the hills east and northwest of Rome. Three others utilised surface water from river Anio that passed Tibur and flowed into the Tiber north of Rome, or from Lacus Alsietinus (modern Lago di Martignano) in the Northwest.

The water was conveyed from the intake spot, the *caput*, by means of channels, *rivi*, into the city. In modern literature, following Vitr. *De arch.* 8.6.1 and 3, the word *rivus* often denotes a channel in general, whereas *specus* specifies an underground channel.[91] At several locations, a *rivus* ran on substructures, bridges, or arches, and some *rivi*, for example stretches of the *rivi* of the aquae Claudia and Anio Novus, were built on top of others. Characteristic of the aqueducts leading to Rome was that their *rivi* were mainly free-flow gravity

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[89] The exception being G.C.M. Jansen's forthcoming dissertation on the water supply systems of Pompeii and Herculaneum. Evans' book (Evans 1993a) on the water distribution of ancient Rome is entirely based on the written evidence of Frontinus. Pace 1998, engaged in the water supply system of Rome in a technical sense, is based on written sources (especially Frontinus and Plin. *N.H.* 31) and some Pompeian data.

[90] See appendix II.2.

[91] Vitr. *De arch.* 8.6.1: Ductus autem aquae generibus tribus: rivis per canales structiles, aut fistulis plumbeis, seu tubulis fictilibus. (...)
Vitr. *De arch.* 8.6.3: Sin autem medii montes erunt inter moenia et caput fontis, sic erit faciendum, uti specus fodiantur sub terra librenturque ad fastigium, quod supra scriptum est. (...) Ashby 1935 did not comply with this difference.

channels, sloping slightly.[92] Inverted siphons, in which water was transported under pressure through a valley by means of closed conduits, as well as water lifting devices, were probably little used.[93] The channels were rectangular at their lower sides, roofed over, but not filled with water up to the top. Often calcareous deposits (sinter) indicate the water levels reached.[94]

Near the city, the majority of the waterlines opened out on settling tanks, *piscinae*, in which the water could become calm and deposits settle.[95] Then the water ran along towards the city, occasionally splitting off into branches, and reached the terminal, from which distribution took place. As it was of utmost importance for distribution that the water arrived in the city at a high level (*Aq.* 18.3), the aqueducts coming from the (south)east ran via an elevated terrain at or near modern Porta Maggiore.

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[92] Blackman 1978, 60-61 + n. 26 offers a good discussion on the bed slopes of water lines. Both Vitruvius 8.6.1 and Plin. *HN* 31.57 seem to have recommended a bed slope not less than one *sicilicus* per hundred feet, that is about 0.02 ‰. Blackman's histograms (Blackman 1978, 62-63) show that the slope in sections of the four great aqueducts of Rome could vary by factors of 100, but also that the greater part of sections show values of slope between 1 and 3 ‰.

[93] Siphons: Vitr. *De arch.* 8.6.5; Pace 1998, 22-23; Hodge 1989, 133; Van Deman 1934, 33 mentioned an inverted siphon in the aqua Anio Vetus, near Ponte Lupo, probably Augustan. Smith 1976, 68 is of the opinion that the Romans had their choice of siphon or *rivus* on substructures or arches determined by the depth of the valley to be crossed. The four aqueducts to Lugdunum (Lyons, France) all had one or more lead siphons (Burdy 1988, 193).

Water lifting devices: Oleson 1984, 259-261 listed for Rome, all in all, two imperial force pumps, which now both seem to have disappeared; his pp. 323-324 deal with the practical application of these devices as bilge pump, well pump, basement pump, mining apparatus, fire extinguisher, ceiling washer, reservoir pump for water-jets and scientific demonstration apparatus. As regards the well pumps, literary evidence suggests their serving irrigation on a small scale, whereas the archaeological evidence points at their use in the household.

[94] Blackman 1978, 56; Hodge 1989, 131.

[95] According to Frontinus all aqueducts except the aquae Appia, Virgo and Alsietina had settling tanks. As his treatise dates of the years before the aquae Traiana and Alexandrina were built, and archaeological data are missing, their occurrence in these water lines is uncertain.

