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The Waters of Rome Aqueducts, Fountains, and the Birth of the Baroque City

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2 The Acqua Vergine and the Renovatio Romae

ALTHOUGH THE TIBER PROVIDED ROME WITH WATER throughout the medieval and Renaissance periods, we have seen that only one of Rome's eleven ancient aqueducts, the Aqua Virgo, still served the city in the mid-sixteenth century. The Virgo was a low-pressure line that in antiquity originally supplied the Baths of Agrippa and later the entire Campus Martius, the low-lying area at the bend of the Tiber that over time became densely inhabited. The name had been changed to Acqua Vergine by the fifteenth century, but it meant the same thing, the "Virgin's aqueduct," and it derived from the original purity of the aqueduct's source springs, located at Salone, about sixteen kilometers outside Rome. But that purity was now compromised, and the Vergine yielded barely a trickle of water that sometimes failed altogether. It was Pius V's avowed goal to provide Rome with a reliable and pure public water supply by restoring the Vergine at the same time he cleaned up the banks of the Tiber. Together these initiatives would create a healthier situation for Rome's inhabitants. For Pius, a more salubrious environment would influence both the physical and the spiritual realms—a cleaner city and healthier bodies would lead to increasingly wholesome souls.[1]

Piecemeal repairs to the aqueduct had been ongoing for more than 120 years (most notably under Nicholas V and Sixtus IV) when the complete restoration was realized in 1570. Although these earlier efforts are usually referred to as restorations, it might be more correct to think of them as repairs, since they never dealt with the aqueduct as a whole. Once the full restoration was complete, it provided the necessary foundation for the most comprehensive water-distribution plan developed for Rome since antiquity. Shaped under Pius's direction, the new plan (worked out with his advisers and architects) remained more or less intact for the next three hundred years, and it provided the impetus for far-reaching spatial, social, cultural, economic, and administrative changes throughout the city. It created the armature for water infrastructure that allowed Pius's immediate successors, Gregory XIII and Sixtus V, and later Paul V to implement their own, more famous waterpower agendas. The restoration of the Acqua Vergine marked the beginning of the real renaissance of Rome's water infrastructure, and with it that of its urban fabric—a renovatio Romae, a physical transformation that was also understood to be crucial to Rome's resurgence as the center of the Christian world.

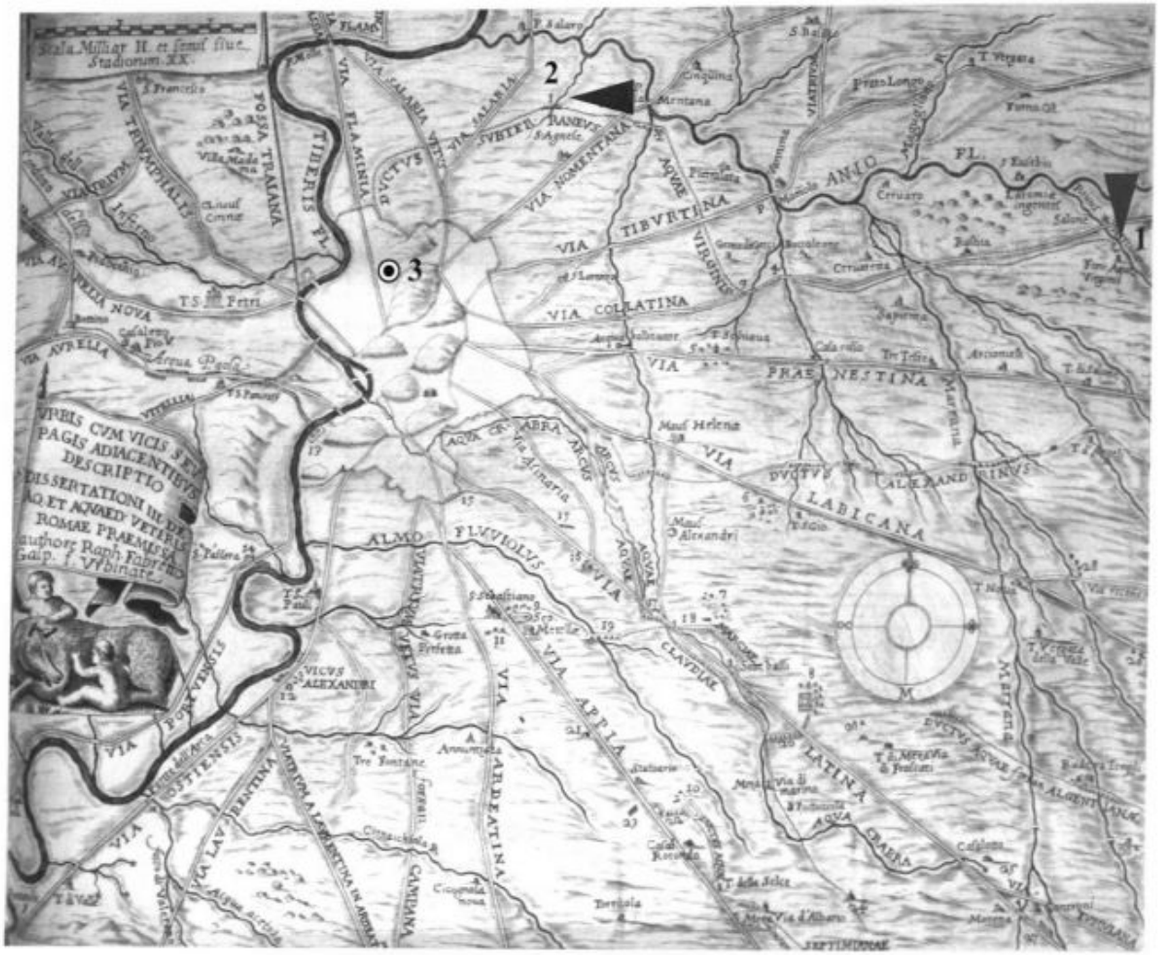
Completing the restoration was a complex operation that involved an interweaving of civil and papal administrations, and of public policy agendas that included public health, patronage, and real estate development. All had to mesh with available technology and a complex, determinative topography. Civil authorities, known as the Roman Council, were housed on the Capitoline Hill, while papal authorities were across the Tiber at the Vatican, and the two bodies competed to dominate the city. Noble families controlled the civic government: influential

individuals, known as Conservatori (Conservators), were elected to the Roman Council annually from the nobility and were the nominal authorities responsible for administering urban business. At the same time, Rome was also the spiritual center of the Catholic Church. The pope (represented publicly by cardinals who carried out his wishes) was the most powerful person in Rome: at the end of the sixteenth century, he functioned somewhat as an absolute monarch. Yet to develop the water-infrastructure projects the reigning pontiff needed to work with the Roman Council, which was sometimes at odds with him as each attempted to control, direct, intercept, and divert water for personal gain and public benefit. In addition were the powerful cardinals, whose first allegiance was often not to Rome at all but to the cities, towns, and estates of their own families. Nonetheless, they too were required to demonstrate the Renaissance idea of *magnificenza*, public virtue, by making physical improvements to Rome, which could include building impressive palaces, churches, and public buildings, and by contributing to public welfare through charitable acts.

Within this context, Pius's plan was implemented by a group of papal and civic officials with far-reaching responsibilities and powers. They developed water-distribution strategies, tended bids, awarded contracts, administered a design-review process, levied and collected taxes, supervised construction work, devised standards, assigned water rights, regulated use, and imposed fines. Meanwhile, architects, engineers, surveyors, masons, and other craft workers carried out the restoration. These workers also designed and built new public fountains, as well as the conduits and related infrastructure needed to deliver water to them. In spite of the many conflicts that arose between the pope and his agents on the one hand and the Roman Council (and the people who actually performed the physical labor) on the other, a distribution plan was in place by 1572.

The linchpin of that plan was the Acqua Vergine, only twenty-one kilometers long from its source at the Salone springs to its terminus in Rome. Hewn in large part through soft volcanic tufa, it ran underground along most of its route, in two places spanning small valleys on low arches that allowed local tributary streams to flow uninterrupted to the Aniene, a tributary of the Tiber. After following a convoluted route from east to north and finally turning south near the Villa Giulia, the aqueduct tunneled beneath the Pincian Hill and the Aurelian Wall under what is now the Villa Medici. *Pozzi*, access points that extended down from the ground level into the *specus* (the channel) of the aqueduct, aerated the water and enabled workers to descend into the channel for maintenance and to remove the calcium deposits that would quickly build up inside. Once inside the city walls, the channel emerged from the slope of the Pincian Hill in an area known in the mid-sixteenth century as Capo le Case (head of the houses), literally, the area where the houses ended and the disabitato, the uninhabited area of orchards and vineyards, began. From that point, the aqueduct channel had originally been carried westward on arches that became taller as the land sloped down to the alluvial plain where the Baths of Agrippa, which the Virgo had been built to serve, were located.

In A.D. 537, all Rome's then-functioning aqueducts were severely damaged or destroyed when the Goth armies invaded and sacked the city. After that, a general lack of maintenance between the sixth and late eighth centuries and rising ground levels (caused by recurrent flooding and debris generated from fires, among other causes) led to the structural deterioration of the Virgo arcades. As imperial power waned in the sixth century, the Catholic Church slowly assumed the administration of Rome's infrastructure, including the aqueducts. By 602, Pope Gregory I had restored the Virgo and perhaps as many as three other aqueducts; Pope Hadrian I repaired these once again during the last quarter of the eighth century. Hadrian's restoration of the Virgo extended only as far as the area now occupied by the Trevi Fountain, which then as now acts as the urban terminus of the aqueduct since the arches near the baths were not rebuilt. According to the Liber Pontificalis there was sufficient water to serve the "whole" Campus Martius, but this may not have been true, for even today there are parts



of the Campo Marzio that are still unserved by the Vergine, which has a slightly wider distribution area than the ancient Virgo.[2]

Although it is unclear exactly how, or by whom, the Virgo was maintained over the next several hundred years (or how any such work would have been financed), the aqueduct was still providing some water to the Campo Marzio in the fourteenth century, although the three other restored aqueducts had ceased to function in the tenth century. The care of the aqueduct had been given to the Maestri delle strade by 1363. These were typically members of important Roman families like the Alberini, Boccapaduli, Frangipane, and Mattei, and they were appointed annually—though often the same men would serve for several years in a row. Their responsibility to maintain the aqueducts, fountains, roads, and bridges had been established during the period when the popes abandoned Rome for Avignon between 1309 and 1377. So important was their work to the well-being of the city that by 1363 the statutes of the Roman Council devoted six paragraphs to the care of the Trevi Fountain, which although of a straightforward design had three separate basins that may have served different functions: for animals, for drinking, and for industrial uses like wool making and laundry. The Maestri gradually increased their influence during the fourteenth century, but their authority over the aqueduct extended only from the Trevi Fountain to the edge of the intramural city—that is, as far as the Porta del Popolo, less than two kilometers, or about one-tenth of the total length of the channel (fig. 2.1).[3]

2.1 The route of the Acqua Vergine from the Salone springs (1) to the Trevi Fountain (3) as plotted on Rafaello Fabretti's 1680 map of the waters and aqueducts of ancient Rome. Restorations completed under Nicholas V and Sixtus IV extended only as far as the area between Via Salaria Vetus and Via Salaria (2). (Rafaello Fabretti, *De aquis et aquaeductibus veteris Romae* [Rome, 1680], map 3. The Vincent Buonanno Collection.)

Once the papacy returned to Rome, the popes focused their attention on eroding civic control over public infrastructure. Boniface IX invalidated the rights of the Council and gained greater jurisdiction over the water supply almost as soon as he was elected. In a papal bull of 6 May 1389, he reprimanded the communal government for usurping control over the Acqua Marrana where it flowed within the city walls, from Porta Metronia through the ruined Circus Maximus to the Tiber. The stream had great economic value, as it was used to power a series of grain mills, irrigate crops, and water cattle. Boniface returned custodianship, and exclusive use, of the entire Marrana to the Church of San Giovanni in Laterano and created a group of conservators known as Difensori dell'Acqua Mariana (as the name was spelled in the papal bull), the "defenders" of the aqueduct, who acted as caretakers, collected fees from those who derived benefit from the stream, and punished unregulated use (fig. 2.2).[4]

Even as Rome reestablished its importance as the physical and spiritual center of the Catholic Church, Catholicism itself was challenged by outside forces, principally the Ottomans, who expanded their control over Asia Minor beginning in the thirteenth century. In 1453 they conquered Constantinople, which had been under Western control since 1204, and the Church perceived the loss as a grave threat to the entire eastern Mediterranean. Nonetheless, this moment marked an important turning point in the renovation of Constantinople's water infrastructure that may have provided a model for Rome. During the 250 years of Catholic control over the city, the ancient Roman aqueduct that had served Constantinople well into the tenth century had all but ceased to function, like those in Rome. But immediately upon capturing

2.2 As plotted on the 1560 reprint of Leonardo Bufalini's 1551 map of Rome, the Acqua Marrana, controlled by San Giovanni in Laterano, approached Rome from the south (1) and flowed through the Circus Maximus to the Tiber (6). Laundries (2 and 3) and mills (4 and 5) were located along its banks, including a Frangipane family compound and mill (5). (Leonardo Bufalini, *Roma*, 1551 [Rome: Danesi, 1911])

the city, Sultan Mehmed II established a new water department and oversaw restoration of the aqueduct. The most impressive aspect of this large-scale program was his restoration and expansion of the Kirkçesme (Forty Fountains) aqueduct, so called for the forty fountains it served.[5]

That same year, whether conscious of Mehmed II's water projects or not, Pope Nicholas V sponsored a restoration of the Acqua Vergine from the Trevi Fountain to a point along its route well beyond the Porta del Popolo but not as far as the Salone springs. It is likely that the noted architect and theorist Leon Battista Alberti was his adviser for this project, as at the same time Nicholas commissioned Alberti to replace the existing terminal fountain with a new Trevi fountain. The entire work was commemorated with an inscription placed above the basin (fig. 2.3).[6]

Alberti had presented a draft of his manuscript *De re aedificata* (On the Art of Building) to Nicholas in 1452. This treatise was a systematic set of criteria that Alberti felt that humanist patrons ought to employ

when planning architectural projects. Alberti defined the role of the architect as a matter of social commitment, of service to humanity. Among the projects available to architectural patrons (princes, in particular), Alberti stressed three related themes: the value of restoring ancient buildings, the importance of providing a reliable water supply, and the need to distribute water wisely, saving the best for drinking while also providing for many other uses. He made these points most forcefully in chapter 10 of his treatise, where he opened his argument in support of architectural restoration—which he linked to the idea of the renovatio Romae—by discussing water infrastructure and describing how to build and maintain aqueduct channels and cisterns.[7]

The renovatio Romae had begun with Pope Martin V, whose election in Konstanz, Germany, ended the Western Schism (1378–1417), during which time rival claimants to the papacy were again resident in Avignon. In 1420, Martin returned the papacy to Rome. The restoration of Rome's physical fabric was part of a new consciousness that Christian Rome was to be identified with ancient Rome. Yet even with this potent argument available to him (and possible knowledge of the work in Constantinople), Nicholas V did not attempt a complete restoration of the Vergine, from source to terminus. In fact, it is entirely possible that because Nicholas and his engineers did not know the actual route that the specus followed, they were unaware that the Salone springs might no longer be supplying the aqueduct. Rather, the Salone springs were thought to be the source of a different ancient aqueduct, the Aqua Appia, which had not functioned for more than a thousand years. In reality springs closer to the city or tributary streams of the Aniene may have infiltrated the limited water supply at that time. Since the Maestri had no mandate to maintain the aqueduct channel outside the Porta del Popolo, it is possible that little of the Salone water

2.3 A view of the Trevi Fountain (designed by Leon Battista Alberti) as it appeared in an image from 1643. The two shields placed below the stemma of Nicholas V carry the SPQR (Senatus Populusque Romanus) inscription. (From Giovanni Domenico Franzini, *Descrittione di Roma antica e moderna* [Rome: 1643]. The Vincent Buonanno Collection.)

2.4 The stemma of Sixtus IV can be still be seen above this access door into the specus of the Acqua Vergine on Via del Nazareno.

actually reached the city during the fifteenth century. Nonetheless, Nicholas's partial restoration, the first documented restoration in more than four hundred years, represented a milestone in the history of Rome's water supply, and it may have encompassed a larger portion of the channel than earlier repair work. The rebuilding extended perhaps as far as an area just north of the Catacombs of Santa Priscilla, where the broken channel crossed through a marshy area that was fed by local natural springs (see fig. 2.1).[8]

The restoration was important to Nicholas's plan to reestablish papal authority over the construction and maintenance of all urban infrastructures. In 1452, just before initiating work on the Vergine, Nicholas revised the statutes of the Maestri delle strade in an effort to curtail their influence by placing them under papal, rather than civil, authority. Nicholas also used the aqueduct restoration to set a precedent for subsuming infrastructure development into an overall strategy to restore the prestige of the Roman Church through the renovatio Romae.[9]

Like all structures, aqueducts need constant maintenance both to ensure their integrity and to remove the hard calcium deposits that form inside the channel, buildups that, if not removed regularly, can stop the flow of water. In 1467, Pope Paul II had to authorize another restoration, as did Sixtus IV in 1475, withdrawing money from the *gabella del studio* (the wine tax that ordinarily supported the University of Rome) for the purpose (fig. 2.4). Little is known about the extent of Paul's restoration, but that of Sixtus was praised in a highly visible Vatican Library mural by Melozzo da Forlì, and in "Meditations at Tivoli," a fairly obscure panegyric by Robert Flemmyng, an English traveler to Rome in 1477. In a lengthy, detailed passage in which Flemmyng mentioned that the water was "almost lost," he stated that after clearing debris from the channel, Sixtus had a "permanent conduit" built to the Trevi Fountain. The poem emphasizes the restoration as an important civic project. Yet Flemmyng never mentioned the Salone springs, which suggests that he too was unaware of the real source.[10]

Although the Vergine water would have been contaminated by the marshy area through which the damaged specus passed, the channel apparently functioned fairly well for another sixty years, during which time it was repaired at least three times: in 1510, by Pope Julius II; in 1513, by Pope Leo X, who also assigned income from the gabella del studio to pay for the work; and again in 1521, when Leo had the exposed arches that ran between the foot of the Pincian Hill and the Trevi Fountain restored. The full extent of these works is not known, but according to both Andrea Fulvio and Bartolomeo Marliani, the water was abundant enough to serve public and private fountains in the neighborhood of the Trevi.[11]

When in 1535, after years of extremely constrained finances, there was a surplus in the papal treasury, Paul III urged the Capitoline administrators to use the money to restore the Acqua Vergine. On 27 November 1535, he nominated twelve "gentlemen" to investigate how the aqueduct might be restored in order "to return Acqua Vergine water from the Salone springs to Rome, which had been without it for many centuries." The implication that water had not flowed for "centuries" is an overstatement, but the occasional (or perhaps frequent) lack of water at the few public fountains would have been a reality, especially during the late summer following a dry spring. Alternatively, the statement could mean that no Salone water—that is water from the true source—had reached the city for centuries and that only the water from other springs located along the route of the broken aqueduct closer to the city was supplying the aqueduct. In any case, in 1536, Johann Fichard, a jurist traveling from Frankfurt, mentioned that there were few fountains and drinking water came from wells and the Tiber.[12]

This document correctly identifies Salone as the ancient aqueduct source, indicating that Paul was aware of this crucial piece of information, which became available for the first time in the fifteenth century. A medieval manuscript copy of *De aquaeductibus urbis Romae*, a survey of the Roman aqueducts written in A.D. 97–98 for Emperor Vespasian by Sextus Julius Frontinus (superintendent of aqueducts),

was available through reproductions by the noted humanist Poggio Bracciolini, who on 9 July 1429 had discovered a copy of the manuscript by Peter the Deacon at Monte Cassino dating from 1130. But apparently the importance of its information regarding the Salone springs went unnoticed for more than a hundred years.[13]

Unfortunately, whatever strategy the "gentlemen" were interested in pursuing was quickly laid aside once Emperor Charles V announced his plan of entering Rome in 1536. Money was needed to prepare and decorate the city for his arrival, and the still-fresh memories of the 1527 sack that accompanied Charles's last visit turned Paul's attention to preparing for a potential assault on Rome. Funds were diverted to pay for a costly strategic reorganization around the Castel Sant'Angelo, specifically at Piazza di Ponte, where Via Trinitas and Via di Panico had recently been constructed. An unrealized plan by Antonio da Sangallo the Younger for new defensive walls for the Campo Marzio, to run from the Mausoleum of Augustus to the Pincian Hill, was also proposed. Although defensive issues were paramount throughout the late 1530s and early 1540s, Paul still carried out important urban projects—in particular, work to straighten and ornament Via del Corso in 1538 and the completion of Via Paolina (begun under Leo X and known as Via Clementina at that time), which connected Piazza del Popolo to Piazza di Spagna. (Once the Vergine was fully restored in 1570 this street provided the most direct route to the first new fountain, which was placed in Piazza del Popolo.)[14]

Nearly ten years passed after the project was set aside before the Vergine restoration was broached again, this time by the papal librarian Agostino Steuco. Convinced that the Vergine of his day did not constitute the entirety of the ancient Virgo, he conducted a survey to determine the course of the aqueduct specus beginning in 1545. Steuco, a learned humanist, had worked for Cardinal Domenico Grimani in Venice, where he wrote highly praised polemical works of biblical exegesis before going to Rome in 1535, the same year that Paul III proposed the restoration of the aqueduct and referred to the Salone springs as its source. By the time Steuco assumed his position in the Vatican Library in 1538, we know that his interests included archaeology, engineering, and city planning, particularly with regard to aqueducts. Not content with reading ancient engineering treatises, Steuco set out on his own initiative—with Frontinus as his textual guide—to study the aqueduct through firsthand observation, just as the architects Donato Bramante and Andrea Palladio had done earlier in the century when they studied and measured the ancient baths and basilicas from direct observation. Like these architects, Steuco embodied a rare combination at that time of scholar, theoretician, and activist.[15]

Through his efforts to follow the Vergine to its source, Steuco became something of an expert on the aqueduct. Perhaps working alone, but probably with an assistant, he traced the course of its channel by following the mounds of calcium deposits that stood alongside the original pozzi along the route. He may even have had advice, if not actual help, from Eufrosino della Volpaia, who in 1547 published his authoritative map of the Roman Campagna, *Mappa della Campagna romana al tempo di Paolo III*, which shows the Salone springs and two aqueduct bridges of the Vergine. It seems likely that the men would have known each other's work, since they both enjoyed the patronage of Paul III during these crucial years. Regardless, Steuco was able to make detailed observations, to assess the aqueduct's condition along its entire length, and to verify (perhaps for the first time since antiquity) that the Salone springs were the same as the springs that Frontinus had described as located sixteen kilometers outside the city. As the aqueduct ran underground for most of its course, this was an arduous exercise. In addition to confirming the aqueduct's source, Steuco discovered that the ancient collection basin built around the springs was gravely deteriorated and that little of its water entered the channel. Rather, it flowed into one of the tributaries of the Aniene that passed nearby. In spite of the damaged basin and channel, he recommended to Paul in

a 1547 treatise, *De revocanda in urbem Aqua Virgine*, that they be restored (figs. 2.5, 2.6).[16]

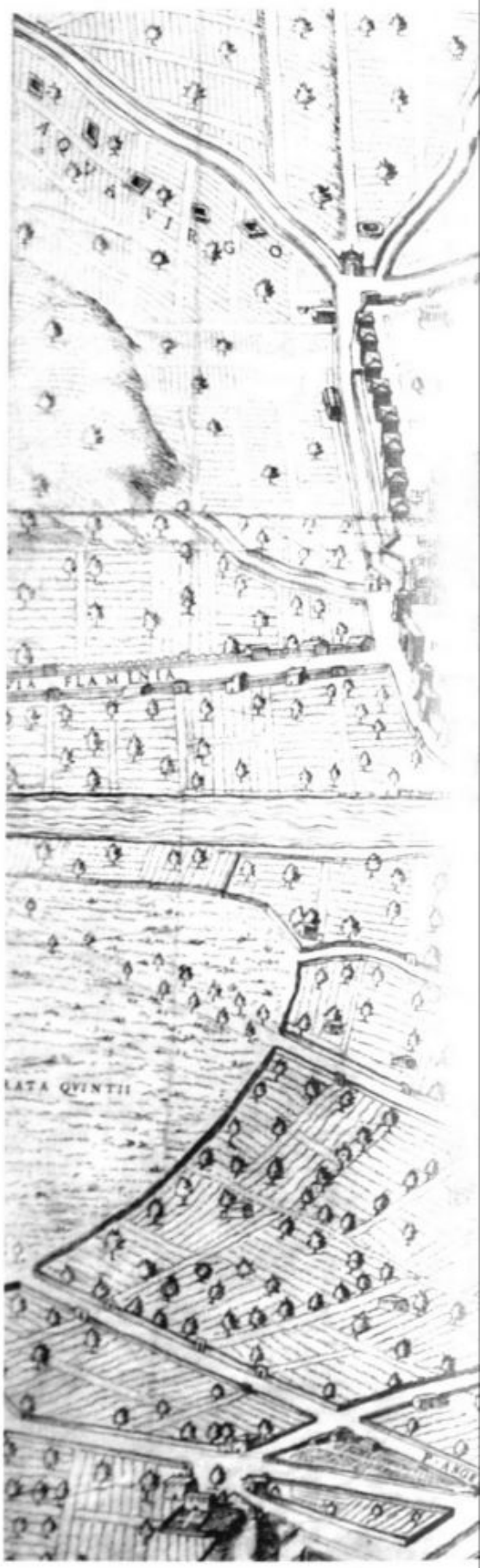
In another treatise, *De via Pauli et de fontibus inducendis in eam*, Steuco explained that the flow of water from the nearby Salone springs was so great that it could be defined as a river. Once restored, he argued, the aqueduct could supply all Rome's residents with water. He urged the pope not to worry about the cost of this work, which the architects he had consulted calculated would be no more than twenty thousand gold scudi. Further, he explained that the prospect of having this salubrious water brought to individual gardens and houses ensured that no one would refuse to pay for the privilege of gaining access to it. Therefore, he assured the pope, the cost would be recovered through domestic sales.[17]

De via Pauli is of particular interest to urban historians because Steuco clearly demonstrated that he understood the role that the water supply from the restored aqueduct would play in the physical rebirth of the city. In this treatise he proposed to Paul the construction of three new public fountains, "the most divine and richest . . . whose jets of water will shoot to the sky" to ornament Via del Corso (which Steuco called "Via Pauli" in the pope's honor). New fountains would be positioned at the beginning, middle, and terminal points of the road—that is, at Piazza Flaminia (Piazza del Popolo), "where the road divides in two, one heading to Ponte Sant'Angelo, the other to Via Lata"; the second "in the middle of that road" (Piazza Colonna); and the third at Piazza San Marco. As Steuco envisioned it, an underground conduit would link the fountains along the Corso, providing free drinking water in addition to ornamenting the city.[18]

From his discussion, it seems that it was Steuco's idea that the fountain in Piazza Flaminia would serve both ceremonial and functional uses. It would provide *grandezza* at the main entry into the city at Porta del Popolo from the north, and it would provide *utilitas* for a new Tiber River port that he envisioned directly to the west of the gate. The next fountains were intended to be landmarks along the major processional route into the city, and they would also serve as water-distribution hubs. From the principal fountains (those at Piazza San Marco and Piazza Colonna) he envisioned underground conduits that would take water far afield, to the Pantheon, Campo dei Fiori, and Palazzo Farnese (the palace of Paul III), where he envisioned two elaborate fountains. Finally, Steuco proposed that water would flow through the entire city and into the homes of illustrious men and asked his reader, the pope, "What could be more joyful than this spectacle?"

In addition to physically ornamenting the city and providing its residents with an abundant water supply, the new fountains, said Steuco, like the restored aqueduct, "would enhance Rome as the center of Christianity, and renew the piety and veneration for Rome among all Christians (since in the past) such acts of benevolence and civic mindedness had awakened a sense of devotion among people as they venerated Rome as a sacred place." It is clear that he envisioned water as an agent of the renovatio Romae, thus expanding the concept as expounded by Popes Martin V and Nicholas V. Water would become an agent to heal the profound sense of physical devastation that hovered over Rome as a result of the 1527 sack and the 1530 flood, as well as the spiritual desolation caused by excesses of the clergy and growing Reformation fervor. Restoration of the Acqua Vergine began to take on a moral purpose—cleansing and reforming the wayward city as well as wayward souls and bringing them to a more virginal state. A purified Rome would be an exemplar for Christian cities everywhere.[19]

Steuco's survey and his proposal to restore the Acqua Vergine and build new fountains throughout the Campo Marzio was part of a larger visionary plan for all Rome and its immediate territory. In another 1547 treatise dedicated to Paul, *De restitudenda navigatione Tiberis*, he put forward grand plans to dredge and straighten the Tiber, build a new port on the river to the west of Porta del Popolo, and improve other port facilities along the river in order to facilitate navigation from towns north of Rome, including Gubbio, his hometown. Thus, in these treatises Steuco



2.5 Pozzi associated with the newly restored Acqua Vergine can be seen in the upper-left-hand quadrant of Mario Cartaro's 1576 map of Rome where they ran along the Pincian Hill. Here several appear in front of the Villa Medici, when in fact they passed underneath it. (Mario Cartaro, *Roma Renasces*, 1576, detail. Biblioteca di Archeologia e Storia dell'Arte, *Fondo Lanciani*, Roma, X 648.)


S.Vitale
M. QVIRINALI
Platea SS. Apostolor
Arcus Portugalli
CVLAMTONA
I
B
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PONS VATICANVS TRIVMPHALIS
Platea Agonis
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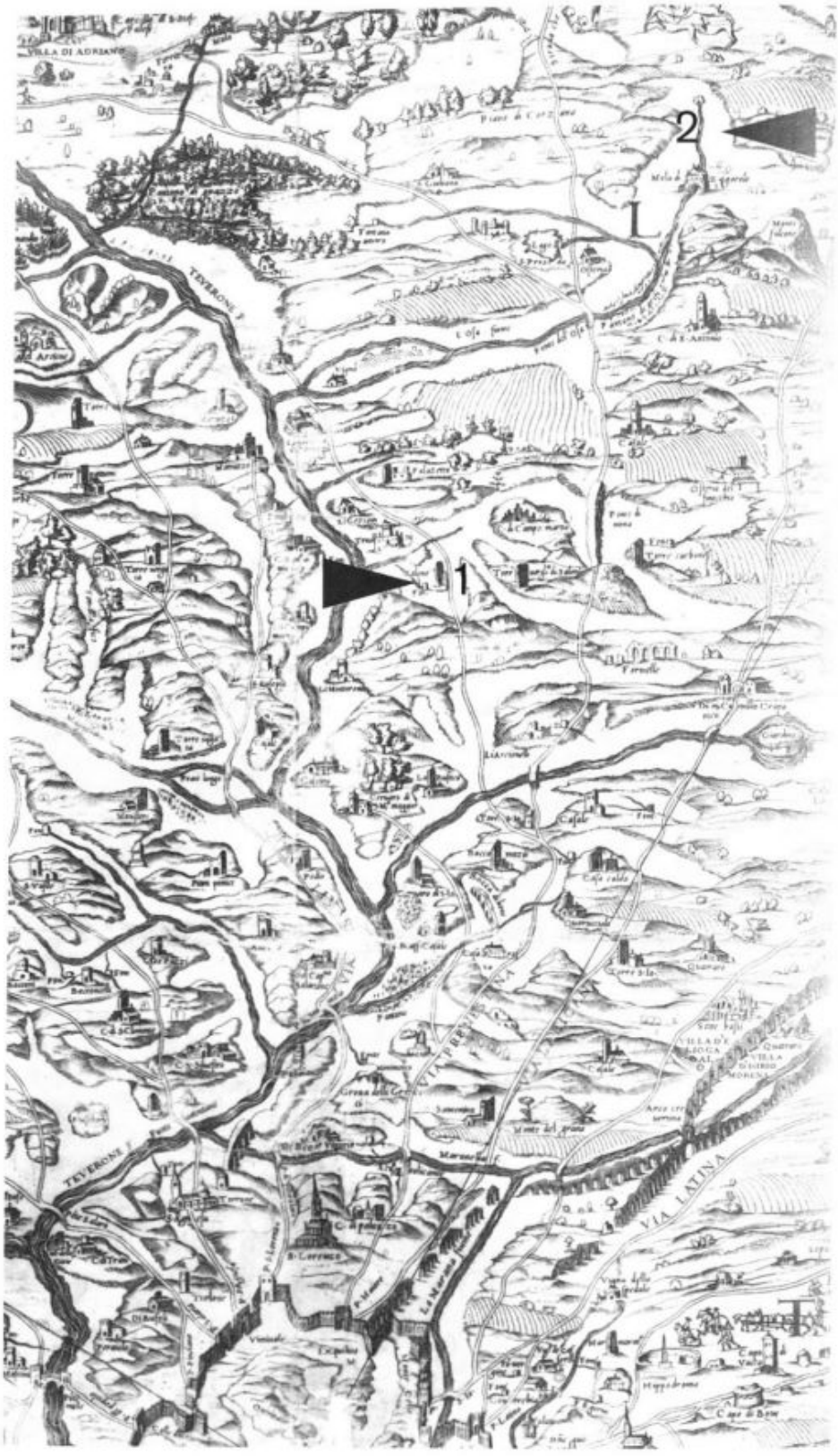
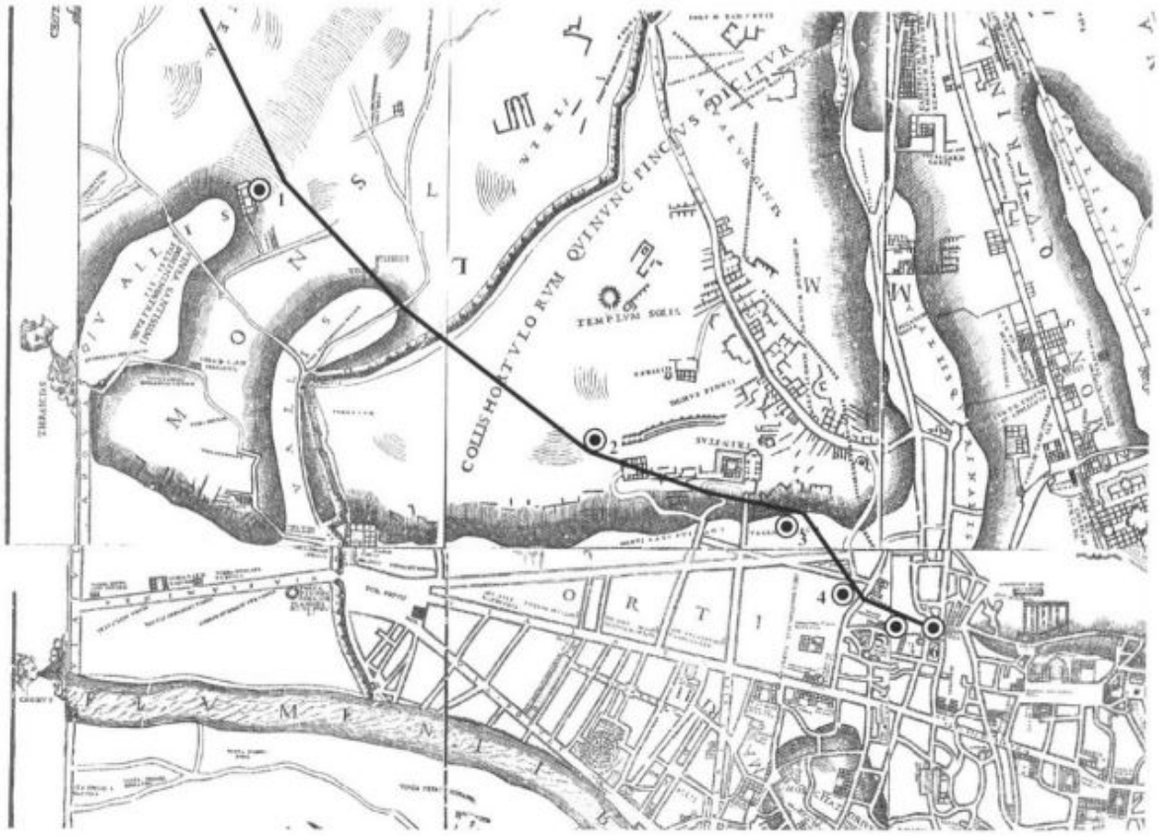


2.6 The Salone springs appear near the middle of Eufrosino della Volpaia's 1547 map of the Roman Compagna, while aboveground ruins of the Aqua Virgo appear as arched bridges at Bocca di Leone (1) and near the Church of Santa Agnese (2). The Pantano dei Griffi springs, which would later supply the Acqua Felice, appear in the upper-right-hand corner. The walls of Rome are seen in the bottom center of the map. (Eufrosino della Volpaia, *Mappa della Campagna romana al tempo di Paolo III*, 1547 [Rome: Danesi, 1914], sheet 2)



outlined a complex urban strategy in which a restored aqueduct, expanded water distribution, a rejuvenated Tiber River, and new port facilities were essential linked components for rebuilding Rome's economic, political, and artistic status. The fountains that he proposed in *De via Pauli* would become the most visible component of Rome's transformation and a constant reminder of Paul's munificence. Like many visionaries, Steuco had ambitious plans, and unfortunately none of his suggestions was realized during his lifetime or Paul's pontificate.[20]

There was barely a trickle of water flowing from the Trevi Fountain in 1548, and when Julius III ascended the papal throne in 1550 conditions were dire. Not only was the Vergine supply seasonally sporadic (depending on rainfall during the previous six months) but illegal taps and authorized private encroachments diverted much of the meager supply to palaces and gardens. One of the most famous of these diversions (in this case legal) was for the garden of the humanist Angelo Colocci. The aqueduct actually ran slightly aboveground through his property, allowing him to tap directly into the channel to obtain water for a highly praised nymph fountain that had ornamented his garden since at least the 1520s. Girolamo Gottifredi, who lived farther north near Via Trinità dei Monti, also took water for his garden, but apparently he did so illegally. The Conservatori tried to punish unauthorized use because it reduced the water available at the Trevi. So, although it is generally assumed that everyone had free access to the water in public fountains, little may actually have been available for the general use (fig. 2.7).[21]

The Roman Council expressed its concern to the new pope about the deplorable condition of the Vergine in a decretal of 21 July 1550. In this

2.7 As plotted on the 1560 reprint of Leonardo Bufalini's 1551 map of Rome, water flowed from the Acqua Vergine to the Trevi Fountain (6). Along the way it was diverted to private gardens including those owned by Pope Julius III (1; starting in 1551), Cardinal Ricci (2; after 1574); Girolamo Gottifredi (3; 1520s), Angelo Colocci (4; 1520s), and perhaps Baldovino Del Monte (5; by the 1550s). (Leonardo Bufalini, *Roma*, 1551 [Rome: Danesi, 1911])

decree, the Council challenged Julius III to support the restoration efforts of the Maestri, who had complained that they were unable to carry out their work because the channel was damaged and filled with debris and broken masonry. The decretal stated that little water reached the city, and soon the supply would fail altogether. They urged immediate action in order to maintain the honor of their office as the conservators of the public realm. But Julius did nothing, perhaps because he intended to use the limited supply of Vergine water for his gardens at Villa Giulia, which lay in a low valley along the route of the aqueduct. The next year he had his architect Bartolomeo Ammanati divert a portion of the water to flow to a new nymphaeum, which nestled in a slightly subterranean cleft, in order to take advantage of the aqueduct. Julius may also have been thinking of the 1552 apologia by Alessandro Petronio that argued that Tiber water was superior to all others, even for drinking (fig. 2.8).[22]

Clearly the situation was untenable, but it was only in 1560, against this backdrop of disorder and water larceny, that the slowly moving wheels of papal administrative machinery began to turn again with regard to restoring the Acqua Vergine. At a public assembly of the Roman Council on 4 October 1560, Pius IV appointed a papal commission to oversee a project to reconnect the aqueduct to the ancient Salone springs, to restore and clean the entire channel, and to bring the spring water into Rome "for the benefit and beauty" of the city. At the same time, two cardinals were directed to meet with the civil magistrates to hear their opinions.[23]

The timing is of particular interest, for it coincided with another concerted effort by the Ottomans to restore and expand Constantinople's aqueducts. At this time, Sultan Süleyman the Magnificent commanded Hasan Aga, the director of the water supply, and Mimar Sinan, the imperial architect, to restore and enlarge the Kirkçesme system, and to find new water sources. Completed between 1554 and 1560–61, this was an impressive project, and one that far surpassed the work on the Acqua Vergine. With considerable speed, Sinan oversaw the restoration of the aqueduct and the placement and construction of scores of new fountains. Perhaps this monumental engineering project in Constantinople, the capital of the Ottoman Empire and the nemesis of Rome, spurred Pius IV to action. Completing the restoration was urgent if Rome were to regain its authority in the face of its greatest religious foe. "The Turkish peril," as the Ottoman threat was called, was real, and communication between the pope and his agents and spies in Constantinople must have been constant.[24]

Nonetheless, when seen against the background of Süleyman and Sinan's recent success and Sultan Mehmed II's original restoration and expansion of the Kirkçesme system, Rome's efforts appear feeble and mired in bureaucratic sniveling. Whereas work in Constantinople proceeded in a relatively forthright manner, this was decidedly not the case in Rome.