1.2.2 From large-scale aqueduct to distribution: the *castellum* and beyond

To facilitate water distribution, *rivi* or *specus* somehow had to give way to smaller apparatus. The transfer of water from built channels into finer conduits took place in buildings often called *castella*. As Vitruvius put it:

> "When they come to the city walls, a reservoir is to be made. To this a triple receptacle is to be joined to receive the water; and three pipes of equal size are to be put in the reservoir, leading to the adjoining receptacles, so that when there is an overflow from the two outer receptacles, it may deliver into the middle receptacle. From the middle receptacle pipes will be taken to all pools and fountains; from the second receptacle to the baths, in order to bring in public revenue; to avoid a deficiency in the public supply, private houses are to be supplied from the third: for private persons will not be able to draw off the water, since they have their own limited supply from their receptacle. The reason I have made this division, is that those who take private supplies into their houses may contribute by the water rate to the maintenance of the aqueducts."[96]

Here, the interest of this Vitruvian passage lies in its technical definition of such a *castellum* and in the way it has been used in publications on Roman water supply systems. Time and again, historians have attempted to use this passage as evidence to postulate either a general water distribution system for the Roman cities, or a preconceived discrimination in favour of certain groups of consumers embedded in public rulings and/or the hardware of the system. Regarding the latter, it is often thought that Vitruvius prescribed or at least recommended a system in which private people had to pay a *vectigal* for the luxury of a private connection from the public water mains to their homes. This issue will be discussed below.[97]

As regards the technical aspect, the *castellum aquae* at Pompeii, bearing striking resemblance to the essential part of Vitruvius' description, that is: *ita*

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[96] Vitr. *De arch.* 8.6.1-2: 1. (...) Cumque venerit ad moenia, efficiatur castellum et castello coniunctum ad recipiendam aquam triplex inmissarium, conlocenturque in castello tres fistulae aequaliter divisae intra receptacula coniuncta, uti, cum abundaverit ab extremis, in medium receptaculum redundet.
2. Ita in medio ponentur fistulae in omnes lacus et salientes, ex altero in balneas vectigal quotannis populo praestent, ex quibus tertio in domus privatas, ne desit in publico; non enim poterint avertere, cum habuerint a capitibus proprias ductiones. Haec autem quare divisa constituerim, hae sunt causae, uti qui privatim ducent in domos vectigalibus tueantur per publicanos aquarum ductus.

[97] See section 4.1.1.

in medio ponentur fistulae in omnes lacus et salientes, ex altero in balneas, ex tertio in domos privatas, has been of great interest. Situated just inside the northern town wall next to Porta Vesuvio, it has an underground channel coming from the north, and at the opposite side three large holes just above street level on the town side of the building. Although other *castella* like the one at Nemausus (Nîmes) do not show such a triple partition, the Pompeii - Vitruvius resemblance has led scholars in the past to suggest that beyond the *castellum*, Pompeii had three more or less independent distribution networks serving different groups of consumers simultaneously, and moreover that the *castellum* at Pompeii constituted a sort of standard.[98] Although the suggestion of three not interconnected networks is hardly plausible, a decisive answer to the problem, as far as Pompeii is concerned, is still lacking because it is not yet known in what way exactly the connection between *castellum aquae*, water towers and consumers was made up. The water supply and distribution systems of Ostia, constituting another potential source of information, have been investigated only recently.[99] Little by little it seems to become clear, however, that towns supplied by an aqueduct had their systems adjusted to local potentialities and restrictions.[100] As both of these comparatively well preserved towns, which are located at a rather short distance from Rome, yield up their water supply and distribution secrets reluctantly, how to gain the desired results for the bigger and more complex city of Rome itself, which has been rebuilt time and time again?

If, because of too meagre a quantity of remains, archaeological research appears to be unable to produce sufficient data for a plausible reconstruction of the system, there is little alternative left than to put up with the information furnished by Frontinus' treatise. Frontinus mentioned 247 *castella* (*Aq*. 78.3). It will be clear that he cannot only have meant the *castella aquae* in the town

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[98] Forbes 1955,163 ff.; Kretzschmer 1958, 50; Landels 1978, 48-49. The *castellum* at Nîmes: Fabre et al. 1991, 84 and 239; Hauck 1989; Kessener 1996. The Pompeii *castellum*: Eschebach 1983, 87-90; Ohlig 1995, 1996, and 2000. For an evaluation see Hodge 1992, 282-291; African *castella*: Ellis 1996.