2.8 The Acqua Vergine passed directly behind a small cleft in the Pincian Hill where Pope Julius III constructed the Villa Giulia. (Antonio Vern, *Carta geologica di Roma*, 1915, detail)

Once Pius was ready to proceed, the contract to supervise the Vergine restoration was contested between Pirro Ligorio, the antiquarian and architect who designed the Villa d'Este in Tivoli and the Casino Pio at the Vatican, and Antonio Trevisi, a military architect, publisher, writer, and occasional tax collector from Lecce, who had been resident in Rome only since 1558. But Trevisi had already completed two important projects there: a second edition of Bufalini's 1551 plan of Rome and a treatise on the inundations of the Tiber, *Il modo per evitare la inondatione dell Tevere in questa alma città di Roma*, both published in 1560. These two works reveal his broad knowledge of the city and must have been sufficient to establish his credentials.[25]

But Ligorio had hands-on hydraulic experience, having designed numerous grand garden fountains. Furthermore, he was also either currently engaged in or had recently completed his own investigation of the Vergine and had made on-site analytical drawings of the different phases of restoration on the aqueduct channel where it was carried aboveground on arches outside the city walls. These credentials notwithstanding, Trevisi, a developer of "mysterious systems and secret methods," was awarded the contract by the Camera Apostolica in a secret meeting on 18 April 1561 and named architect to the pope.[26]

Apparently, the choice of Trevisi was not announced to the Roman Council until nearly two months later, when the papal committee supplied the Conservatori with details about his fee and how the costs were to be divided between the various constituencies: five thousand scudi from the pope himself; five thousand from the College of Cardinals; three thousand from the Cancelleria; and the remaining seven thousand from the Roman Council (through taxes). At the same time, Luca Peto, a noted jurist and civil magistrate who earlier had been the custodian for the Tiber River banks—and would later be instrumental in formulating a new law code under Pope Gregory XIII—was named project administrator. He was to bring "Aqua di Salone water to the Trevi Fountain, following the same route as the ancients"—a route that had been verified by Steuco's research.[27]

With this, the Camera Apostolica effectively wrested control of the project from the Roman Council. Despite the benefit of the Maestri's vast experience in supervising the maintenance of the Acqua Vergine for more than two hundred years, the Council was marginalized once again. In order to protect its own interests the Council felt it necessary to appoint (in a secret meeting on 19 February 1562) its own oversight architect, Bartolomeo Gritti, who was given a mandate to "review the work on the aqueduct and to visit there continually" and to report to the deputies appointed by the Council—Mario Frangipane (also the commissioner of antiquities), Rutilio Alberini, Horatio Nari, and Luca Peto. Both Frangipane and Alberini were from distinguished Roman families, while Nari and Peto had held other important civic positions. Perhaps in retaliation for being excluded from the selection of Trevisi, the Roman Council was also slow to remit its share of the cost: the Camera Apostolica pressed it for payment on several occasions between 9 April 1562 and 18 January 1563.[28]

Original documents are scarce, which makes it difficult for us to understand exactly what work Trevisi himself might have performed, but his title was *appaltatore* (contractor). This could mean that either he collected taxes or he acted as a contractor, and, indeed, he may have done both—overseeing tax collection to pay for the work and then supervising and paying for it. Whatever the precise meaning of the term in this instance, he quickly found himself at odds with the *minori concessionari delle opere* (subcontractors) who were engaged to complete the work. As an architect, Trevisi would have been familiar with construction protocol and techniques, but controversies of an unspecified nature broke out between him and the concessionari almost immediately. It appears that he allowed work to drag on with "incomprehensible and blameworthy indolence"; the situation became so acrimonious that Cardinals Giovanni Antonio Serbelloni (a nephew of the pope) and Benedetto Lomellini, who were in charge of the papal committee, urged Pius to terminate his contract because the concessionari were insisting that Trevisi was impossible to work with.[29] Yet Trevisi was not fired. Apparently, work came to

a standstill: Trevisi's restoration was not mentioned again in the Council minutes until November 1564, when it was reported that several Council members, including Peto, had discussed the subject with the pope.[30]

After Pius IV's death in 1565, Pius V reorganized the workforce and ordered a full accounting of the progress, while inexplicably retaining Trevisi, who died within a few months. Peto now assumed a far more important role, and in his final report, published in 1570, he stated that he had been entrusted by the Council to examine the springs and the entire aqueduct and to report his findings directly to it. He informed the Council that under Trevisi little restoration work had actually been accomplished, in spite of the fact that nearly all the money was gone. In the report, Peto was careful to cite both Pliny and Frontinus as precedents for his own work and to compare what he himself had seen to what they had seen. Yet he failed to refer to either Steuco or Ligorio's fastidious examinations, both of which had preceded his own.[31]

Whether Peto knew of their work remains unknown, but it seems unlikely that he was ignorant at least of Ligorio's work, which, though unpublished, was completed only a few years earlier. Although a technical report, Peto's treatise is also an apologia intended to highlight his own accomplishments by linking his work to the more glorious names of ancient authors. He implied that until his own investigations the source of the aqueduct was unknown and that the Salone springs were still considered to be the source of the Aqua Appia. Later he implied that it was he who was bold enough to determine that the aqueduct could be restored. Yet both Steuco and Ligorio had already drawn similar conclusions and had confirmed Frontinus's statement about the Virgo's source.[32]

Shortly after Pius V ascended the papal throne in August 1566, Rome was ravaged by intense heat and sirocco winds that led to a particularly brutal epidemic (probably typhoid), felt most severely in the Campo Marzio. The situation was aggravated by standing water that collected at the foot of the Pincian Hill, where springs seeped from the hillside, while some water also issued from the broken aqueduct channel in the same area. Although the scientific principles of water-borne diseases were not understood at the time, that Pius had at least a rudimentary awareness that standing water created a health hazard was made clear in a document of 1569 in which he made the connection between removing standing water from the foot of the Pincian Hill and the improvement of public health. Thus, his agenda for a healthy city and clean river clearly included draining marshy areas, a project that also increased his fervor to complete the aqueduct restoration initiated by his predecessor. Cardinal Giovanni Ricci da Montepulciano proposed raising money to restore the aqueduct as a response to the epidemic. This would have doubly served the city, improving the water supply and minimizing standing water by sealing the inner surfaces of the aqueduct with waterproof concrete.[33]

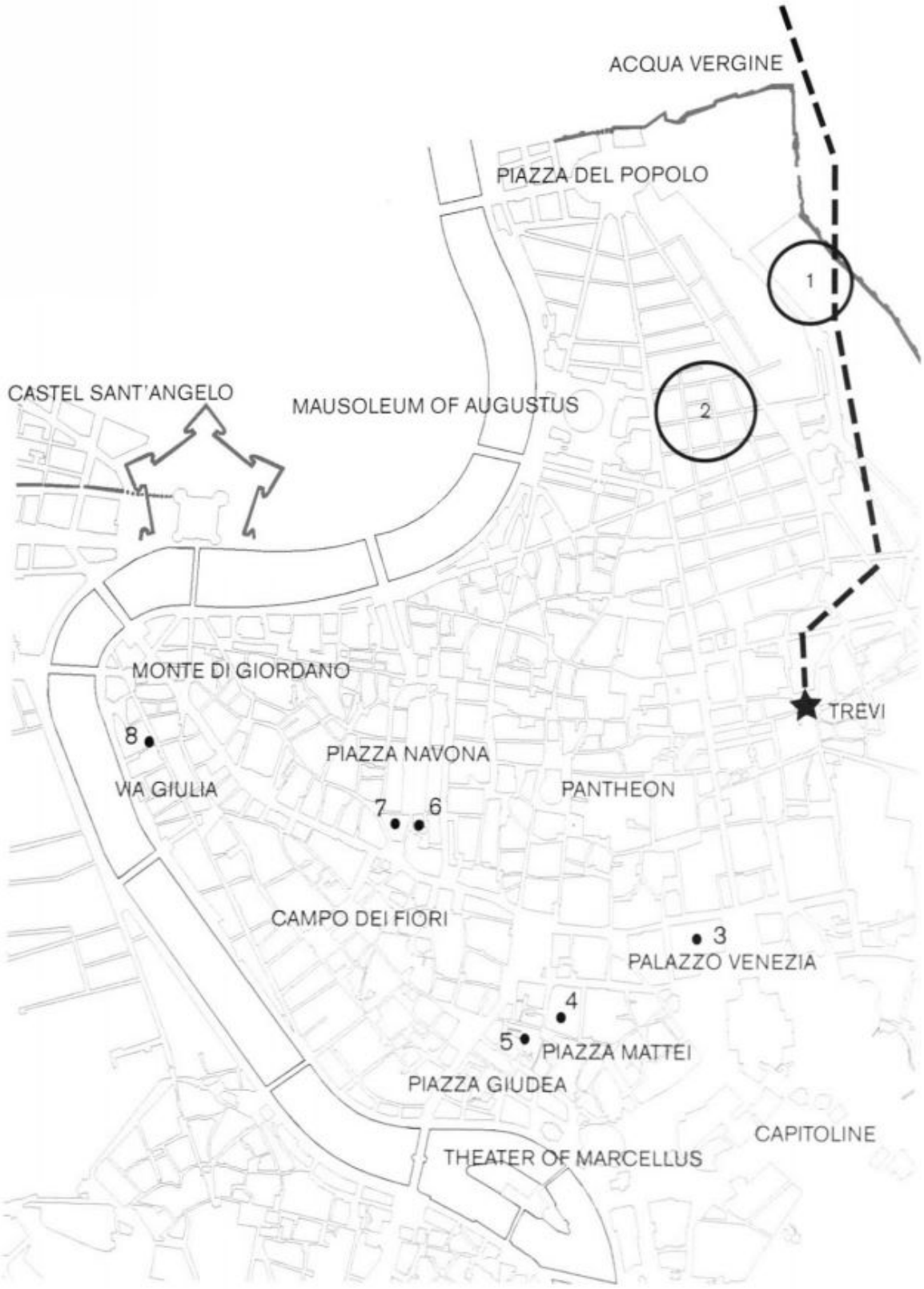
Pius established the Cardinals' Committee in Charge of Roads, Bridges, and Fountains (which I shall refer to as the Water Committee) on 31 July 1567 to oversee and facilitate the restoration of the aqueduct, even though the Maestri delle strade already held responsibility for the roads, bridges, and fountains of Rome—another example of the ongoing struggle by the papacy to erode civil authority. Cardinal Ricci was named head of the committee, and six men made up the standing members: two cardinals (Flavio Orsini and Giovanni Luigi Cornaro), two papal officials (Bartolomeo Barrotti, the papal treasurer, and Monsignor Ludovico Torres, the presidente delle strade, who supervised the Maestri), and two noblemen (Ludovico Mattei and Prospero Boccapaduli), who were appointed deputati dal Popolo romano, deputies for the Roman Council. Six rotating committee positions were assigned to members of the Council, ensuring that its authority would be diluted. These included the two Maestri delle strade, for one-year terms; three Conservatori, whose terms were only three months; and the prior of the Caporioni (a group consisting of the heads of each neighborhood), for a one-year term. The architect Nanni di Bacio Bigio (Giovanni Lippi), who had close ties to Cardinal Ricci, was named technical adviser for the project. As with

other cardinals' committees, the mandate of these men was to carry out the intentions of the pope rather than develop fresh policies.[34]

These committee members were important individuals in papal and civic administrations, and they also owned palaces within the abitato (the so-called inhabited area of Campo Marzio, Trastevere, and the Borgo), as well as vineyards, orchards, and gardens in the disabitato. By the time Cardinal Ricci was appointed head of the Water Committee, he had already played an important role in papal finance, administration, and diplomacy for some time. Starting out in service to Cardinal Alessandro Farnese, Ricci had been elevated to the College of Cardinals primarily because of his business acumen. He was a papal nuncio under Paul III; the private treasurer of Julius III; and commissioner of roads in Rome under Pius IV. He also owned the Villa Ricci (later the Villa Medici), which stood more than thirty meters directly above the route of the underground channel of the Acqua Vergine on the Pincian Hill and therefore appeared to be too high up to benefit from the water. Another member, Cardinal Orsini, came from one of the most ancient and distinguished Roman noble families and owned several large properties in the Campo Marzio, including a palace on Piazza Navona and a huge garden near the Mausoleum of Augustus, as well as another garden on the Pincian Hill. Members of his extended family also owned important palaces at the Theater of Marcellus and Monte Giordano. Cardinal Cornaro came from a prestigious Venetian family and lived at Palazzo Venezia next to his titular church, San Marco. Monsignor Torres owned a palace on Piazza Navona, across the street from that of Cardinal Orsini. The Mattei and Boccapaduli families both had strong ties to the civic government and owned extensive properties in the area just outside the Jewish Ghetto: the Boccapaduli property lay near the main gate into the ghetto at Piazza Giudea, and the Mattei just to the north on Piazza Mattei (fig. 2.9).[35]

It was another year before a contract with the stonemasons and trench diggers who would work on the aqueduct was signed, on 2 September 1568. By that time, Tommaso dei Cavalieri, a Roman Conservatore who had been a beloved friend of Michelangelo's (and both the subject and recipient of scores of the artist's sonnets and drawings), had taken charge of administering the contracts. Later that month, Giacomo della Porta was appointed to represent the Roman Council on the Water Committee after Nanni di Baccio Bigio died. Della Porta's specific task was to oversee the "construction of the fresh water–distribution system." At the same time he was appointed architectural adviser for a new committee, "super Aqua Salonis," to complete the restoration of the aqueduct. Bartolomeo Gritti, the Council's oversight architect for the restoration in 1562, assisted him. Della Porta, who arrived in Rome (from Porlezza, near Como) in 1559, identified himself as a sculptor and was also occupied in *comprovendi*, agreements for the sale and purchase of excavated objects. Although not yet as well known as he would be at the end of the century—when he was "generally held by everyone to be the first and principal architect of Rome"—by 1568 he had become highly regarded.[36]

In 1562, della Porta had apprenticed himself to Guidetto Guidetti and was assigned to work on the Oratorio del Crocefisso di San Marcello. Ranuncio Farnese (to whom Modio's treatise denouncing Tiber water as unsafe for drinking was dedicated in 1556) sponsored that project, and Farnese served as a kind of patron for della Porta well into the pontificate of Gregory XIII. On Guidetti's death in 1564, della Porta inherited Guidetti's commissions, including construction supervision of the Palazzo dei Conservatori (designed by Michelangelo), the seat of the civic government. Following the death of Michelangelo that same year, the Roman Council appointed della Porta to replace him as architetto del Popolo romano. After the Trevisi scandal, della Porta's appointment to the Water Committee and the Aqua Salonis Committee was specifically recommended because of his reputation for diligence and honesty—a reputation Michelangelo had also had.[37] Furthermore, della Porta had some experience of working with fountains. In 1563 he supervised the restoration of the Trevi Fountain for Pius IV, adding a separate fountain to accommodate horses, and designed a public



2.9 Properties owned by Water Committee members included Villa Ricci (1), Orsini Gardens (2), and the palazzi of Cardinal Cornaro (3), Muzio Mattei (4), Prospero Boccapaduli (5), Monsignor Torres (6), Cardinal Flavio Orsini (7), and Cardinal Ricci (8).

laundry fountain at the site of a natural spring near the Church of San Giorgio in Velabro.[38] Even so, perhaps the most persuasive argument for choosing della Porta for this important project was that he had worked on the Basilica of Saint Peter's, respecting Michelangelo's designs.[39]

Chosen because he understood the value of authority, including that of Michelangelo and no doubt also that of ancient Roman precedent, della Porta would in fact be called upon to devise new strategies to see the Vergine restoration through to completion. As work progressed, his responsibilities increased, and he took on jobs that had previously been awarded to others. Ultimately, with the assistance of Gritti he oversaw the repair of the entire length of the channel, the complete overhaul and amplification of the original springs, the restoration of the holding basin at the springs, the survey for the distribution routes within the city, the design and construction of a series of new public fountains, and the design and arrangement of the conduits to deliver the water to them.