[99] Meiggs 1973, 143 presented a description of the water supply and distribution system of Ostia based on a rather superficial observation. Bruun 1991, 285, being aware of its defectiveness, adopted this description. See also Ricciardi & Santa Maria Scrinari 1996.

[100] For North African cities Wilson 1998, 90, referring to Wilson 1997, suggests that "urban strategies of water supply relied on the use of all available sources - wells, cisterns for rainwater, local springs, and remote aqueduct-led springs - to ensure the best chance of riding out a dry season of unpredictable length."

wall as stated in Vitr. *De arch.* 8.6.1. Therefore, the question that must be addressed is: What did Frontinus understand by the word *castellum*?
An analysis of his use of the word *castellum* leads to an interesting observation: Frontinus did not use it in the Vitruvian sense as a building in which water entering the city was conducted into smaller lead conduits. If he mentioned water transfer at the terminal of an aqueduct or branch of an aqueduct, he did so by circumscription. For example, about the aquae Claudia and Anio Novus he wrote:

> "Their arches end behind the gardens of Pallas, and from that point their waters are distributed in pipes to serve the city."[101]

And the Specus Octavianus, a branch from the aqua Anio Vetus:

> "... reaches the Asinian Gardens in the neighbourhood of the Via Nova, from where it is distributed throughout that district."[102]

However, the word *castellum* does occur in *De aquae ductu* several times. It is used to define certain devices that play a prominent part in the water distribution system; they numbered, as stated above, 247 items. Reviewing the water quantities that each of the aqueducts delivered and distributed to various groups of consumers in the city, Frontinus set forth the number of *castella* used per aqueduct.[103]
Furthermore, *castellum* is used in the context of rulings that set standards for the installations of private water conduits. A *senatus consultum*, which he quoted, dated 11 BC, put it this way:

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[101] *Aq.* 20.2: Finiuntur arcus earum post hortos Pallantianos et inde in usum urbis fistulis diducuntur. See on this passage Bruun 1991, 126, who stated that it "cannot be used as evidence that the very large amount of water carried by these aqueducts was conducted from there all over the city through lead pipes". In this context, Bruun pointed at the Arcus Neroniani, which was a branch of the aqua Claudia. Branching off, however, did probably take place upstream from the *terminus*, just south of present Porta Maggiore. In my view, the difference made between fistulae for distribution and a *rivus* as a branch from the aqueduct (the Arcus Neroniani) should be noted.
[102] *Aq.* 21.2: ... pervenit in regionem Viae Novae ad hortos Asinianos, unde per illum tractum distribuitur. Other instances: *Aq.* 5.9, 19.7-9, 21.3, 22.2, 76.6.
[103] *Aq.* 79.2 (aqua Appia 20), 80.2 (aqua Anio Vetus 35), 81.2 (aqua Marcia 51), 82.2 (aqua Tepula 14), 83.2 (aqua Iulia 17), 84.2 (aqua Virgo 18), 86.3 (aquae Claudia and Anio Novus 92).

> "That no private person be permitted to tap water from the public conduits (*rivi*) and that all those who have the right to draw water draw it from the reservoirs (*castella*) and that the curators of the aqueducts point out places within the city where private persons may properly create reservoirs (*castella*), from which to draw the water that they had received from the public reservoir (*castellum*) through the curators of aqueducts."[104]

It is noteworthy that in this version, as well as in other translations into English, *castellum* has been understood as reservoir.[105]
Frontinus, who apparently agreed with its content, did however comment upon this *senatus consultum*:

> "In this resolution of the Senate, it is worthy of note that the resolution does not permit water to be drawn except from *castella*, in order that the conduits (*rivi*) or the public pipes (*fistulae publicae*) not be frequently cut into."[106]

Maybe, by his time, the practice had changed a bit, and branch lead pipes from the mains had been installed, as is indirectly suggested. Another passage seems to confirm this change. Discussing, in a practical way, the sizes of the fistulae connected to a *castellum*, Frontinus wrote:

> "This principle is regularly employed whenever several *quinariae* are delivered by one pipe and received in a reservoir, from which consumers receive their individual supply – this being done to ensure that the conduit would not be tapped too often (*Aq.* 27.3)."[107]

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[104] *Aq.* 106.1 (= EJ 278c; translation Braund 1985 no. 798c.) ne cui privato aquam ducere ex rivis publicis liceret, utique omnes ei quibus aquae ducendae ius esset datum ex castellis ducerent, animadverterentque curatores aquarum, quibus locis intra urbem apte castella privati facere possent, ex quibus aquam ducerent quam ex castello cummunem accepissent a curatoribus aquarum.