The 30th of August 1570 was a glorious day in Rome. Finally, "amid great public rejoicing," water poured once more into the Trevi Fountain, the terminus of the restored aqueduct. After nearly six hundred years of limited water supply, the aqueduct now delivered water to the city at the rate of 16,560 liters per minute. But to be truly effective as an instrument of the renovatio Romae, as Pius V understood, the water needed to be available in many locations, not just at the Trevi Fountain, located at the far-eastern edge of the abitato. Therefore, even before the restoration was complete, Pius articulated his desire to place a fountain in front of the Pantheon and another farther west, in Piazza Navona, for both beauty and utility. In order to send water to these and other locations, a distribution plan that was flexible enough to allow for multiple public fountains scattered throughout the Campo Marzio had to be implemented immediately. Della Porta must have begun formulating such a plan as soon as he was hired. How was he able to conceive and implement it? Up to this point, the model of ancient Rome had been ever present to Pius, the Water Committee, the architects, the engineers, and the construction crews. In fact, the entire restoration process was largely an imitation of ancient precedents. But distributing the water as widely as Pius demanded would require innovation. Without a viable plan that took into account the topography through which the water would flow, the potential of the Vergine to irrigate urban growth would remain untapped.[40]

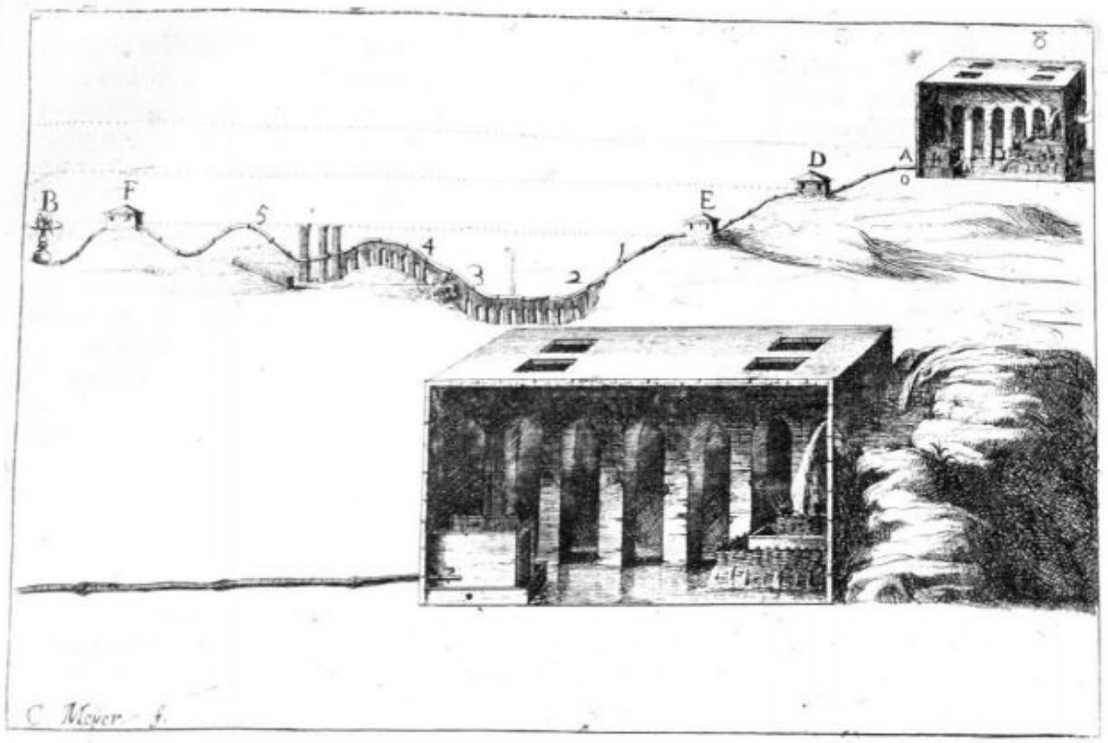
3 Surveying the City, Distributing the Water

Once the acqua vergine had been restored it was necessary to distribute its water more widely in order to rehabilitate Rome's urban fabric in the way Pius V had envisioned. There was a great deal at stake: not only were individuals and institutions as eager to gain access to the water through private fountains as ordinary residents were through public ones, but Pius's renovatio Romae demanded an abundance of pure water for grandezza. But because Rome had been without an adequate water supply for centuries, few members of the Water Committee, or the engineers, architects, and laborers who would do the work, were familiar with the planning, construction, and administration necessary to create a water-distribution system that could supply multiple users in many locations over the two square kilometers of the Campo Marzio. Frontinus had laid out the general parameters for distribution in the first century, but it is unclear how useful his recently discovered treatise *De aquaeductibus urbis Romae* would have been in practice and how many of the people involved in the distribution process were aware of the text.

Even from the beginning of the restoration project it would have been clear that while the quantity of water was impressive, it could be distributed only to areas that were lower in elevation than the terminus of the aqueduct at the Trevi Fountain, which was only about nineteen meters above sea level. What Rome needed was an efficient system that was inexpensive to operate and easy to maintain. Gravity flow was the logical solution, for it would have been unrealistic to use mechanical pumps driven by human or animal power to increase pressure, as one might for a garden fountain.

The principle of gravity flow is simple. Essentially, aqueducts are manufactured streams, and, like streams, their water flows continuously downhill—in this case, in a covered channel—by means of gravity. Once the water reaches its destination, it flows into a large basin fitted with pipes. As the water flows into these pipes, pressure is created; even as the pipes carry the water to lower elevations, it can, once released, return to the level at which it left the basin. Yet as simple as this seems, it could be difficult to determine how much water was available and the exact level of its pressure at a location remote from the source. During the late Renaissance, as in antiquity, a formula for accurately calculating water flow had not

3.1 The principle of gravity flow is illustrated in this seventeenth-century print. "A" marks a castello constructed at the water's source and "B" represents the ultimate destination of the water at a fountain. "D," "E," and "F" are intermediate calming stations where the high pressure of the water is arrested and some water diverted for use in the immediate area. Numbers 1–5 indicate topographic conditions along the route of a siphon that carries the water under pressure across a valley before reascending a small hill. Note that castello F is lower in elevation than castello E across the valley. (Cornelius Meier, "Dell'avvertenze che si devono havere nel livellare delli siti dalli quali s'hanno da condurre l'acque alle Fontane," in Meier, *L'arte di restituire a Roma la tralasciata navigatione del Tevere*... [Rome, 1685], 8. The Vincent Buonanno Collection.)

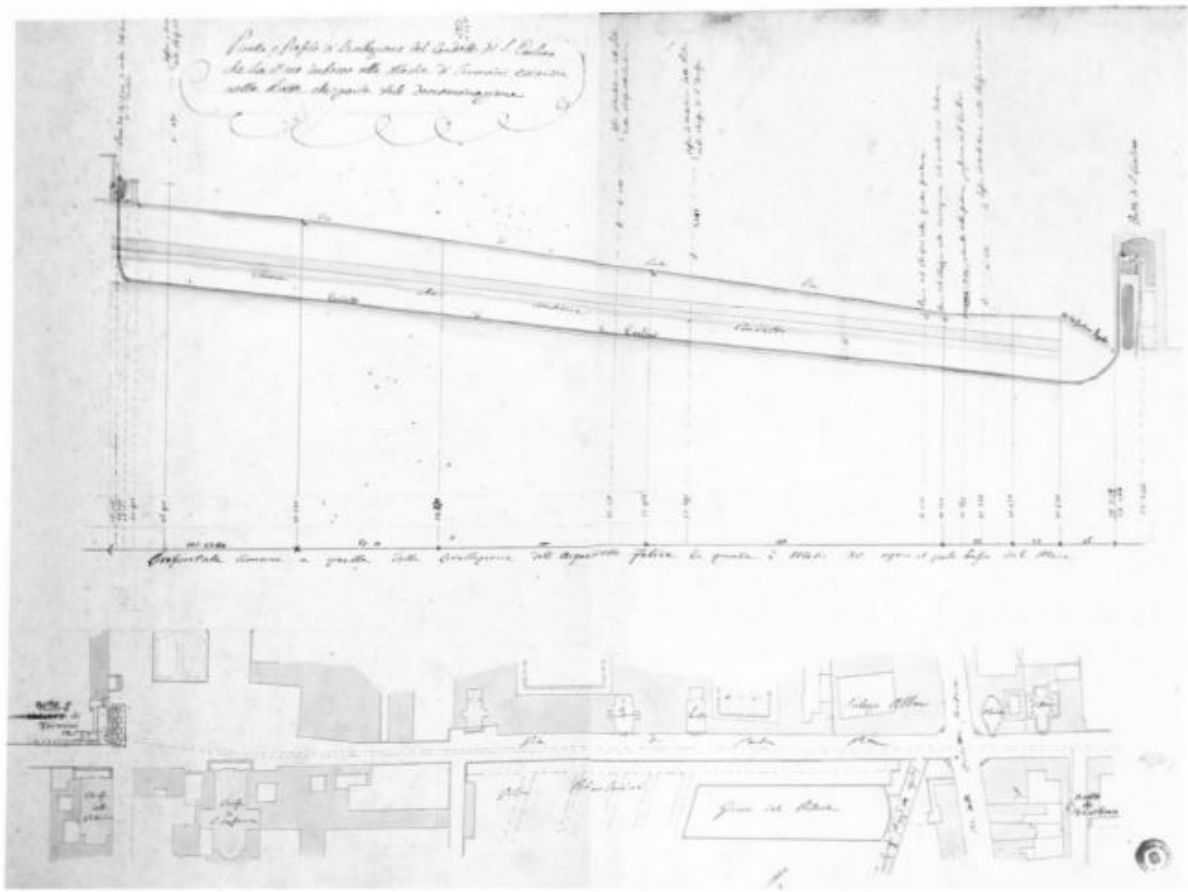


Dell'auuertenze che ſi deuono hauere nel liuellare delli ſiti dalli quali s'hanno da condurre l'acque alle Fontane.

been perfected, in part because of seasonal variation in the water supply. Even the vast water-distribution system of imperial Rome — with 11 aqueducts and perhaps as many as 1,252 public fountains, as well as numerous private fountains, imperial baths, and other water features — had been designed and constructed to exploit gravity flow without benefit of accurate hydraulic formulas. In 1570, in spite of technical writings by Leon Battista Alberti, Leonardo da Vinci, Taccola (Mariano di Iacopo), and Francesco di Giorgio that were widely known among the educated elite, and in spite of the rediscovery or survival of ancient texts by Vitruvius, Frontinus, and Hero of Alexander, hydraulic projects relied on empirical expertise rather than precise scientific knowledge.[1]

Gravity-flow distribution depends on many factors, all of which must be considered when designing a delivery system. These include the elevation of the springs at their source relative to the elevation of the various neighborhoods to be served, the distance of the springs from the city, the gradient of the aqueduct channel, the altitude of any settling tanks along the route, the material and construction of the conduits and pipes, and the amount of water flowing through them. Because Rome's water supply is so pure and free of debris, settling tanks are typically unnecessary. Rather, each of Rome's aqueducts (both today and in the past) delivers water to a distribution basin, called a *castello*. Pipes installed in the basin walls then send the water to public and private fountains throughout the distribution area — a watershed defined by the available pressure of water flowing out. From the spring to the castello, the water flows within the aqueduct channel with room for air circulation above the stream of water. Once the water leaves the castello in pipes (buried under the streets), its flow is constricted and pressure is created. The more pressure in the pipes and the greater the difference in elevation between the castello and the fountain, the higher the water can shoot when finally released (fig. 3.1).[2]

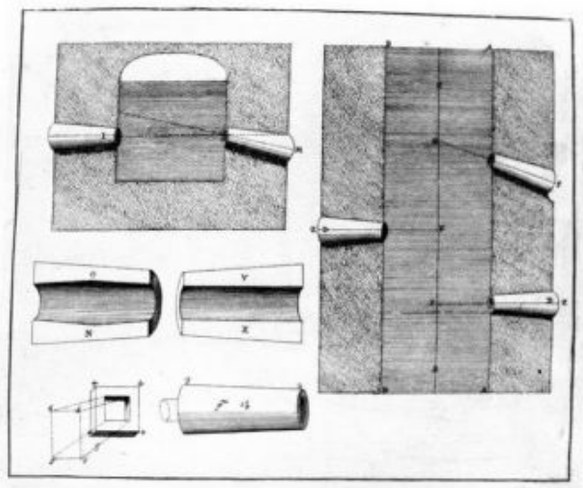
The elevation at which the water leaves the castello determines the maximum height it can attain



in another location. If water leaves the castello under pressure at an elevation of nineteen meters, for example (its approximate level at the Trevi Fountain in 1570), that is the maximum height it can attain when released. Realistically these limits were rarely achieved during the late Renaissance since any number of imperfectly understood impediments—such as the friction created by the rough inner surfaces of terra-cotta pipes, air trapped in the pipes, water larceny, and seasonal variations in water supply—could interfere with the height the water could jet. Thus, the new drinking fountains, animal troughs, and laundry basins that were intended to serve the city had to be designed to function even in the driest years, when water supplies would be lowest. Additionally, the new civic fountains that were principally intended to ornament the city were expected to produce a dramatic water display at all times. The jets thus had to be placed well below the hypothetical level of available pressure so that water could shoot up vertically or gush out horizontally with force (fig. 3.2).

A surprising number of issues (which have received scant attention in histories of Rome's urban development) needed to be resolved before Vergine water could flow out to public and private fountains. It was crucial to decide how much water should be reserved for public fountains, where those fountains should be placed, what purposes they should serve (drinking, washing, ornamentation, watering animals, and so on), how much water should flow to each, and how any run-off water would be handled. The

3.2 As we can see from this nineteenth-century plan, the Condotto di San Carlo carried water from the castello at the Moses Fountain (top left) under the roadbed of Via Pia, past the Four Fountains, to a second high-level castello built specifically to provide water to the Quirinal Gardens. This was standard practice to maintain a high elevation for water distribution throughout Rome. The door to a similar castello nearby (see fig. 7.12) can still be seen in the perimeter wall of the Church of San Carlo alle Quattro Fontane. (*Pianta, e Profilo di livellazione del Condotto di S. Carlino*, 19th century, Archivio di Stato di Roma, Disegni e piante, Collection 1, Cartella 78/B, 221)



3.3 Available pressure depended on the angle and level at which distribution pipes were installed in the walls of the aqueduct specus (shown here) or a distribution castello. (From Carlo Fontana, *Utilissimo trattato dell'Acque Correnti* [Rome, 1696], 63. The Vincent Buonanno Collection.)

designers and administrators of the system needed to determine standards for conduit sizes, as well as the materials from which the conduits were to be made and the various routes they would follow. Private subscribers had to be dealt with as well: decisions needed to be made about how much water, and at what cost, should be made available to them, how it should be distributed, and how it was to be administered. These issues were the same as those faced by the imperial water administrators, but with so little recent experience on which to draw, the Renaissance planners found that nearly every step in the distribution process was essentially a new experience—from surveying the routes and laying the conduits to designing the fountain basins and developing the administrative strategy.[3]

Whereas ancient precedent had served to outline a basic approach for aqueduct restoration, experimentation would now guide the distribution process. The only exception was how the water was measured; sixteenth-century engineers used the same simple (and inadequate) formula, in which the cross-section of the depth of water within the aqueduct channel was calculated, that the ancient Romans had—a formula that took absolutely no account of velocity and was therefore as inaccurate in 1570 as it had been in antiquity. Although it was well known that water flow varied under differing conditions, no one had yet worked out an accurate method of quantifying these differences. Water under pressure (that is, water inside a pipe) was measured by the diameter of the pipe, known as a *fistola*. The standard measure in the sixteenth century was reckoned as an *oncia*, with the diameter of the fistola for a single oncia being 2.2 centimeters (one-tenth of a *palmo*). Properly installed at a ninety-degree angle to the wall, a 1-oncia pipe delivered almost a quarter liter per second, or 19,872 liters per day (fig. 3.3).[4]

Available pressure varied depending on the level at which each pipe was installed in the castello. A pipe that had been inserted nearer to the upper level of the water, for example, would have a greater distribution potential but less pressure, and thus a greater chance of running dry during drought conditions. Alternatively, a pipe inserted closer to the bottom of the castello would have greater pressure but could not deliver water as widely. Nonetheless, its lower position would ensure a water supply during dry seasons. In addition, greater water depth created greater pressure and faster-flowing water. Thus, it became necessary to ensure that all pipes were horizontal and installed at the same level; a lower or angled pipe, even if it were of the same diameter, would draw more water. It is a truism that whenever regulations are imposed to control water access, subversion will occur. This was certainly the case in Rome, where it had been known in antiquity that nudging the horizontal distribution pipe so that it pointed slightly downward would also increase the flow of water through it. Greedy private subscribers, pliant watermen who supervised water distribution, and outright water thieves who tampered with the pipes in order to augment individual allotments all knew this trick and used it repeatedly to their advantage.[5]

Clearly the task of designing an entirely new gravity-flow water-distribution system was especially challenging, and whatever strategy was finally adopted would be critical for the future development of the city. The problem in 1570, as for the ancient

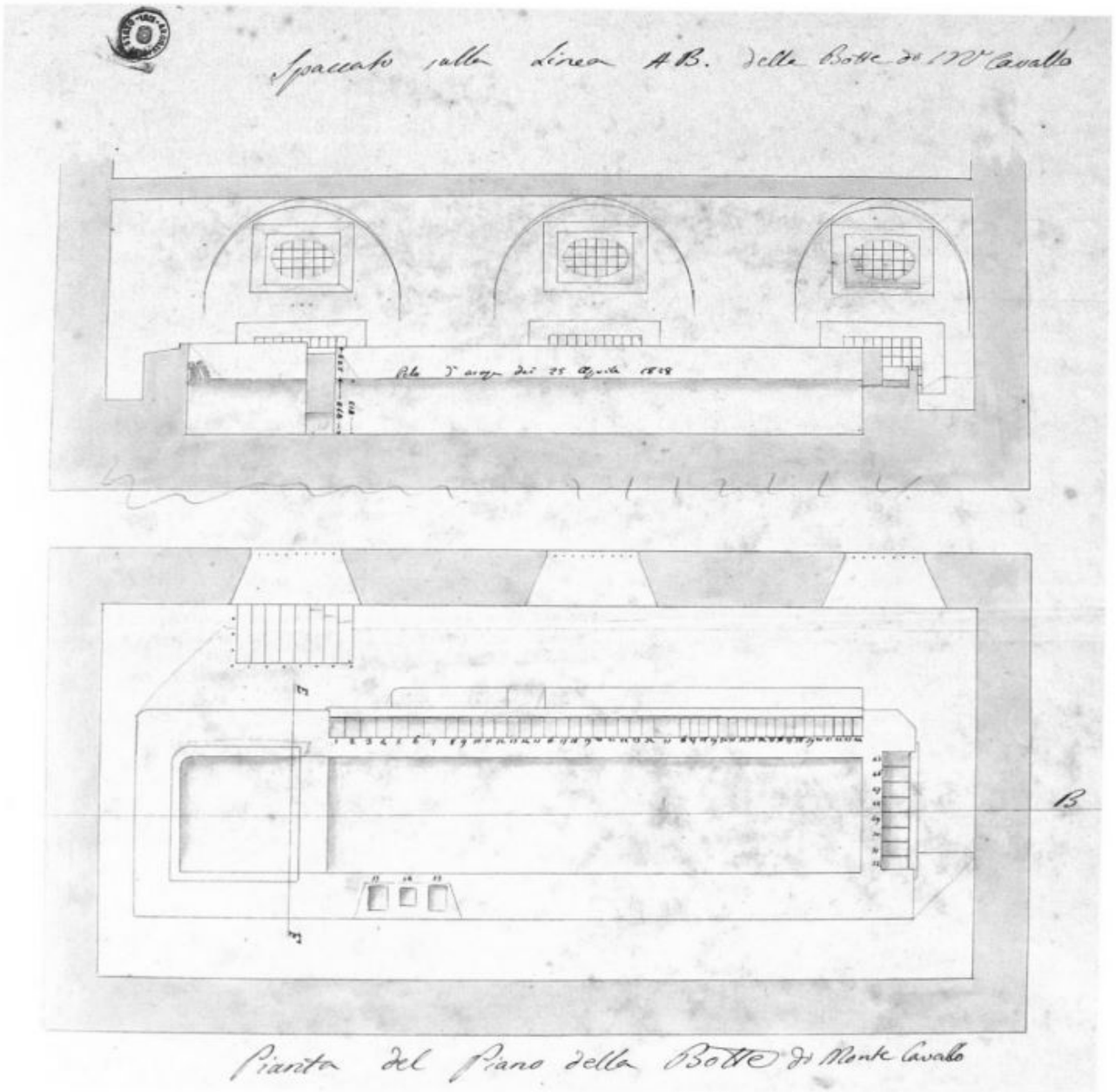
Romans, was to deliver an unknown and seasonally variable quantity of water from a specific location and elevation to a series of fountains located at different distances and different elevations from the source—a not inconsiderable task. To further complicate matters, the Acqua Vergine, like its predecessor the Virgo, was a low-pressure system that had to serve an essentially flat yet wide distribution area extending from the Porta del Popolo in the north to the base of the Pincian Hill in the east, then west to the Tiber and as far south as the foot of the Capitoline Hill. In some parts of the distribution area there was an elevation change of less than two meters from the source of the water (and therefore of available pressure), and under the best circumstances it was only slightly less than six meters.

Distribution becomes even more complex as the number of fountains and private subscribers increases (fig. 3.4). Imagine that a hypothetical hundred oncie are intended for ten hypothetical fountains: in theory this means that each fountain could receive one-tenth of the available supply. The reality may be quite different. Some fountains may be designated for more populous districts, or at key industrial areas, or at formal locations that need more water for impressive displays; other fountains may be intended for smaller neighborhoods, where the need may be less. Additionally, some fountains will be located closer to the distribution castello, while others will be farther away, and no two will be positioned at exactly the same elevation. The equation must be adjusted so that each fountain receives the amount of water it needs without depriving another of its share. In addition, the system must be designed in such a way that all the fountains continue to receive water in dry seasons. Regardless of how the water is distributed, the total amount will always be 100 percent. When a fountain is added, either a new water source must be made available by tapping new springs (at the same or a higher elevation) or adjustments must be made to the amount of water provided to the other fountains. To illustrate this point it might be helpful to think of the delicate equilibrium of a mobile. Each element is calibrated so that balance is established and maintained, even though outside conditions, such as airflow, might change at any time. If any piece is removed or replaced by an element of a different weight, the mobile will lose its equilibrium and be thrown off balance. The same is true if a new element is added to the mobile. In order to restore equipoise all the other pieces must then be adjusted—some might be made smaller, while others might be made larger, or removed entirely.