[105] With the exception of Evans 1993, 44 who let pass *castellum* untranslated; In the German translation of Kühne (WAS I, 81-120) it was understood as Verteilerbauwerk, Grimal has chosen château d'eau.

[106] *Aq.* 106.3: In hoc S.C. dignum adnotatione est, quod aquam non nisi ex castello duci permittit, ne aut rivi aut fistulae publicae frequenter lacerentur. Bruun 1991, 127 utilised this passage to reinforce his argumentation in favour of *rivi* as part of the distribution network in the city. Some text editions added *extra* after *intra* in *Aq.* 106.1, and so solved the problem of the *rivi* in this passage by a reference to private connections to the aqueducts outside the city.

[107] Est autem fere tum in usu, cum plures quinariae impetratae, ne rivus saepius convulneretur, una fistula excipiuntur in castellum, ex quo singuli suum modum

The surmise of a change in practice is corroborated by some lines in the *Digesta*, in which the issue is brought up for discussion of whether someone who drew off water from a water tank (*castellum*), that is from a receptacle for the collection of public water (*ex eo receptaculo, quod aquam publicam suscipit*) (*Dig.* 43.20.1.39), should be given equal rights as those who drew it off from a source: If it is permitted to draw the water from the water tank (...) it is permitted to draw the water from the water tank either out of the water course (*rivus*) or out of any other public place (*Dig.* 43.20.1.40-41).[108]
Whereas Vitruvius used *castellum* to indicate a building which was likewise the terminal of an aqueduct and starting point for distribution through town, Frontinus (and *Dig.*) took it as a rather vague word defining a device utilised to enable private people to deduce their granted share from the public water works, a word with mainly a functional meaning.[109] What concrete form was given in Rome to this functionality is hard to say. Maybe the *castellum* looked like the water towers of Pompeii, or like small reservoirs with feed and outlet pipes incorporated at certain height in other buildings. Frontinus' account of the water division amongst the different groups of consumers does not allow us to establish whether private *castella* were included in the number of 247. *Castella* in the Vitruvian sense were few: Rome numbered eleven large-scale aqueducts with a limited number of branches.
Since Frontinus seems not to have disagreed with this S.C. of 11 BC, it can be supposed that in his view the water distribution system of the city of Rome a century earlier in essence operated like this: At each terminal of the grand-scale aqueducts and their branches, water was transferred from the aqueducts into *fistulae publicae* or *rivi* that were connected with several *castella*, from which

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recipiunt. Branch lead pipes did constitute an illegal water system anyway (*Aq.* 115. 3-4).

[108] Si ex castello permissum est, dandum erit interdictum: Permittitur autem aquam ex castello vel ex rivo vel ex quo alio loco publico ducere.

[109] Although there is no definite *terminus technicus* for *castellum* in the distribution system (Larsen 1982, 65 + n. 1), a distinction is often made in modern literature. The Vitruvian type is defined as *castellum publicum* (Larsen 1982, 41) or primary *castellum* (Fahlbusch 1989, 116), whereas *castella* in town are called secondary *castella* (Hodge 1992, 292-294). The term *castellum divisorium* is understood both as the former (Hodge 1984, 205 and 1992, 279-291), and as the latter type (Larsen 1982, 41), maybe to set them apart from *castella* along the aqueduct itself (Vitr. *De arch.* 8.6.7; Hodge 1992, 165) which might have had a different function (Fahlbusch 1989, 114 ff).

part of the city was supplied with water, possibly by means of other *castella*.[110] By his own time, the system must have been more complex, since by then all *regiones* and even public fountains drew their water from more than one aqueduct (*Aq.* 87.3 and 5), an arrangement that presupposed interconnection. Moreover, *castella* were no longer the only places where private connections to the mains were made.
At the end of the first century AD, at the far end of the conduits, three types of consumer groups were present in the city of Rome: water was delivered in the name of the emperor, to private people, and for public use (*Aq.* 78.3).

One more issue cannot be left out. An important characteristic of the Roman water system seems to have been that water flowed as artificial rivers through the aqueducts, day and night (*Aq.* 104.2).[111] If the same applied to the system inside the city, if there was ample supply or if consumers turned off their taps or stopped fetching water at night, water would have overflowed from (public) fountains, *castella* and other natural places as a consequence.[112] After it had, in passing, carried away some street-refuse, it would have vanished into the sewerage only to be discharged into the river Tiber. This option is brought forward by Frontinus, who recognised that in that way public health might be served (*Aq.* 88.3; 111.2).
If, on the other hand, water were a rather scarce commodity, an alternative would be to utilize the overflow. If so, one might suppose rulings about entitlement to water, together with water saving measures or installations. Rulings about entitlement did exist and will be discussed below (section 4.1). A method to utilise water overflow might be to sell it or give it away. This method manifested itself as the use of *aqua caduca*, which was also regulated (*Aq.* 94.4; 111.1). What it actually looked like is still unknown since no remains have ever been considered as devices for that purpose.
Finally, a way to save water would have been to adjust the supply to the demand. Such a procedure presupposes the occurrence of storage facilities such as storage basins outside the city or reservoirs in the distribution system. To the

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[110] Hodge 1992, 291; Pace 1998. See, however, Bruun 1991, 118-123, discussing Fahlbusch 1989, 142, for the possibility of free-flow channels in the urban distribution net.

[111] Hodge 1989, 132; Bruun 1991, 110-114 doubts the water flow at night.

[112] Ohlig 1995 understood, in my view correctly, the second part of Vitr. *De arch.* 8.6.1 as advice on the regulation of surplus water. If too much water reached town, or if private people or public baths turned off their taps, the surplus would flow into the middle receptacle earmarked for public fountains. As public installations probably had no taps, the surplus would not threaten private conduits or public baths.

best of my knowledge, no early imperial storage basins nearby Rome have ever been attested to. Large reservoirs were built rather early elsewhere. The Piscina Mirabilis, which was supposed to supply the imperial navy in the Thyrrenian sea after Agrippa had designed the naval base at Misenum, might serve as an example.[113] In Rome, large reservoirs, in which water entering when there was little demand could be kept until it was needed, were connected to the imperial bath complexes, dating from the early second century AD and beyond.[114] There is, however, one building that, if identification is correct, served as a reservoir near the city and had no direct connection to the imperial bathhouses. This building was part of the Aurelian wall south of Porta Tiburtina. Recent excavations seem to have proven beyond any doubt that the structure was a reservoir built circa 200 AD, against the triple aqueduct of the aquae Marcia, Tepula, and Iulia.[115] This reservoir might hint at others, now destroyed or not yet excavated. The fact, that none of the known reservoirs in Rome dates before the second century AD, suggests that they were not built before that age. Maybe economising by building up buffer stocks was an alternative to constructing new supply lines again and again, which had come to a halt after the aqua Traiana had been built. Whether or not smaller distribution devices served as buffer stocks is impossible to say.

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[113] Maiuri 1958, 99-101 dated the Piscina Mirabilis as Augustan; D'Arms 1970, 81 n. 39 thought that the masonry was certainly of early Julio-Claudian date; See also Eschebach 1983, 86-87; Tsuk 1996, 117-119.

[114] Sette Sale near the Baths of Trajan, a reservoir in back of the Baths of Caracalla, and the bottege del Termini near the Baths of Diocletian.

[115] Volpe 1996, 43-52 summarizes the different interpretations of the remains of the building: Piranesi thought that the building was the origin of the rivus Herculaneus, which was a branch of the aqua Marcia; Nibby (1820) identified the structure as a reservoir, Parker (1876) as a *castellum* of the *aqua* Tepula. Lanciani, Calza (1914), Richmond (1930) were of the opinion that it had been an *insula*. Packer 1971, 27, 34, 75, 79 + Pl. CXIII, Fig. 322 considered the remains at the outside of the Aurelianic wall as the garden façade of an apartment building four stories high.