As the technical adviser for the Water Committee, Giacomo della Porta (assisted by Bartolomeo Gritti) was responsible for developing a distribution system that would satisfy all these requirements. But where might he have looked for precedents? There were at least three general models: existing public waterworks in Rome, nearby villa garden waterworks, and systems in other cities. There were two aqueducts in Rome: the old Virgo/Vergine and the Acqua Damasiana, neither of which was an appropriate model for the newly restored Vergine. Before the Vergine was renovated, it had supplied only the Trevi Fountain, a few private garden fountains located directly along its route, and perhaps three or four small public drinking fountains that were fairly close to the Trevi.

On the other side of the Tiber was the Acqua Damasiana, a short, spring-fed aqueduct originally built for Pope Damasus (366–84). Bramante had restored it for Pope Alexander VI between 1505 and 1507 for use in the Belvedere, and Matteo Bartolani da Castello (with Gritti as the on-site supervisor) renovated it between 1562 and 1564 for the Vatican Gardens. There it provided water for a few ornamental fountains, a fish pool, a nymphaeum, the Belvedere Court, and

3.4 This nineteenth-century drawing shows water entering the capture basin at the Quirinal castello (far left in the upper section) then flowing into the long regulating basin, at the far right end of which we see pipes leading into the distributing basin for individual subscribers. In the plan below, distributing basins (each of which would have had its own pipe) are shown for fifty-five subscribers. The pipes have been embedded in the thick wall of the regulating basin as a means of preventing tampering. ("Spaccato e pianta della Botte di Monte Cavallo," 1828, Archivio di Stato di Roma, Disegni e piante, Collection 1, Cartella 78, 227)



for drinking. Some of its water also flowed to a civic fountain in Piazza San Pietro, known as Santa Caterina, which in turn fed its run-off water to a *beveratore* (public drinking trough) that would have been widely used by pilgrims. Unlike the Vergine, the Damasiana had a superior head of pressure even though its water supply was small. Its operational elevation within the Vatican Gardens was more than fifty meters above sea level, while the elevation of Piazza San Pietro, where the terminal fountain was located, was probably no higher than about twenty meters at that time. Because of the high pressure, its water could be displayed in one of the garden fountains and the runoff could then be sent to another fountain at a lower elevation, such as the Santa Caterina fountain thirty meters below it. This meant that the lower fountain could be relatively tall (the Santa Caterina was perhaps five or six meters high), and it could have a jet of water shoot up in an eye-catching spray even though the supply was limited. Displays like this were impossible with Acqua Vergine water because of its limited pressure, but Gritti's experience here was to prove invaluable.[6]

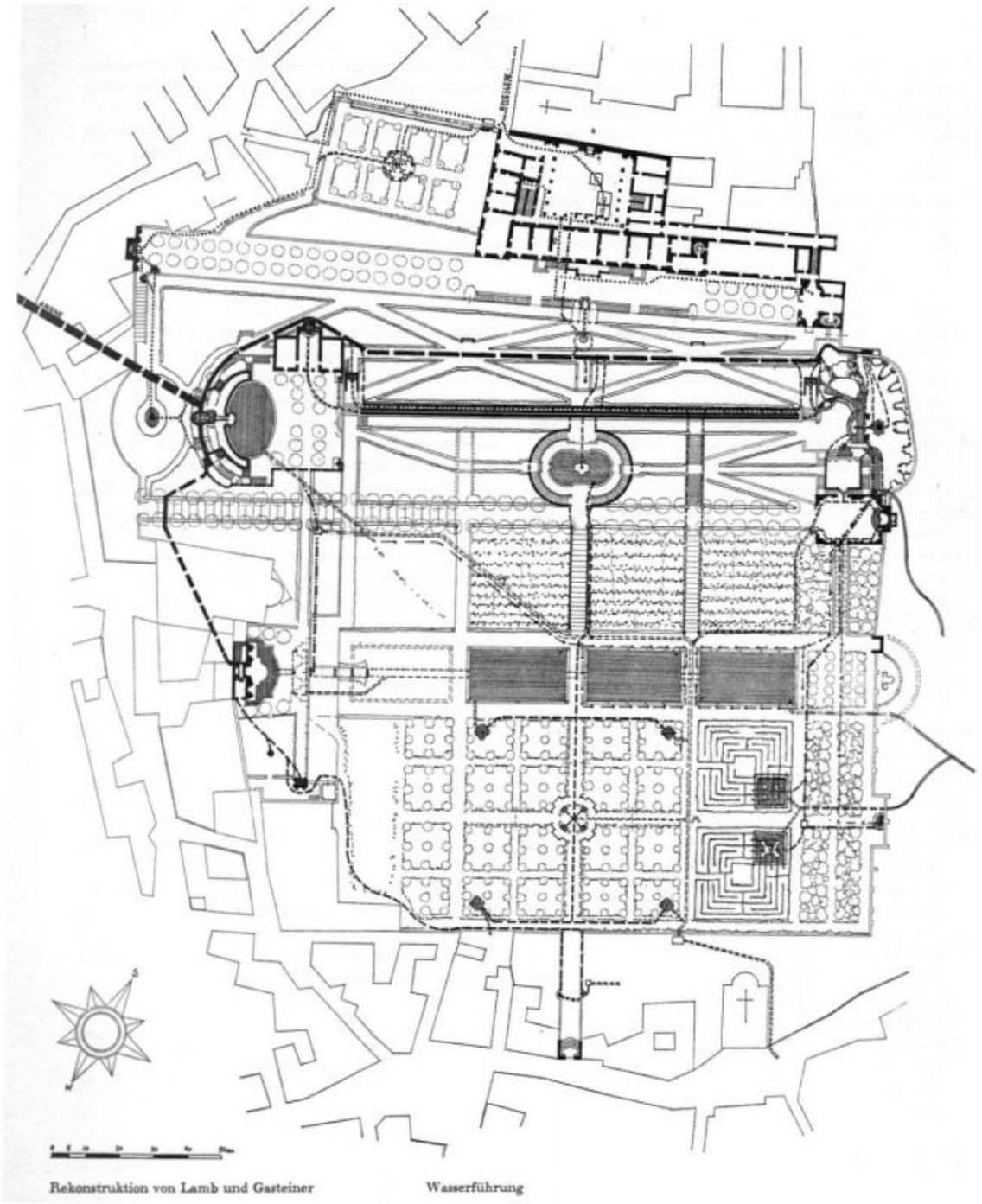
Della Porta could also have looked at the extravagant new gardens outside Rome, such as the Villa Lante at Bagnaia, Villa Farnese at Caprarola, and the Villa d'Este at Tivoli, for a model, but they too were unsuitable. All were designed and implemented more or less at a single stroke, and all relied on private, high-pressure aqueducts with abundant water. The Villa d'Este, for example, had already achieved enormous fame for the beauty of its fountains and the profusion of its water. Not only was this villa situated in a dramatic landscape with impressive topographic variation, but much of the water flowed directly downhill from one fountain to the next, losing pressure along the way. Since the Campo Marzio was essentially flat, there was no opportunity for water to flow from one grand civic fountain to another. Rather, each needed its own dedicated line in order to ensure as dramatic a water display as possible (fig. 3.5).[7]

A third option for della Porta was to study other urban systems. Perhaps he was aware of the impressive water-distribution system in Siena, which was widely known through treatises written by Taccola and Francesco di Giorgio—treatises that had been transcribed numerous times by others. Della Porta could have been familiar with the system either through the literature or from a personal visit to Siena, perhaps during his journey when he moved from Como to Rome in 1559. Siena's water system was not as impressive as it had been at its height between the thirteenth and the mid-fourteenth centuries, but there were perhaps a dozen public fountains and several minor fountains that were still operated and maintained by the city. Unfortunately, the Sienese system, even though it was also gravity driven, was unsuitable as a model for the Vergine. It was constructed around a series of underground channels, called *bottini*, that followed promising veins of water from the seeps where the water appeared on the face of the hill back into the hillside, going deeper and deeper to capture more water. Public fountains were placed at points where the water emerged from the face of the hill to fall directly into a basin. The most important and impressive of these was the Gaia Fountain in the Campo (fig. 3.6).[8]

It is unlikely that either della Porta or Gritti had firsthand knowledge of the water-distribution system in Constantinople, which was the most highly developed of any European or Mediterranean Basin city at the time. Nonetheless, reports concerning the newly restored aqueducts and fountains there must have come in along with other reports to Pius V—information that he would have passed to the Water Committee and della Porta. As exciting as the news would have been, its relevance for Rome was limited, as Constantinople's water was circulated in an entirely different manner. Cisterns were used to store the water, which was later distributed rather than allowed to flow freely. Perhaps cisterns were considered and rejected by the Water Committee because they did not follow the ancient model practiced in Rome.[9]

It was clear that della Porta needed to devise a modus operandi that responded to and reflected the specific topographic conditions of the Campo Marzio. First he built a short branch line, which, after diverging from the main Acqua Vergine channel under Cardinal Ricci's villa, terminated at its own distribution castello in the northern part of the city beneath the Pincian Hill in the area known as San Sebastianello, just north of Piazza della Trinità (now Piazza di Spagna). It is probably not coincidental that the new castello stood at the beginning of Via del Sebastianello, a new road (opened in 1564) that led up to the Villa Ricci and to the Church and Monastery of Santa Maria della Trinità at the top of the hill. Another, more symbolic, advantage of the site was that a small chapel to Saint Sebastian stood nearby. In Rome, Sebastian had been identified as a protector against plague, malaria, and other virulent diseases since at least the ninth century, and this chapel stood above one of the dampest and most pestilent areas of Rome.[10]

Because the Acqua Vergine channel was about 9 meters below grade at this point, the new castello was also located underground. The operational level of the water in the specus, only about 19.70 meters, dictated the underground location. This was about 70 centimeters higher than the level at the Trevi Fountain, 750 meters to the south. Although this may



3.5 This plan of the Villa d'Este shows the relative elevations of the fountains. The highest levels of the garden are at the top and upper left of the image. From there the water flowed down to the lower terraced levels of the garden (bottom and right of the image) and then to the town. (Carl Lamb, "Wasserführung," in Lamb, *Die Villa d'Este in Tivoli: Ein Beitrag zur Geschichte der Gartenkunst* [Munich: Prestel-Verlag, 1966], 39)

sound insignificant, it was crucial to della Porta, as it increased the available pressure by about 15 percent over the level that could be achieved at the Trevi. The decision to build the second castello was vital to the development of a comprehensive water-distribution plan—and not incidentally to the economic development of the northern Campo Marzio, for it could serve such areas as the Porta di Ripetta and Piazza del Popolo that could not otherwise be reached easily from the Trevi.[11]

On 4 November 1570, the Water Committee put forth a plan to distribute water from the castello at San Sebastianello to the major piazzas and streets of the Campo Marzio. But first, before any of the fountains could be designed, money needed to be found to finance them. A Fountain Committee made up of Ludovico Mattei, Prospero Boccapaduli, and Marcello Niger was appointed to consider ways to raise money. In January 1571 a Florentine merchant, Bartolomeo Bonamici, was sold 180 new tax contracts for this purpose. The tax, to be levied on all types of meat, had a value of approximately twenty thousand scudi, for which Bonamici could charge 7 percent interest. It was also decided that any money generated from the sale of water concessions to private subscribers (who were still to be determined) would be used to pay for the fountains. In a secret meeting held on 19 June 1571, the Roman Council studied different pricing proposals for the subscriptions and decided that only cardinals would be allowed to receive more than one oncia of water.[12]

On 2 July the Conservatore Tommaso dei Cavalieri proposed that the price for an oncia should be set at forty scudi as long as the dedicated private pipe was less than three *canne* (6.7 meters) distant from one of the dedicated intermediary bottini (small junction boxes that should not be confused with the Sienese bottini), located underground at regular intervals along the main trunk line. According to this proposal, the cost of a private connection would increase with distance from the main line at a rate of one-half scudo for every canna (ten palmi, or 2.2 meters) of additional distance up to fifty canne, for a maximum

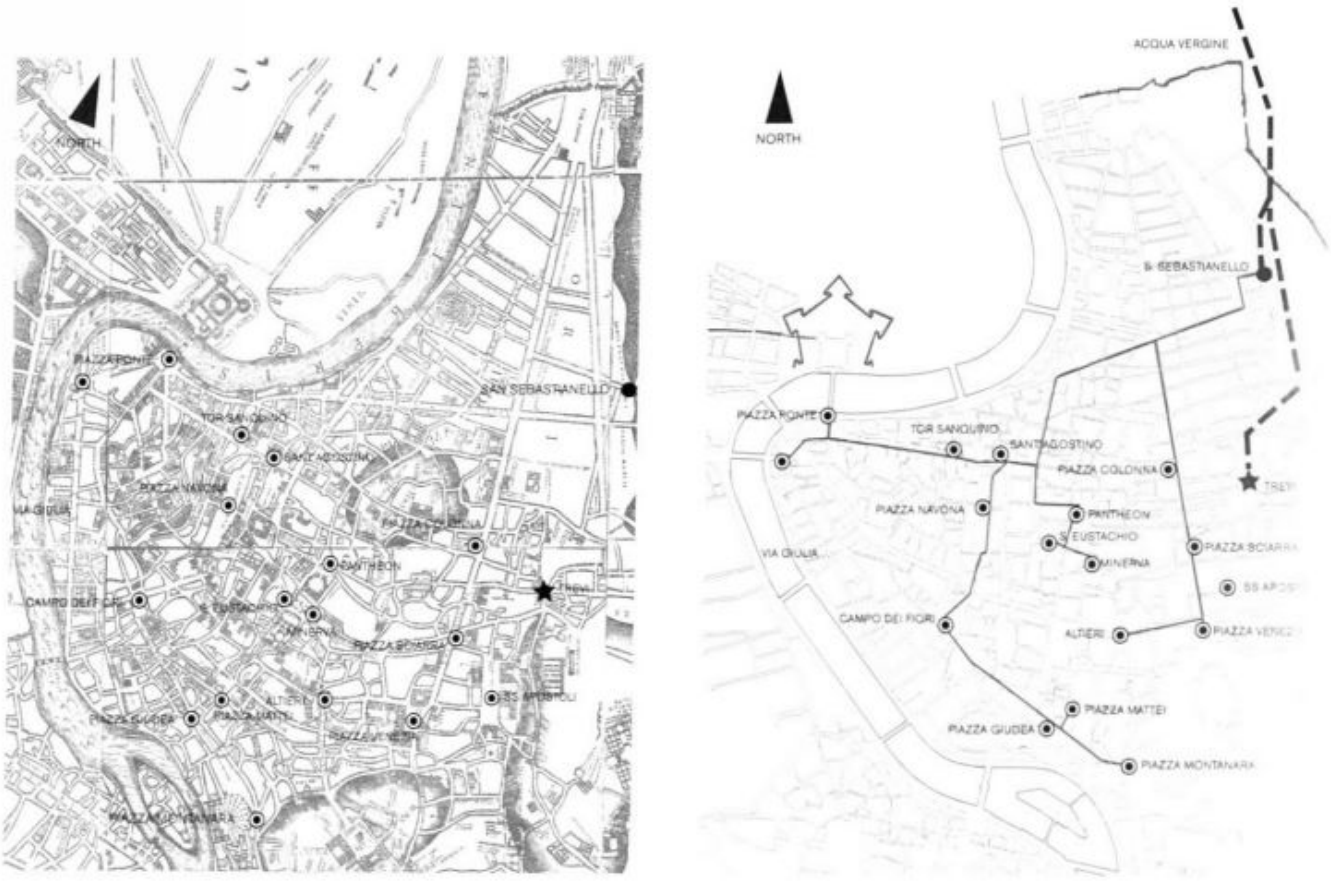
3.6 Gaia Fountain, Siena (Photograph by Roy Fokker, http://commons.wikimedia.org/wiki/File:Fuente_Gaia_de_Siena.JPG)

additional charge of twenty-five scudi. Accordingly, any additional distance would be charged at a flat rate of fifteen scudi. The cost would decrease by half for subscribers who purchased only half an oncia. By October, the committee had finally settled on a flat fee of eighty scudi per oncia, with the cost of laying and making the private conduits to be borne in all cases by the subscriber. Additionally, these subscribers were required to pay for the water as soon as they had received authorization, before the pipes could be installed. Further, they were required to pay for the cost of repairing any damage to the street that was caused by the work—including putting in new paving if the street were already paved. Finally, although the eighty scudi per oncia was a onetime fee, the subscriber could be taxed as necessary for maintenance and restoration of the pipe. The rationale, according to Cavalieri, was that a flat rate would not penalize those who lived farther away from the main lines, and, more important, that the beauty of the city would increase along with the number of fountains built.[13]

Without specifying an explicit typology, the November 1570 plan proposed seventeen new public fountains for the Campo Marzio. Fountains located in Piazza Colonna, Piazza Sciarra, Piazza dei Santissimi Apostoli, Piazza San Marco, and Piazza Altieri (at the Church of the Gesù) would be served by one branch of the main trunk line, while the other branch would go to Piazza Sant'Agostino, the Pantheon, Piazza Minerva, and Piazza San Eustachio. A second trunk line would parallel the first but diverge at Piazza Sant'Apollinare, where it then would divide into two branches. The first would lead to Piazza Torre Sanguigna, then to Piazza di Ponte Sant'Angelo and Via Giulia, the second to Piazza Navona, Campo dei Fiori, Piazza Giudea, Piazza Mattei, and Piazza Montanara. It is unclear why this number of sites was proposed, but all were in densely populated areas and many were near the palaces of important Roman nobles and cardinals, including members of the committee. No fountains were proposed north of San Sebastianello or at the Porto di Ripetta, the northern port on the Tiber near the Mausoleum of Augustus. And although two fountains were to stand near it, no fountain was proposed inside the Jewish Ghetto. These omissions were intentional, as both the northern area above the mausoleum and the southern area of the ghetto were considered physically or socially marginal to the city. The most efficient routes for the conduits would follow existing streets (fig. 3.7).[14]

Della Porta may have had access to a new map of Rome created by Leonardo Bufalini and published by him in 1551 (reprinted in 1560 by Antonio Trevisi). This map provided an early ichnography (horizontal ground plan) of the walls, streets, and major monuments of Rome, yet it was not a scientific plan in the sense that true distances and elevations had been fully measured and recorded. Although surveying techniques were widely employed at this time in building construction and for laying out streets, there was no survey of the entire city that could provide a uniform reference, nor were there surveys of individual neighborhoods. The information at hand was precise but local. More important, contour-elevation mapping had not yet been developed. It was incumbent upon della Porta to conduct a survey as soon as he was hired in order to establish relative elevations. The survey would then be used to determine where the level of available pressure would be sufficient. He needed to form a mental or graphic image of the topographic relations between the individual fountain sites and the subterranean castello beneath San Sebastianello in order to establish equilibrium (both in plan and in section) across the entire system. To do this, he needed a datum against which he could measure the level of the water at the underground castello and then apply throughout the distribution area, so that he could confirm that it was possible to deliver water to the proposed sites (fig. 3.8).[15]

Lacking even a cursory description of della Porta's process or any notes from his survey, we cannot reconstruct his methodology. I would like to think that in addition to using traditional surveying methods, della Porta would have used his own understanding of the city around him—an understanding that came from direct observation and was second nature to any well-trained and observant architect or engineer in his position. It does not seem unreasonable to suppose



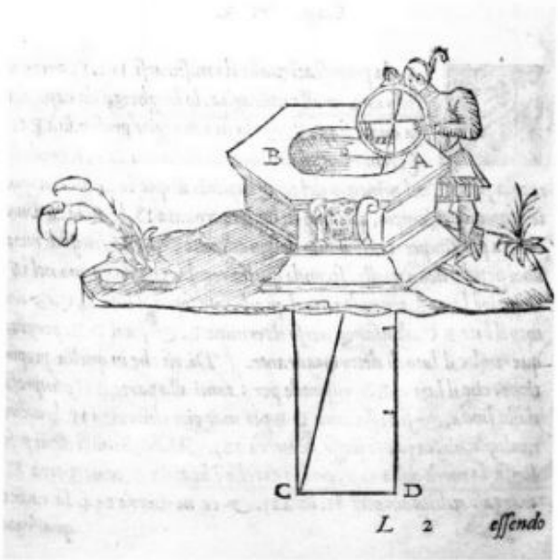
that he could have intuitively understood that the many inscriptions that had been placed on building facades to record historic Tiber floods could provide the necessary datum from which to begin his survey. These commemorative inscriptions marked the highest level reached by each flood and permanently inscribed the memory of the contour line that had been left as a stain on building walls throughout the Campo Marzio for many years—just as stains left from the 1966 flood of the Arno can still be seen in Florence today, more than forty years later.[16]

We have seen that one of the most alarming Tiber floods (reaching 18.90 meters) occurred in 1557, just two years before della Porta moved to Rome. The residual high-water line from that flood would still have been visible in many piazzas, streets, and courtyards in Rome, even though some buildings had been cleaned and restored and new commemorative markers installed. These landmarks—stains and scripts—would have become familiar to della Porta during the eleven years since his arrival. Although this temporary water table sloped imperceptibly until it reached the Tiber Island, where its drop was more marked, it was nonetheless perceived as level, since the residual stain left by the water as it began to recede was essentially horizontal within each of the flooded piazzas.

Several markers were available that recorded Rome's most notable recent floods—at least nine markers for the 1495 flood, nine for the 1530 flood (the highest yet recorded in Rome), and three for the 1557 flood—and nearly all of them were situated within the Vergine distribution area. These included three inscriptions (one from each of the floods) that had been affixed to the facade of the Church of Santa Maria sopra Minerva (see fig. 1.8), and another inscription from 1530 located in Piazza del Popolo.

3.7 In November 1570, the Water Committee proposed seventeen new Acqua Vergine fountains for the Campo Marzio, as plotted on a twenty-first-century street plan (right) and the 1560 reprint of Leonardo Bufalini's 1551 map. (Left: Leonardo Bufalini, *Roma*, 1551 [Rome: Danesi, 1911])

RIGHT, TOP **3.8** An astrolabe could be used to determine the depth of a well from its mouth (as shown here) or a ground-level shaft in order to determine the level of water inside. (From Cosimo Bartoli, *Del modo di misurare* [Venice, 1564], 42. The Huntington Library, San Marino, California, RB 705743.)

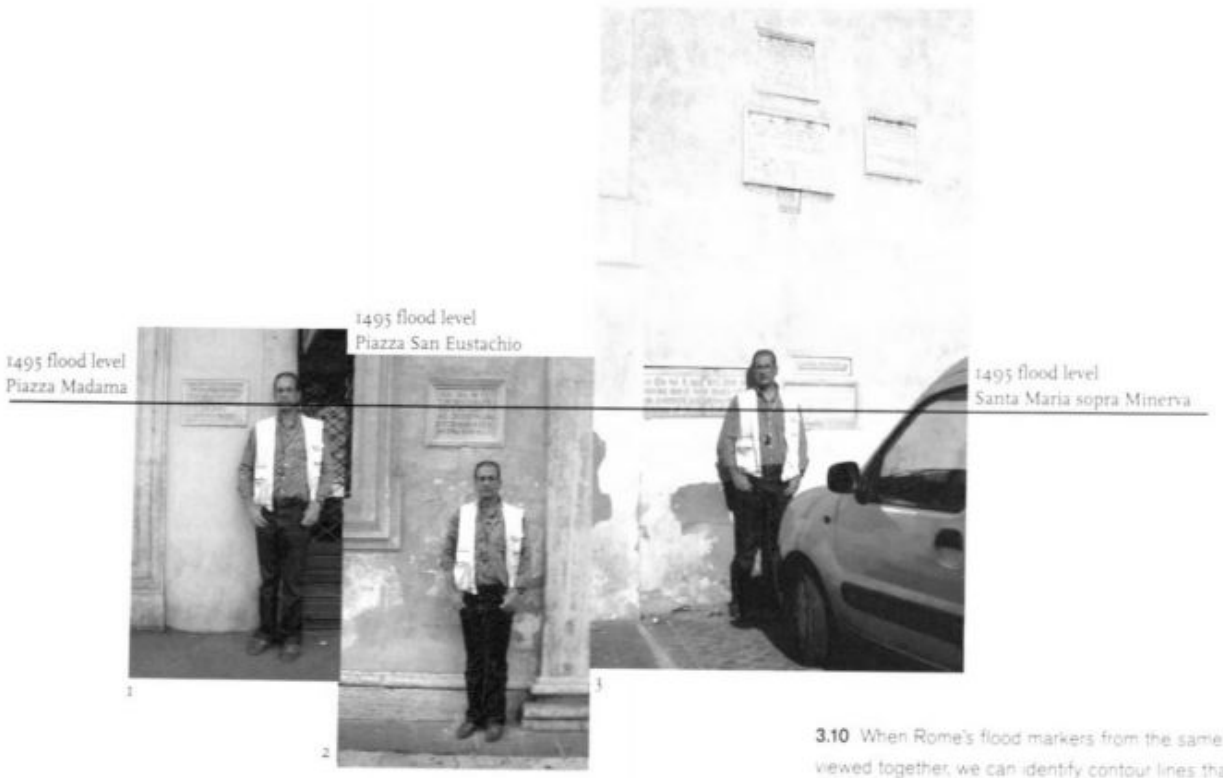


RIGHT, BOTTOM **3.9** Piazza del Popolo, showing the location of two flood markers on the wall at the left (Cornelius Meier, *Prospettiva della rinominata piazza e Guglia del Popolo*, detail, in Meier, *L'arte di restituire a Roma la tralasciata navigatione del Tevere* [Rome, 1685], 150. The Vincent Scamanno Collection.)

Using simple geometry and standard surveying instruments, it would have been a straightforward task to gauge the difference in elevation between the level of the water as it fell from the main channel at the Trevi Fountain and any nearby marker, or even to stains still seen in Piazza di Trevi. Slightly more difficult, yet entirely possible, would be to measure the difference between, for example, the marker for the 1530 flood placed at the corner of Via del Corso and Via Otto Cantone or the one at Piazza del Popolo and the operational level of the water at the castello at San Sebastianello. In fact, the level of water in the castello exceeded the 1530 flood line by about seventy-five centimeters, a difference that could be easily extrapolated for use in the specific locations chosen for fountain sites, where stains and scripts might also still exist (fig. 3.9).

The beauty of this intuitive method is that it allowed della Porta to understand the flood line as a constant. Against this regulating line the ground plane on which he walked and on which his fountains would stand could be seen to rise and fall. Hence, variations across the city could be perceived, and he could develop a new spatial awareness, one that would influence his work, as the individual fountains could be designed only after the elevations had been established. The height of each fountain would then reflect its unique relationship to the castello, with taller fountains designed for the lower elevations and shorter fountains for the higher (fig. 3.10).

Apparently the Water Committee intended to implement its proposal for seventeen fountains, but



3.10 When Rome's flood markers from the same event are viewed together, we can identify contour lines that reveal the topography of the Campo Marzio. Top: Inscriptions recording the 1495 flood, still in their original locations within a few hundred meters of one another between Piazza Navona and Piazza Santa Maria sopra Minerva, are adjusted to show the street level as a constant. Bottom: The same images have been adjusted to demonstrate the relative elevations of the flooded piazzas. By thinking of the flood line rather than the street level as the constant, we can "read" topographic variation across the Campo Marzio. (Photographs: © 2007 Rossella Nastri)

given the committee's earlier record with the restoration of the aqueduct, it was inevitable that there would be delays as the committee and the Roman Council now disagreed about distribution as well. Although they had administered other urban infrastructures like roads for centuries, neither group had administrative experience with an expansive water-infrastructure system, which was not only more complex—for it relied on the vagaries of nature—but also dynamic and essentially invisible. Nonetheless, each body wanted to assert control over the process. Nowhere was their struggle more apparent than in the decision to award the contract to construct and lay the main trunk lines under Roman streets. Like the Trevisi debacle with the aqueduct restoration, this contract became the focus of a protracted power play that led to lengthy delays and costly mistakes.

As in the past, the pope and his cardinals naturally wanted to retain all the power in their own hands and to limit the Capitoline magistrates to an advisory role on the Water Committee. Not surprisingly, the Roman Council was unwilling to become the mere executor of the cardinals' decisions, while the Maestri delle strade, who had nominal jurisdiction over the streets and piazzas where the conduits were to be laid and the fountains built, wanted greater authority as well. Having the power to choose the architect who would actually oversee the work was not simply a question of prestige. In a decretal of 1571 that was reminiscent of their 1550 harangue to Julius III to restore the Acqua Vergine, the Conservatori of the Roman Council reinforced the notion that their authority came from the people, in whose interest, according to the statutes, they acted as guardians.[17]

Because of these continued squabbles, which were raging as they debated pricing strategies, it was another six months before a contract was let for the conduits. On 16 May 1571, as both an expedient and in order to thwart the Roman Council, the cardinals unilaterally decided to conclude an agreement with a sculptor named Fra Guglielmo della Porta—no relation to Giacomo—to design stone distribution conduits of his own "invention," and to supervise their construction and placement. The choice of Guglielmo was problematic, and it had immediate negative consequences. Over his career, he had shown interest in water (he had made many artistic sketches of the Tiber and its mills), but apparently he had never designed a fountain, let alone a delivery conduit. What knowledge he possessed that made him appear to be the right person for the job is unclear. An interest in water technology is suggested by the fact that he owned an important treatise by Leonardo da Vinci (the Codex Leicester) that is concerned in part with hydraulics, but Guglielmo was primarily a sculptor, not a hydraulic architect. Certainly he was qualified to design and execute ornamental fountain sculptures, but to experts such as Giacomo della Porta and the Maestri, who were experienced in overseeing large-scale public infrastructure projects, the decision to hire him must have seemed ludicrous. The project's success depended not on graceful carvings but on the care with which levels were taken and pipes constructed. Guglielmo was trusted and admired by many powerful individuals, however, and in the past Cardinal Alessandro Farnese and Popes Paul III and Paul IV had all commissioned him for sculptural projects. Evidently his experience with carving stone and perhaps his possession of a hydraulic treatise were enough to give him credibility in the eyes of the Water Committee.[18]

According to the contract, Guglielmo was to complete the work in two years. The first phase of construction consisted of two sets of conduits (the main trunk lines) to be laid from the new San Sebastianello castello. These conduits would pass across the north end of the Piazza di Spagna to Via del Croce and then turn south to pass under the piazza and turn west at Via Santa Maria in Trinità (now Via dei Condotti—Conduit Street—in reference to the conduits laid under its roadbed) to Via del Corso. At this point, one line would head west toward Piazza Navona, and the other would turn south down Via del Corso toward Palazzo San Marco, the residence of Cardinal Cornaro, a member of the Water Committee. On 6 June 1571, two weeks after Guglielmo's contract was approved, construction of the first length of conduit began. That same day, Giacomo della Porta and

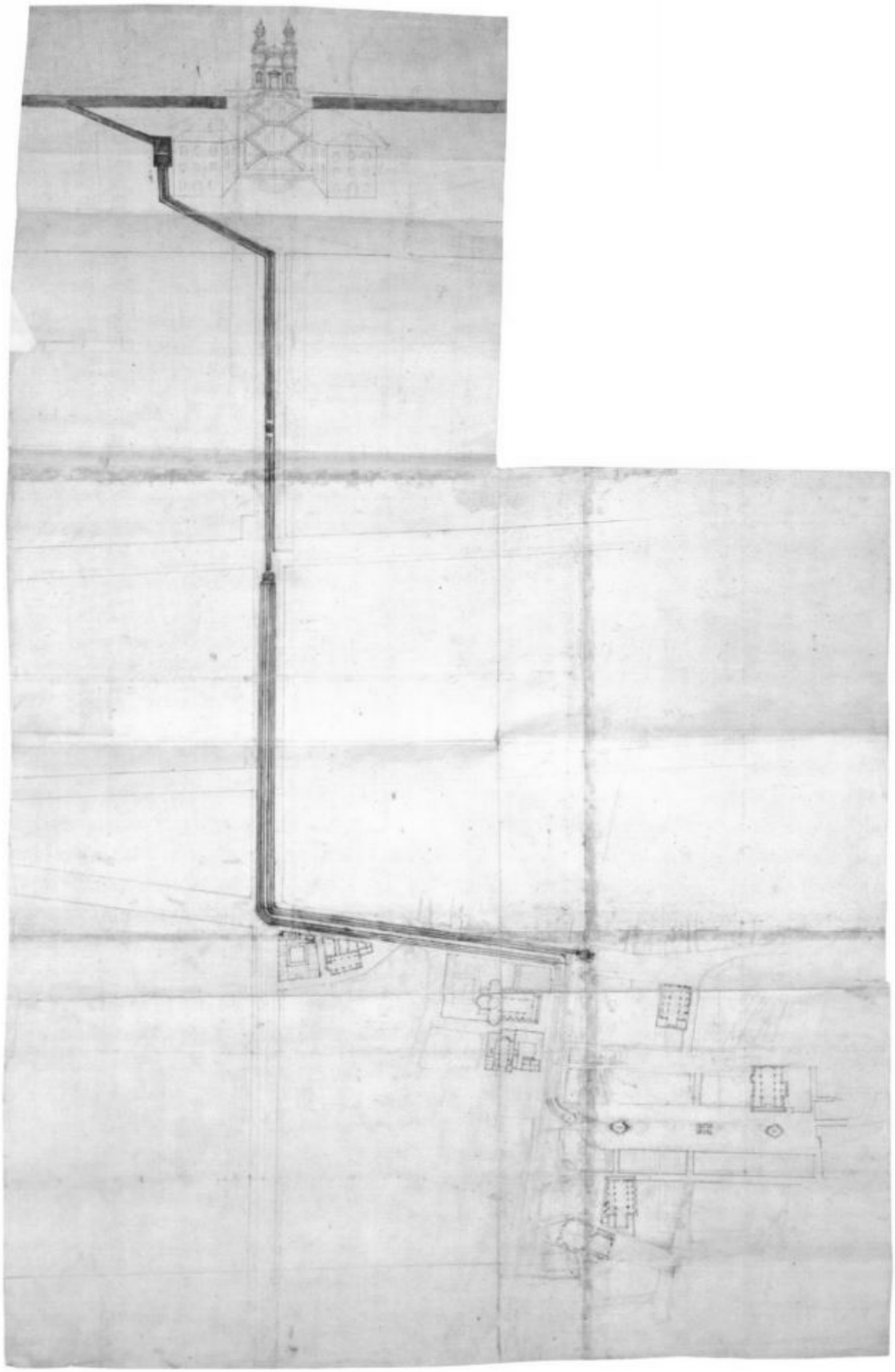
Gritti signed a contract to employ two masons, "ma[e]stro Johannes, alias Abraham Michael de Carpo, and Ludovicus de Belinzono" to construct the castello at San Sebastianello and provide it with two basins (fig. 3.11).[19]

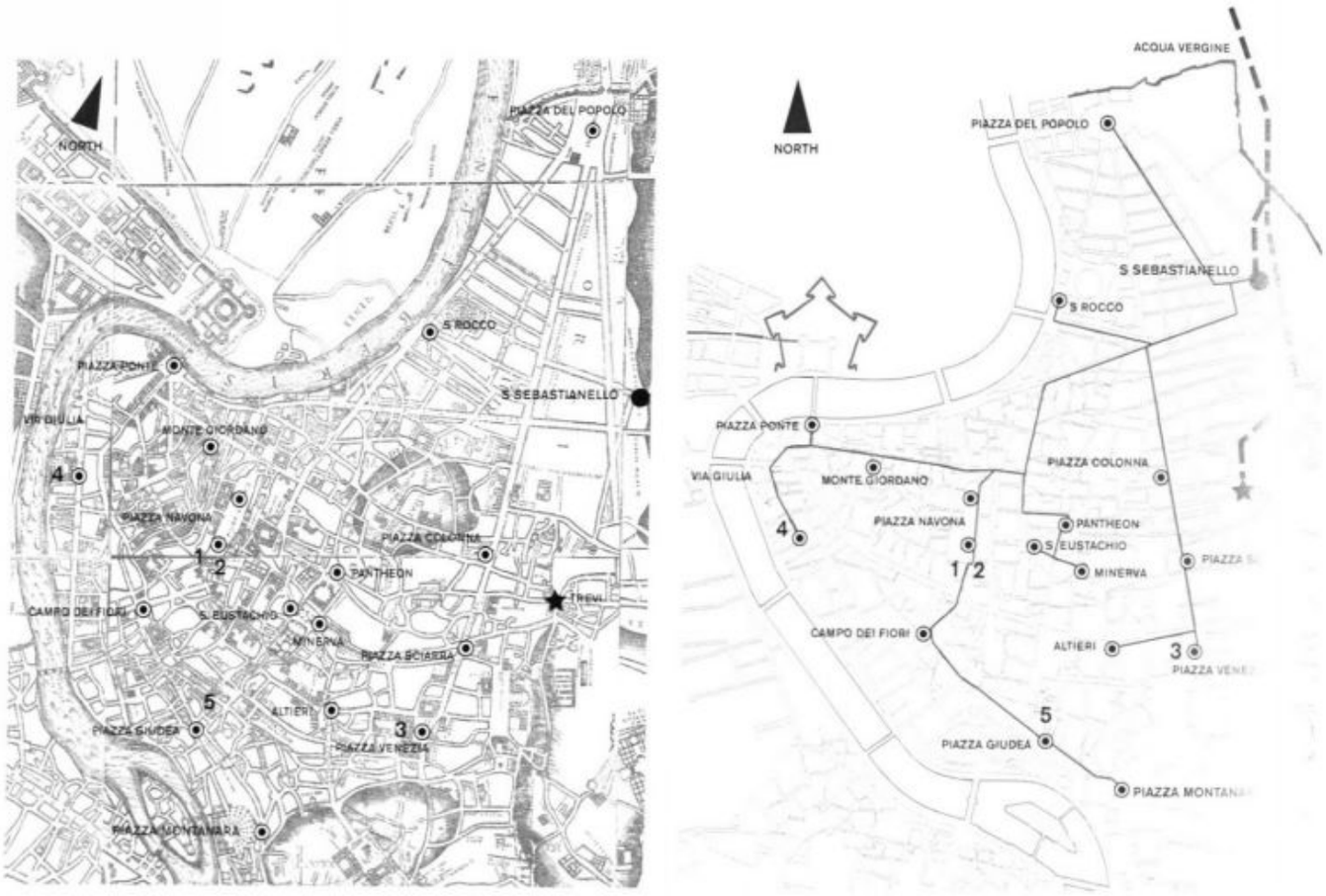
Shortly thereafter, the Water Committee put forth a second proposal, which represented a major change in water-distribution strategy from the original plan of November 1570. Unlike the earlier proposal, a fountain was now recommended for Piazza del Popolo at the northern entry into the city (the Porta del Popolo), an area that was much less densely inhabited than the rest of the abitato, and another was proposed for Piazza Santa Maria in Trinità, which stood at the bottom of the Pincian Hill. A third fountain was recommended at the Church of San Rocco near the Tiber River. In the new document, two fountains instead of one were proposed for Piazza Navona, and several sites were eliminated, including Piazza Mattei and Piazza dei Santissimi Apostoli (fig. 3.12).[20]

At that time, the Arco del Portogallo, which stood more than a half kilometer to the south of the Porta del Popolo, was symbolically the northern limit of the abitato. Located near the Church of San Lorenzo in Lucina, the arch was considered the gateway to Via del Corso since the area to the north was filled with orchards, gardens, vineyards, and an extensive open drain known as Chiavica di San Silvestro, while the area between the Monastery of San Silvestro and the foot of Monte della Trinità was described as a swamp. Via del Corso was tortuous even at the best of times, and it was transformed into a canal whenever it rained. Nonetheless, the decision to send water outside this physical and symbolic boundary of the abitato reflected Pius V's desire to create a northern magnet to help alleviate congestion in the Campo Marzio. This in turn was likely to stimulate economic development and property speculation once the details of the plan were made public. In any case, many Water Committee members already owned property in the area, which by this means suddenly became desirable real estate.[21]

Although it was not stated explicitly, the three newly proposed fountains also must have been intended to ornament and serve different types of city gateways. A fountain located at the Porta del Popolo would be particularly important for the fast approaching Jubilee Year, 1575, as thousands of pilgrims would have their first glimpse of Rome, although they may have already had their first taste of Vergine water at a beveratore on Via Flaminia built by Julius III that used run-off water from his nymphaeum. This was the first Jubilee to occur after the Council of Trent, and an estimated four hundred thousand pilgrims flooded into the city with renewed religious fervor, even though plague raged throughout Italy. The San Rocco fountain would have been especially useful at the busy Ripetta port, which like the Porta del Popolo was a vital gateway into the city. Finally, it seems logical that a fountain in the Piazza della Trinità would have served as a gateway for Vergine water in the northern part of the Campo Marzio. In this way, it would be similar to the Trevi Fountain, which terminated the main trunk of the aqueduct and physically and symbolically announced the arrival of Vergine water to the place where it was made available to the city. There was no possibility of building a fountain for the short branch of the aqueduct that terminated at the San Sebastianello castello, since it was about nine meters below the ground. Therefore a fountain in the nearby Piazza della Trinità—the first convenient location at a low enough elevation—would offer an ideal opportunity to publicly announce the entry

3.11 Giacomo della Porta's water-distribution plan carefully delineates the double-basin castello at San Sebastianello (upper left) and shows the main conduit heading down Via Trinità and a small bottino from which local residents will draw water. The conduit divides at Via del Corso after passing through a bottino and divides again just outside Piazza Navona, where there is another bottino, from which pipes will ultimately lead to Piazza della Rotonda. (Giacomo della Porta, Acqua Vergine distribution plan, 1571. Biblioteca Apostolica Vaticana, Cod. Vat. Lat. 11257, f. 149.)





of the water into the north of the city and provide a fitting termination to the vista down Via Paolina (now Via del Babuino). The importance of bringing water to these sites in order to spur development north and east of the Arco di Portogallo is made clear by a comparison of Antonio Dosio's 1561 plan of Rome (fig. 3.13) with Mario Cartaro's 1576 plan (see fig. 2.5); by 1561 these areas had become much more densely inhabited.