1.3 EXCURSUS: LEAD FISTULAE IN AN AQUEDUCT? A commentary upon the first lines of Vitruvius *De Architectura* 8.6.4

> But if water is to be conducted by lead pipes, first of all a *castellum* is to be built *ad caput*. Then the cross-section of the pipes for the supply of water is to be determined, and the pipes are to be laid from the *castellum* to the *castellum* in the town wall.[116]

In modern translations, the above passage has been interpreted as a discussion of the upper reaches of an aqueduct from the source up to its terminal, the *castellum* in the town wall that served as starting point for urban distribution: a supply line entirely made of lead fistulae.[117] The large-scale Roman aqueducts that have been investigated up to now, however, consisted mainly of masonry channels, whereas lead pipes were used for the final distribution in town. The only application of lead fistulae as part of large-scale supply lines known to me is that in which water under pressure was transported across a valley.[118] One might wonder why Vitruvius would have described an application of lead fistulae totally different from the usual.[119] True, the notion of a supply line entirely made of lead pipes seems to be self-evident, but might be incorrect. It is my aim to show here that Vitruvius discussed another part of the water supply system, namely the fistulae that constituted the connection between a *castellum* for private water use on the one side, and the terminal of a large-scale supply line on the other, a part of the distribution system in which lead fistulae have frequently been attested to. For that purpose a look at the build-up of Vitr. *De arch.* 8.6.1-11, dealing with aqueducts, is essential.

Vitruvius' discourse starts with a classification of the existing types of conduits based on the material used: there were *rivi* in built-up channels, lead fistulae, and terracotta *tubuli*. The channels had to have a certain slope, and also had to offer shelter from the sun. It continues with instructions on how to design the

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[116] Vitr. *De Arch.* 8.6.4: Sin autem fistulis plumbeis ducetur, primum castellum ad caput struatur, deinde ad copiam aquae lumen fistularum constituatur, eaeque fistulae castello conlocentur ad castellum, quod erit in moenibus.

[117] Granger 1955-1956, Morgan 1960, Callebat 1973, Fensterbusch 1987, Peters 1997.

[118] For example the Gier aqueduct to Lyons (Burdy 1988, 198). Water was conveyed through the valley of the Yzeron by means of twelve big lead pipes, which were laid side by side. The most important Roman (inverted) siphons are listed in Smith 1976, 54.

[119] Callebat 1973, 161 refers to a statement (which I have not been able to check) of P. Grimal in *Vitruve et la technique des aqueducs* 1945, 165, who was of the opinion that Vitruvius speculated on a theoretical option. See also Hodge 1981, 487.

transfer of water from the large-scale aqueduct into the urban distribution system, and how to prevent shortage in public fountains.[120] His remedy was twofold: Firstly private people should have their own conduits from a *caput* to their houses, and secondly both *balnea* and private people should have to pay a tax for the maintenance of the water supply.[121] In *De arch.* 8.6.3 Vitruvius returned to the large-scale aqueduct. If there were hills in between the *caput fontis* - origin of the aqueduct - and the town wall, tunnels were to be dug in order to maintain the slope of the *rivus*. Depending on the type of soil, it was enough to hew out a *specus*. Otherwise a vaulted masonry channel had to be built, and both kinds of tunnels were to have shafts (*putei*) at regular distances. After that Vitruvius went on with the lines cited above, dealing with the second type of conduit, lead fistulae. He did not specify in which segment these pipes should be laid, but he wrote that *ad caput* a *castellum* had to be built, that the size of the pipes had to be established dependent on the amount of water, and that the fistulae had to be laid from the *castellum ad caput* up to the *castellum* in the town wall. The remaining part of *De arch.* 8.6.4 is taken up by nomenclature, sizes and weights of fistulae, from very big ones with a diameter of just under 60 cm, to the smallest with a diameter of less than 3 cm. Modern translations have interpreted *castellum ad caput* as a *castellum* at the spring or at the intake from the river.[122] At a cursory reading, this interpretation seems correct. The implication, however, would be that in that case the whole aqueduct outside town was to be made of lead pipes. A different meaning of *caput* would dispose of this difficulty. Maybe, Vitruvius' continuation might present an answer:

> The *ductio*, however, which will be made with lead pipes must have the following arrangement. If there is a fall from the *caput* to the *moenia*, and there are no intervening hills which are so high as to interrupt (my addition: the water course so that tunnels have to be dug as is stated in 8.6.3), but

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[120] See section 1.2. Ohlig 1995, however, has demonstrated explicitly that Vitruvius' advice on the *triplex inmissarium* had nothing to do with shortage. The French translation of Callebat and the Dutch of Peters both correctly interpreted the last lines of Vitr. *De arch.* 8.6.1 as a way to handle surplus.

[121] As regards the first remedy Callebat's translation showed a different note: "De fait les particuliers ne pourront pas détourner les eaux d'usage public dès l'instant où les adductions spéciales leur amèneront l'eau depuis les sources." The implication would be that Vitruvius was of the opinion that private people should build their own conduits from the source to their homes, a thought hardly conceivable in a sizeable town.

[122] See note 117.

> valleys, it is necessary to build substructures to keep up the plane as in the *rivi* and channels (see 8.6.1). If, however the way round the hills is not long, a roundabout is to be made, but if the valleys are wide, the water course will be directed downhill. On reaching the bottom, a low substructure is built so that the level may continue as long as possible. This will form the *venter* which the Greeks call *coelia.* Next, on reaching the opposite side, since the length of the *venter* made it swell quietly, the water will be forced to rise up to the top of the hill.[123]

Again, prima facie Vitruvius seems to have spoken of a large-scale aqueduct consisting entirely of lead pipes, for his discussion on fistulae proper is continued by considerations that were of importance when planning a conduit made of lead pipes. Closer reading, however, suggests a different interpretation. Whenever valleys instead of high hills constituted the obstacles, there were three options to solve the specific levelling problems. Firstly, if the valley was narrow, substructures might be built to continue the gradient of the *rivi* and channels. A second option to keep up the plane was a circuit along the hillsides. This solution was only practical if the detour was not too long. Finally, if they were wide, valleys could be crossed by means of a *venter*.[124] In *De arch.* 8.6.6. the *geniculus* is discussed, a fourth option to reach the far side of a valley. Such an elbow deserved no recommendation since fistulae and their joints would break down easily under the air pressure it entailed. A *venter* too needed a device to reduce air pressure. Vitruvius went on:

> Thus, those who conduct water through lead pipes in this way will be able to produce fine results, because like this they can make its descents, circuits, *venters*, and risings when there is a regular fall from the *caput* to the *moenia.*[125]

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[123] Vitr. *De arch.* 8.6.5: Ea autem ductio, quae per fistulas plumbeas est futura, hanc habebit expeditionem. Quodsi caput habeat libramenta ad moenia montesque medii non fuerint alteriores, ut possint interpellare, sed intervalla, necesse est substurere ad libramenta, quemadmodum in rivis et canalibus. Sin autem non longa erit circumitio, circumductionibus, sin autem valles erunt perpetuae, in declinato loco cursus dirigentur. Cum venerint ad imum, non alte substruitur, ut sit libratum quam longissimum; hoc autem erit venter, quod Graeci appellant coelian. Deinde cum venerit adversis clivum, ex longo spatio ventris leniter tumescit exprimatur in altitudinem summi clivi.

[124] See appendix II.2.

[125] Ita per fistulas plumbeas aquam qui ducent, his rationibus bellissime poterunt efficere, quod et decursus et circumductiones et ventres et expressus hac ratione possunt fieri, cum habebunt a capitibus ad moenia [ad] fastigii libramenta.