As with the first distribution plan, fountains were proposed for the most populous neighborhoods and for many piazzas where important palaces were located, including those of five of the permanent members of the Water Committee (though they were not mentioned by name): Cardinals Orsini, Ricci, and Cornaro, Monsignor Torres, and Prospero Boccapaduli of the Roman Council (whose family, like that of Cardinal Ricci, had arrived from Montepulciano several centuries earlier). Fountains were proposed for Via Giulia, "halfway along the street" near Cardinal Ricci's palace (now Palazzo Sacchetti); in front of Cardinal Cornaro's residence, the Palazzo Venezia at Piazza San Marco; and at Piazza Giudea, which was located outside the main gate into the newly enclosed Jewish Ghetto, near the palace of Boccapaduli. Most interesting was the fountain proposed for the south end of Piazza Navona directly in front of Palazzo Pasquino (Cardinal Orsini's palace), which stood opposite the palace of Monsignor Torres, where since 9 April 1570 Cardinal Orsini had possessed the right to control a hundred-palmo square area, over a corner of which the fountain was to be placed. Fountains were

3.12 The Water Committee proposed seventeen new Acqua Vergine fountains for the Campo Marzio in late 1571 as plotted on a twenty-first-century street plan (right) and the 1560 copy of Leonardo Bufalini's 1551 map. Five residences of key committee members were located near these fountains: Cardinal Orsini (1), Monsignor Torres (2), Cardinal Cornaro (3), Cardinal Ricci (4), and Prospero Boccapaduli (5). (Left: Leonardo Bufalini, *Roma*, 1551 [Rome: Danesi, 1911])

also proposed in front of Orsini properties at Monte Giordano and Campo dei Fiori that were owned by members of his extended family (fig. 3.14).[22]

In addition to the obvious private benefit of easy access to water for their palaces, committee members could also claim public benefits of various kinds. Proximity to a fountain would reflect the importance of a cardinal and his extended family, his status within the papal court, and his role in bringing water to the city; it would also express the Renaissance idea of magnificenza, or public virtue. The cardinal could thus appear to fulfill his responsibilities as an architectural patron and benefactor of the city without, in many instances, spending much money. Here the cardinal's obligation to improve the physical fabric of Rome, imposed as a responsibility by the papacy, was neatly conflated with an opportunity to aggrandize his own prestige and that of his family.[23]

Della Porta advised the Water Committee that construction should begin immediately. Nine fountains were slated, one each for Piazza del Popolo, Piazza Colonna, Piazza della Rotonda, Piazza San Marco, Campo dei Fiori, Piazza Giudea, and Piazza Montanara, and two for Piazza Navona. Although little remains from della Porta's survey, his 1571 drawing of the proposed route for Guglielmo's conduits between San Sebastianello and Piazza Navona demonstrates the care with which he studied the various sites (see fig. 3.11). The drawing shows the location of several underground bottini, two civic fountains, one at each end of Piazza Navona, and a drinking trough in the center and carefully delineates the ground plans of several private buildings (including the Palazzo Aragona at the corner of Via della Scrofa and Via Trinità), religious institutions (including the Churches of Sant'Agostino, San Luigi dei Francesi, and San Giacomo dei Spagnoli), and the Collegio Germano. The plan may have helped determine the location at which each building would connect to the trunk line with a dedicated pipe. In 1576, residents in these buildings were among the first to receive private concessions from the conduit that would later cross Piazza Navona from north to south, including Ottavio Gracco, the Water Committee's notary.[24]

All the selected sites, with the exception of Piazza Colonna and Piazza del Popolo, were in densely populated parts of the city located between Via del Corso and Piazza Navona, and many of them were important commercial sites in residential areas. All of them, including Piazza Colonna and Piazza del Popolo, were among the largest open spaces in the Campo Marzio. Campo dei Fiori, Piazza della Rotonda, and Piazza Navona all served as public markets (the campo also hosted public hangings), while Piazza Giudea, just outside the main gate to the ghetto, was especially important as the location where rags and old clothes were purchased for papermaking. Piazza della Rotonda, in particular, had a profound resonance for Romans since the Pantheon (La Rotonda) was not only an obvious reminder of the city's imperial history but had been converted to Christian use in the seventh century as the Church of Santa Maria ad Martires and as such was a prescient example of the renovatio Romae. In addition to being a large public market, Piazza Navona was also a key site for ceremonial and festival occasions. Piazza Montanara, always teeming with peasants who came to the city looking for work, stood immediately adjacent to the ancient Theater of Marcellus. The need for public fountains would indeed have been greatest at points such as these, where the drama of quotidian life was enacted.[25]

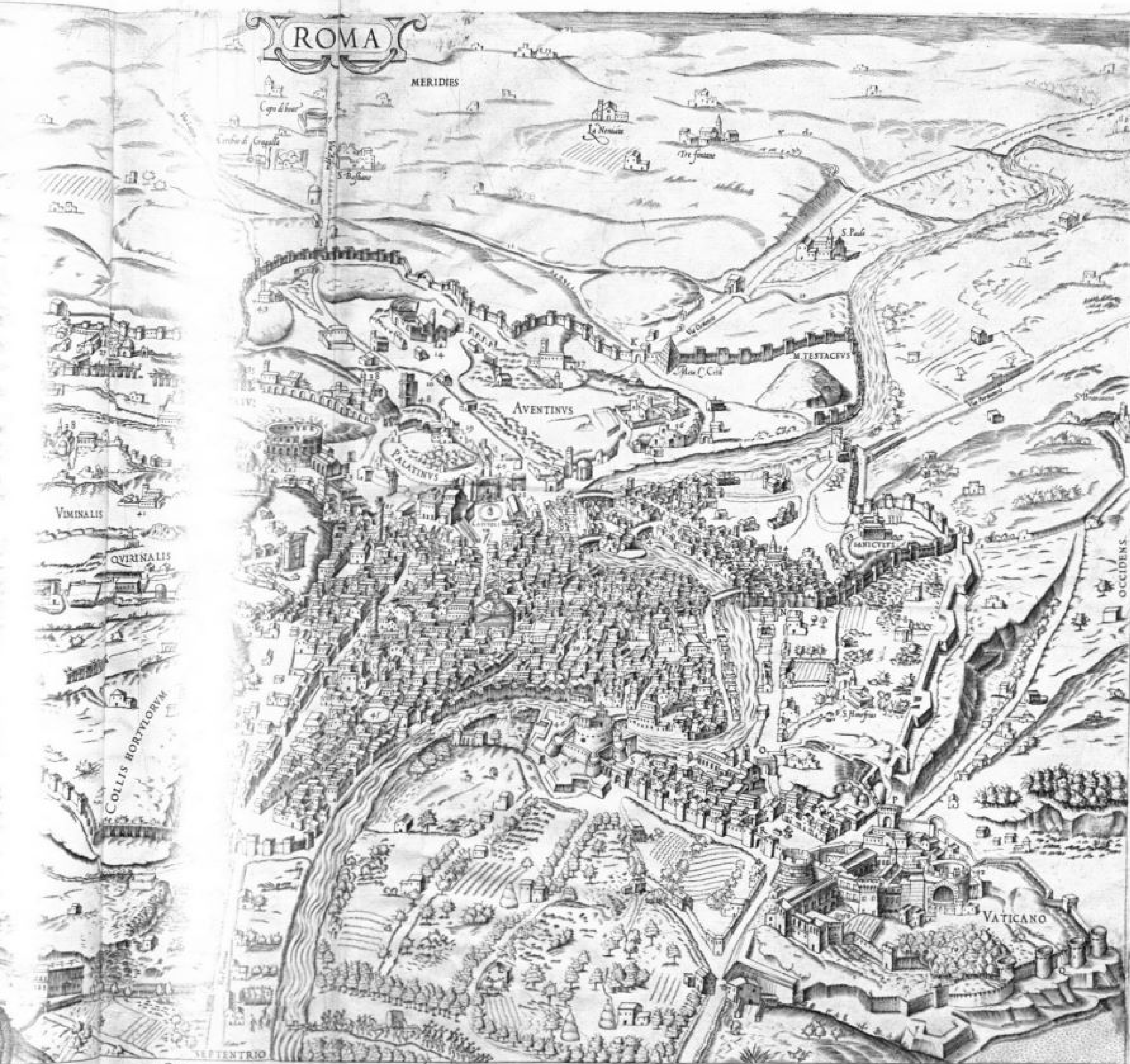
Piazza del Popolo, Piazza Colonna, and Piazza San Marco (sites that Agostino Steuco originally proposed in 1547) were all located along Via del Corso. Although the Corso more or less marked the eastern boundary of the abitato in 1570, it, and the piazzas along its length, played an important role in the ceremonial and diplomatic life of Rome. It was along this street that many ritual processions of important state visitors moved through the city from the Porta del Popolo to Palazzo Venezia before turning northwest to cut across the Campo Marzio to the Ponte Sant'Angelo and then to Saint Peter's. The new fountains encountered along the route would impress visitors with their beauty, slake the newcomers' thirst, and reinforce the idea of papal munificence—a benefit of particular importance during the 1575

Jubilee. On 7 July 1571, with all these considerations in mind, the Water Committee decided that Vergine water would flow first to the Piazza del Popolo, which was located only 750 meters away from the castello, closer than any of the other proposed sites.[26]

But some unanticipated problems needed to be resolved before the fountains could be built. In June 1571, Guglielmo della Porta began constructing the first trunk line, using a type of travertine known as "pietra de la cava d'Orta" (stone from the Orta quarry), which he described as being similar to marble. There were three sizes of pipe that made up the conduits. They were six, eight, and twelve palmi in length (approximately 1.3, 1.8, and 2.7 meters) depending on their use, with a center bore 1.5 palmi (33.5 centimeters) in diameter to carry the water. Guglielmo was to be paid thirteen scudi per canna, a price that included constructing the necessary vents, purgation chambers, access points for cleaning the conduits, iron bars, lead, mortar, stucco, and junction boxes (bottini). Two masons, Francesco del Schela and Andrea da Orta, were in charge of manufacturing the conduits.[27]

Technical problems became apparent during the first test, which occurred in October 1571, after only a hundred meters of the conduit had been laid. Ordinarily, a test was conducted to determine whether the course had been properly surveyed to ensure a constant gradient for the conduit and assess available pressure. In this case, it seems that the survey had been correct, but the material failed to perform as planned. According to the reports made at the time, the stone conduits leaked "like a sieve," allowing water to fill the deep trenches and even to flow out

3.13 Giovanni Antonio Dosio's 1561 plan of Rome clearly shows how sparsely populated was the area between Via del Corso and the foot of the Palatine Hill in the northern part of the city (seen left of center near the bottom of the map). The Arco di Portogallo, seen crossing Via del Corso near the center of the map, was considered the entry into the abitato until the mid-fifteenth century. Via Paolina is only roughly indicated by the space between the houses to the east (left) of the Corso. (Giovanni Antonio Dosio, *Sebastianus a regibus clodiensis in aere incidebat*, Rome 1561. Bibliotheca Hertziana, Rome.)



PONTES
Pons . Aelius vulgo S.
. Ianiculus vulgo S. X
. Fabricius vulgo 4 Ca
. Cestius vulgo S. Barth
. Palatinus vulgo S.

AQUÆ ET AQUÆDUCT
Aqueductus Claudie
Aquæ Marcie.
Aq. Augurte.
Aq. Virginis vulgo fon
Aq. Cabra vulgo la

11 Aq Daria.

THERMAE
12 Therme Diocletiane.
13 Th. Constantiniane.
14 Th. Antoniane.
15 Th. Titiane. vulgo 7 sale.

AMPHITHEATRA ET THEATRA
16. Amp. Vespesiani dicitur Coliseo.
17 Amp. Castrense.
18 Theat. Marcelli.

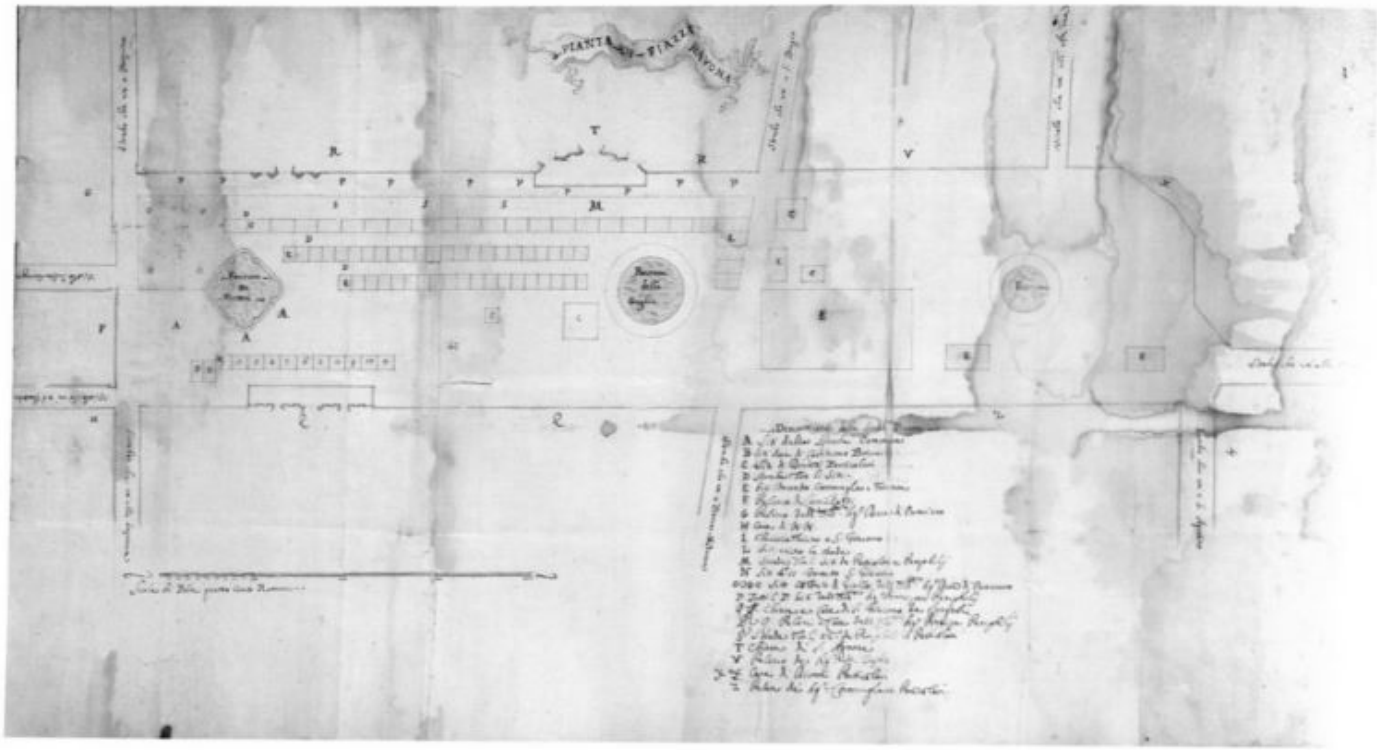
CIRCI
19 Circus maximus vulgo Cerchi.
20 Circus Agonalis.

ARCUS
21 Arc. Claudij dictus di Portugallo.
22 Arc. Iani quadrifrontis.
23 Arc. Titi Vespesiani.

COLUMNÆ
24 Colum. Antonini.
25 Colum. Traiani.

TEMPLA
26 Pantheon vulgo la Rotonda.
27 Templum Lateranense.
28. T. S. Marie maioris.
29. T. S. + in hierusalem.
30 .T. Trinitatis.
31 .T. S. Marie Populi.
32 .T. S. Petri.
33 .T. S. Petri in monte aureo.
34. T. S. Marie in Trãstiberi.
35. T. S. Sabine.
36. T. S Alexij.
37 .T. S. Sabi.
38 .T. S. Gregorij.
39 .T. S Stephani rotondi.
40 .T. S. Clementis.
41 .T. S. Laurentij in palisperna.
42 .T. S. Petri ad vincula.
43. T. S. Ioan. ante portam latinam.

VARIA
44 Villa Iulij III.
45 Mausoleum Aug.
46 Moles Adriani Castel S. Angelo.
47 Domus Fernesiorum.
48 Septizonium Seueri.
49 Forum Boarium.
50 Beluedere.



into the streets—travertine, unlike marble, is porous. The conduit could not be repaired. Work ceased immediately, and Guglielmo della Porta was fired.[28]

Even though this test may have been conducted behind temporary hoardings, it took place directly under the windows of the Palazzo Jacobilli, the residence of the French ambassador. The flowing water—and the resultant standing water—would have alerted him and everyone nearby to the failure. In his report on the damages, Giacomo della Porta commented that the excavated earth, which was left in heaps at the edges of the open trench, fell back into the ditch, undoing most of the work that had been accomplished up to that point. The inability of the Water Committee to supervise the work was the greatest impediment to the timely completion of the project, but Pius V must also be held culpable for granting the committee too much power and for approving the unsuitable choice of Guglielmo della Porta. Had the Maestri delle strade, with their extensive experience of overseeing urban restoration and construction projects, been given greater authority to choose an experienced hydraulic architect and to supervise the work themselves, such problems might have been avoided. Fortunately, the Roman Council had already decided to use terra-cotta for the conduits leading to Piazza del Popolo. Terra-cotta pipes could be manufactured and installed quickly, and they cost only four scudi per canna, rather than the thirteen scudi for stone pipes. Because laying the main trunk lines to Piazza Navona and elsewhere was now seriously behind schedule, all the stone conduits were removed and replaced with terra-cotta pipes. It is unclear who took over the supervision of laying the new conduits, but it was probably Gritti, as Giacomo della Porta's name is not mentioned in this regard until June 1573, at which point the two jointly supervised construction.[29]

From the start, a pattern was set that continued for the next three hundred years, in which topography created an invisible boundary line for water

3.14 Plan of Piazza Navona, c. 1650. Both the north and south fountains have been drawn incorrectly: the two are identical, both longer than they are wide. The round basin in the middle shows the location of the Four Rivers Fountain by Bernini. The hundred-palmo-square area that was in Cardinal Orsini's control by April 1570 is in the upper left (figure "O"). ("Roma. Pianta [del mercato] di Piazza Navona con descrizione [dei proprietari dei banchi]." Orsini Family Papers, Collection 902, box 17, Department of Special Collections, Charles E. Young Research Library, University of California, Los Angeles)

distribution. Within the line, pontiffs and members of the Water Committee could use the gift or sale of a water subscription to repay debts (both financial and social), strengthen familial and institutional alliances, support charitable institutions, honor services rendered, and curry favor. By 1572 water had already been promised or delivered to five private subscribers along the stretch of Via Paolina that was closest to the castello at San Sebastianello. In April 1572 a mason was paid for a trench he had made that carried the new terra-cotta conduit from Via Paolina (where it branched from the main line) down Via Gregoriana to a new fountain at the Hospital of San Giacomo degli Incurabili near the Tiber. At the same time, Tommaso Manriquez, who was the "master of the Sacred Palace" (that is, the Vatican Palace), was awarded water from the same conduit for his residence, located where the Collegio Greco now stands. It cannot have been a coincidence that several important players in the Acqua Vergine project already owned properties along its route, including Cardinal Orsini, who owned a large garden between Via Paolina and Via del Corso; some financial backers for the restoration; Maestri delle strade; and people closely related to them. Two nobles, Alessandro Grandi, who had provided financial support for the restoration in 1561 under Pius IV, and Horatio Nari, a member of the original aqueduct committee for the Roman Council, also received water gifts in April 1572. These may have been the only water donations made by Pius V, who died on 1 May 1572.[30]

Pope Gregory XIII ascended the papal throne on 13 May, and that same month a mason was contracted to build the channel to carry the last stretch of conduit down Via Paolina, a sparsely populated street that provided the most direct route to Piazza del Popolo, where it would serve the first civic fountain. The conduit had reached Piazza del Popolo by the end of 1572, and it seems likely that a temporary basin of some sort was available to receive the water while the civic fountain was under construction. Early the next year, Aloisius Lilius, a physician and an astronomer who at the time was devising his new plan to reform the calendar (what became known as the Gregorian Calendar in 1582) for the pope, received a water gift from Gregory.[31]

Nobles, cardinals, and other influential people who lived along one of the distribution routes could optimistically expect to acquire some of the water for personal use through purchase, as a gift from the Water Committee, or directly from the pope. Typically, a private connection required that the individual or community (such as a monastery) solicit the committee for an allotment; the committee would then decide whether the water would be sold or donated to the applicant, who then was issued a permit. As in antiquity, money collected from the water subscribers was used to defray costs, and in the case of the Vergine, the money was earmarked specifically for the construction of the new civic fountains, such as the one intended for Piazza del Popolo.[32]

By 1573 many more subscribers were receiving Vergine water. Among them were Dottore Diego Andrade, Vicenzo Compagno, and Francesco Bonviso, each of whom received small allotments for their residences on Via Santa Maria in Trinità from the main conduit that ran under that street—a street that was already being referred to as Via dei Condotti. In September 1573, the Hospital of Sant'Ambrogio on Piazza San Lorenzo in Lucina received half an oncia. And by November 1574, when a thousand terra-cotta pipes were being manufactured every month, water was flowing as far west as the Monastery of Santa Maria in Campo Marzio. Street by street, as fast as the terra-cotta pipes could be laid, the infusion of Vergine water was giving new life to the Campo Marzio as the major trunk lines were tapped for private fountains located in the buildings that flanked their routes. By February 1575, there were nearly thirty palaces, houses, and monasteries and two hospitals with private water supplies, in addition to temporary basins in Piazza del Popolo and Piazza Navona. These private fountains were located in the area bordered by the foot of the Pincian hill, Via della Ripetta, Piazza San Lorenzo in Lucina, and the Church of San Giacomo degli Spagnoli at Piazza Navona (fig. 3.15).[33]

By December 1575, water had penetrated even more deeply into the Campo Marzio, and the number

3.15 Documented Acqua Vergine allotments to private individuals, churches, and hospitals plotted on Etienne Du Pérac's 1577 map of Rome in the order in which they were approved between April 1572 and November 1575: the Hospital of San Giacomo degli Incurabili (1); the residences of Tommaso Manriquez (2), Cardinal Flavio Orsini (3), Alessandro Grandi (4), Luzio Gigli (5), Pasquino Querzetto (6), Diego Andrade, Francesco Bonviso, Vicenzo Compagno, Girolamo de Tarano, Sebastiano Caccino, Bartolomeo de Grisanti, Giovanni and Antonio de Mangoni, Pomponio Firmani, and Giulia Cervaria de Verallis (7), and Claudio de Valle, Orazio Rucelli, Cesare Cuneo, Alessandro Ponsiano, Pietro de Pelini de Biella, and Numa Pompilio Condopoli (8); the Hospital of Sant'Ambrogio (9); the residences of Alonzo Dinetti and Cesare Cuneo (10); the Church of Santa Maria in Campo Marzio (11); the residences of Bartolomeo Gritti, Ottavio Gracco, and Francesco Ruina (12), and Polido de Polidoro, Tiburzio de Pacifici and the Church of San Giacomo Spagnoli (13); the Church of San Luigi dei Francesi (14); the residences of Alessandro Cardelli, Marcello and Marc Antonio Ferro (15), and Orazio Bongiovanni, the Collegio Germanico, and the Church of San Agostino (16); and the residence of Camillo Capilupo (17). For 7 and 8, the precise locations of these water recipients cannot be determined and have been listed only as falling along a certain conduit. Where several names appear, all received water from the same fistola. By November 1575, at least eleven additional patents had been granted, but they are impossible to locate. The dashed line represents the route of the Acqua Vergine under the Pincian Hill (gray) and aboveground in the Campo Marzio (black) where it terminates at the Trevi Fountain. (Etienne Du Pérac, *Nova Urbis Romae Descriptio*, 1577, sheet 8)

of subscribers had nearly doubled. Conduits now stretched as far as the Church of San Luigi dei Francesi and Piazza della Rotonda to the east of Piazza Navona, and Piazza Cardelli (where Bartolomeo Gritti lived) to the northwest. By 1577, water had reached Palazzo Lancellotti ai Coronari, but these private concessions represented only about fifty oncie of the total supply. Nonetheless, this was an impressive quantity of water (about 993,600 liters per day) to be monitored and used, and several kilometers of public and private conduits to be maintained. The intricate nature of the distribution system is made clear in a diagram from the 1720s that lays out the pipelines for seventeen private subscribers who received Vergine water from a small bottino located in the garden of Cristoforo Cenci in the Campo Marzio (fig. 3.16).[34]

Also, any run-off water had to be dealt with on-site. Because of the low level of pressure, water would have been available only to courtyards and rooms on the ground floor and to basement *cantine* (storage and workrooms). Because water flowed constantly, measures needed to be taken to ensure that runoff did not flood the basements. This had profound implications for the further development of urban infrastructure, as it implies that a removal system for the overflow water from individual buildings—that is, a system of private drains that linked to public drains (which in turn were directed to the Tiber)—had to be installed at the same time.

Soon each property that received water was marked with a *cassetta idrometrica* (water meter), which was placed on its street facade, whose level varied from building to building depending on its elevation at grade. This device, invented by Monsignor Biscia (at the time presidente dell'Acqua Vergine), modulated water flow. Over time, some (perhaps all) buildings to which water was delivered also bore a *pietra di livello* ("stone of the level," an inscription) that indicated the source of the water, including both the name of the aqueduct and the specific castello, and sometimes, like the flood markers, the exact level of the water available in that location (fig. 3.17). The earliest extant record dates from 1602. It mentions another pietra di livello in the garden of Fabrizio Nari. This was the same property located at the foot of the Pincian Hill that was once owned by Horatio Nari, a member of the original aqueduct-restoration committee. The document mentions that the inscription was repositioned at the same time that the Acqua Vergine delivery pipe (the fistola) was reinstalled. Some nineteenth-century

3.16 Subscriber pipelines from a single Acqua Vergine juncture box, 1720s. Pipe "I" is made of both terra-cotta and lead, which indicates that it probably carried a larger quantity of water than the other pipes. ("Pianta della nova situatione fatta da Matteo Fontaniere, dentro al'Giardino del ill.o sig.e Cristoforo Cenci." Photograph: Mike O'Neill. Copyright MEON HDTV Productions, Ltd., 2009.)

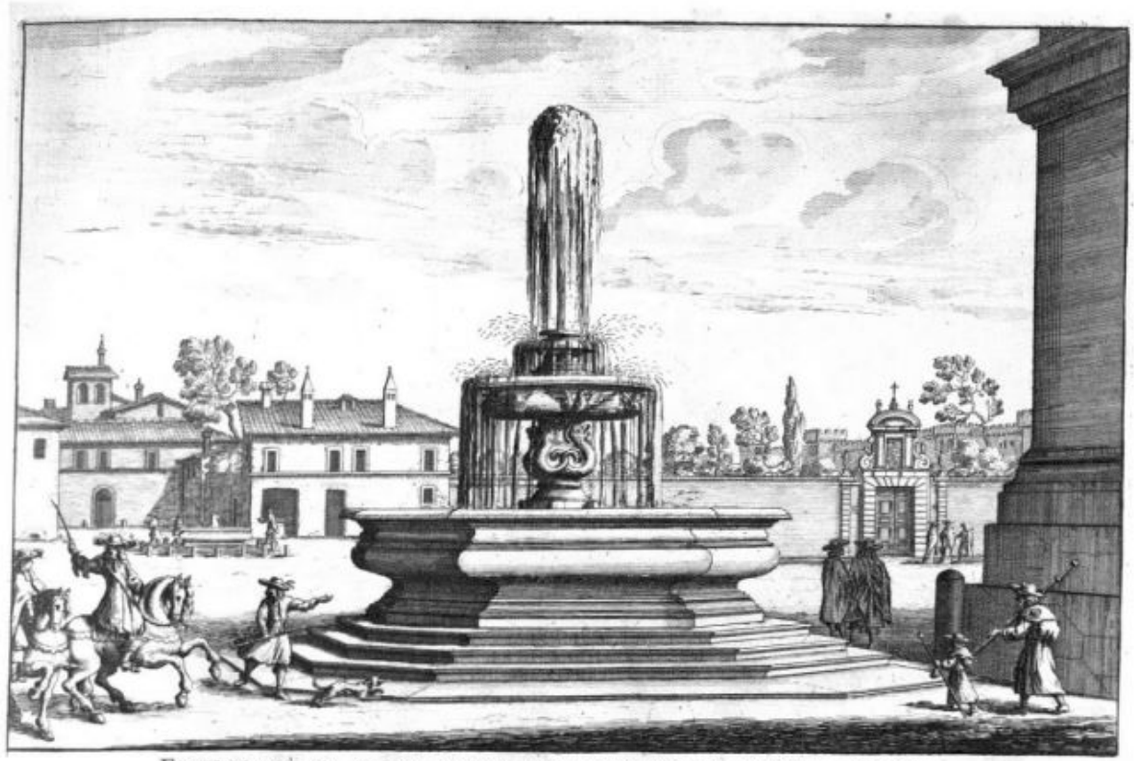
meters and a few of the inscriptions still survive, and from them it is possible to visualize how the water that was available to each building would have been constrained by the level of pressure it could attain. Although the water meters were a bit unsightly, they nonetheless could be seen as a mark of social status for they indicated that the owner could afford to purchase Vergine water for a private fountain or, more advantageously, had received it free from the Water Committee or pontiff. As private water conduits were typically carried under the entry portal to the palace (for easy maintenance) they often led straight ahead to a courtyard fountain, which could then be glimpsed, and admired, through the open door from the street.[35]

By 1583 (and perhaps sooner), it had become law that any distribution fistola must be placed at a specific level, defined as 15 oncie (oncia was a linear as well as a liquid measure), or 27.9 centimeters, below the level of the cassetta idrometrica, as dictated by the Water Committee. Thus, for example, if a courtyard, workshop, or kitchen fountain was designed to be the access point for the water, the precise level at which any spouts could be positioned could not be negotiated. While this restriction placed a restraint on the fountain designer, it was necessary in order to ensure that no spouts were inserted below that line, where pressure would be greater, which would illegally increase the flow of water.[36]

Thus, along with the boon of fresh water came the responsibility of being open to inspection by the Water Committee, which needed access to the meters from the public streets for maintenance and to monitor illegal use, which quickly became rampant. No organization or person was immune from scrutiny. Even monasteries were required to comply. Bottini and *cassette* were placed outside cloisters so that the committee could regulate them without violating the rules of cloistered life. Even cardinals and members of the nobility were discovered to be scofflaws, and sometimes graft ran in families. Both Girolamo and Alessandro Gabrieli were fined for water fraud: Girolamo because his garden fountain was drawing too much water in 1581, and Alessandro for tapping into the runoff from a public drinking fountain in 1584. Fines could be severe—as high as two thousand scudi and the loss of all water rights—but were generally limited to five hundred scudi for gentlemen, and three lashings for offenders beneath that rank.[37]

In 1575, by which time water was flowing to nearly fifty private fountains, the first civic fountain was finally inaugurated in Piazza del Popolo. Because the elevation of the piazza was only about five meters lower than the castello at San Sebastianello, the fountain was small—only four meters high. It was a rather modest yet elegant affair that would not have been out of place in any Italian Renaissance piazza. The lower basin, designed by Giacomo della Porta, had a deeply carved and fluid profile that would become a hallmark of his fountains. The basin was placed above the street level on three wide shallow steps, and a carved stone chalice, shaped rather like a goblet with a flat wide bowl, stood in the center of the basin. The chalice, in turn, was surmounted by a *pátera*, a kind of symbolic inverted ancient chalice (in this case without a stem) used for libations to the gods. In its center was a modest jet of water, which symbolically might have recalled the missing stem. A test must have been conducted to ensure that there was adequate water pressure available for a fountain in this important piazza. Nonetheless, it was determined in 1577 that the fountain was too tall to display Vergine water

3.17 The pietra di livello and nineteenth-century cassette idrometriche at Palazzo Muccioli at the intersection of Via Giulia and Via di Santa Caterina are still in situ.



FONTANA SV LA PIAZZA DELLA PORTA DEL POPOLO SOTTO LA GVGLIA
Architet^a del Cau. Domenico Fontana.

G.B. Falda del. et inc. G. Iac. Rossi le stampa in Roma alla pace co' pri. del S.P. 14

properly, which probably meant that the jet of water was not suitably impressive. In the autumn of that year the pátera was provided with a new, shorter pedestal, "in order to lower the fountain" (fig. 3.18). What had happened in the meantime? And why didn't Giacomo della Porta suffer the same fate for this design flaw—one that could be seen by anyone entering through the Porta del Popolo—as Guglielmo della Porta had in 1571 for his negligence with channels and pipes, or as Antonio Trevisi had in 1565 for fraud related to the aqueduct restoration?[38]

Two possible explanations have relevance, both for della Porta personally and for the fountain design. The Piazza del Popolo fountain drew about fifteen oncie for its own use, and, although more than fifty private subscribers and charitable institutions were receiving dedicated water supplies from the castello at San Sebastianello, there were originally no other civic fountains. As we saw, about fifty oncie of Vergine water were carried from the castello to these documented private subscribers. Even so, it would soon be discovered that many subscribers were illegally drawing additional water, thereby seriously diminishing the public supply. Then three additional civic fountains had begun drawing water (probably fifteen oncie each) from the same castello as the Piazza del Popolo fountain by 1576. Even if more water were diverted from the main specus into the channel at San Sebastianello for the new fountains, the level of available pressure in the castello would have been altered, perhaps reducing the already low level of pressure available to Piazza del Popolo.

It seems that it took several years to fine-tune the distribution strategy, and apparently it was not until 1583 that a plan finally evolved and was fully implemented to ensure that all fountains drew water at

3.18 The redesigned fountain at the Piazza del Popolo, seen with a new pedestal installed in 1577. While the proportions of the fountain are correct, it is shown vastly out of scale in relation to the people in the piazza. Such distortions were common at this time. (Giovanni Battista Falda, "La fontana di Piazza del Popolo," in Falda, *Le fontane di Roma* [Rome, 1675], 14. The Vincent Buonanno Collection.)

the same level in order to equalize pressure across the system. That plan described the level at which every access pipe was to be installed for public fountains and insisted that each pipe must be installed at a ninety-degree angle to the castello wall. Pipes or siphons that angled downward were specifically prohibited because they would draw off more water than their share, decreasing pressure throughout the entire system. By 1583 it had become clear that any new trunk lines would have to be linked to either a new basin at San Sebastianello or an entirely new castello since the structural integrity of any basin could be compromised by too many connections. A new, smaller castello and a fountain were built where the Acqua Vergine passed by Piazza del Bufalo, and some fountains, including the one in Piazza Colonna, were then supplied from it rather than from San Sebastianello. Apparently it was not until 1585, under Sixtus V, that any new Vergine fountains were authorized or new private allotments of Vergine water resumed.[39]

Rainfall, or lack thereof, may provide another reason for replacing the upper basin. It takes from four to six months for rainfall to percolate through the layers of volcanic soil that overlies the catchment area that feeds the Acqua Vergine springs, located more than thirty meters below ground at Salone. Perhaps the test for available pressure, which would have been made before the fountain was completed and certainly before it was unveiled, was conducted during a particularly wet year. It is possible that a dry rainy season in 1576–77 (typically from November to March) could have significantly lowered the distribution potential of the Vergine during the following summer, as there would have been less water to distribute. Any design would have to anticipate such conditions. Rather than negligence or fraud, della Porta's mistake was part of the natural process of equalizing the distribution system. Furthermore, the mistake, although public, in that anyone passing through the piazza could see that the water display was less than dazzling, was relatively easy and inexpensive to correct, unlike Trevisi's embezzlement or Guglielmo della Porta's faulty conduits.[40]

Between 1572 and 1575, Giacomo della Porta and his workshop were busy designing and carving fountains for Piazza del Popolo, Piazza Navona, Piazza della Rotonda, and Piazza Colonna. As each piazza stood at a different elevation and a different distance from the castello at San Sebastianello, the fountains could not be alike, as each would have specific requirements based on its location. It was the level at which the distribution pipes were placed in the side wall of San Sebastianello that would regulate how water could be displayed in each fountain. Piazza della Rotonda, which had the lowest elevation, had therefore the most advantageous site, which meant that a taller fountain could be placed there. This also meant that lower fountains would be necessary for the higher elevations at Piazza Navona and Piazza Colonna. Also, there might be enough available pressure in Piazza della Rotonda to give its fountain an impressive jet of water, while this would have been impossible in Piazza Navona or Piazza Colonna. The same principles would apply for all the other proposed Vergine fountains. The difficulties related to creating a display of water under conditions as variable as these become apparent only when we direct our attention to each individual fountain.

When della Porta first turned to this daunting task, his experience as a fountain designer was limited. But he quickly grew to appreciate water as a material that could actually shape fountain design (rather than simply respond to the container made for it), and as his understanding of the specifics of Campo Marzio topography and gravity-flow technology deepened, he emerged as a master of the form, unequalled for fifty years, until Gian Lorenzo Bernini transformed fountain design forever.