Of course it was an option to lay lead pipes in side-hill channels or build substructures to support a lead conduit and keep up the desired steady slope. But a closed conduit, fistula or *tubulus*, was necessary only if water, after descending, should rise under pressure in order not to lose height in its course to the city. This was only the case in a *venter* or in the despised *geniculus*.
In *De arch.* 8.6.7. Vitruvius advised building *castella* at regular intervals in the aqueduct, except in the *venters* and their descending and ascending pipes, in order to facilitate eventual repairs. A hint to reduce building costs is thrown out in *De arch.* 8.6.8: One might use terracotta *tubuli*. So here Vitruvius passed on to the third conduit type. These terracotta pipes should have a certain thickness and be joined properly. Moreover, a block of stone should enclose the elbows on either side of the *venter*.
Thus the force of air pressure in the conduit would be under control and damage would be avoided. Everything else was to be made like using lead pipes. Furthermore, when water was let in from the *caput* for the first time, one had to put in ashes first to fill up insufficiently coated joints (*De arch.* 8.6.9). Finally, in *De arch.* 8.6.10-11, Vitruvius described the pros of *tubuli* and the cons of lead pipes: Terracotta pipes were more practical to repair, less insalubrious, and the water led through them would have a better taste.[126]
Striking in Vitruvius discussion on terracotta pipes is that he only compared them to lead fistulae, not to masonry channels. Moreover, that attention was mainly paid to the use of *tubuli* in a *venter* and particularly to the *venter*'s connection to the descending and rising pipes, the most vulnerable parts in which water had to change direction. Therefore, in my view, Vitruvius thought of *tubuli* instead of lead pipes in the very sections in which water was transported under pressure. That is to say that he did not allude to free flow conduits. So it cannot be inferred that Vitr. *De arch.* 8.6.5-9 covered an aqueduct completely made of lead pipes, on the contrary. Therefore, it is not necessary to regard the *castellum ad caput* of *De arch.* 8.6.4 as the starting-point of a large-scale aqueduct.
Besides, it is worthwhile to take a closer look at the use of the word *caput*. It is used in paragraph 8.6 several more times: once in *De arch.* 8.6.2, in relation to private people who had their own private conduit from a *caput*, and twice in *De arch.* 8.6.9, discussing the difficulties entailed in the use of *tubuli* in a *venter*. In view of the pressure in the conduit, the water should carefully be let into the *tubuli* '*a capite*'. Secondly it would be wise to plug up the *tubuli* and put up

[126] In the Greek world terracotta pipes were commonly used. It is not fully beyond doubt that Vitruvius compared the Roman practice to the Greek. For a comparison of (the remains of) the Greek and Roman water supply systems, see Fahlbusch 1982.

ashes *a capite* before the *venter* was put into use. On the other hand, twice it is absolutely clear that Vitruvius meant the starting-point of a large-scale aqueduct. When hills stood in between the *caput fontis* and the town wall, a *specus* had to be dug (*De arch.* 8.6.3), and when there were no hills but valleys between *caput* and town wall, another specific problem needed to be solved (*De arch.* 8.6.5).

In conclusion, it is plausible that Vitruvius used *caput* as a general word to define some beginning of a conduit: either the spring or the intake from a river at the origin of a large-scale aqueduct, or the beginning of a private pipe at a public or private *castellum*, or the place where a *rivus* was transferred into the *tubuli* or fistulae descending to a *venter*, that is to say the starting-point of a terracotta or lead pressure conduit.[127] In connection with the fact that Vitruvius limited his discussion on the use of terracotta pipes in substitution for lead fistulae to those parts in which water was conveyed under pressure, it may therefore be possible that the *castellum ad caput* in the first lines of Vitruvius 8.6.4 should better be interpreted as a private *castellum* in the city from which lead pipes were to be connected to private people on the one side and to a public *castellum* on the other. Such an interpretation corresponds to a *senatus consultum* issued at Rome in 11 BC:

> ... that no private person shall be permitted to draw water from the public conduits, and that all those to whom the right to take water has been granted shall take it from *castella*, and that the *curatores aquarum* point out places within the city where private persons may properly build *castella* from which they take the water they received through the *curatores aquarum*.[128]

[127] Similar to Capogrossi Colognesi 1966, 23 n. 40 who suggested that the wording *caput aquae* evolved from just the natural starting-point, the *fons*, into a wider concept including the legal starting-point, that is the place where private conduits drew water from the public supply. Compare his pages 13-21 on *inter alia Dig.* 43.20.1.8 defining the starting point of a water stream: either a spring, a lake, a river, or a place where water oozing through soil was caught.

[128] *Aq.* 106.1: ne qui privato aquam ducere ex rivis publicis liceret, utique omnes ei quibus aquae ducendae ius esset datum ex castellis ducerent, animadverterentque curatores aquarum, quibus locis intra urbem apte castella privati facere possent, ex quibus aquam ducerent quam ex castello communi accepissent a curatoribus aquarum.