

VILLAS, HORTICULTURE AND IRRIGATION INFRASTRUCTURE IN THE TIBER VALLEY

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All wealth came from agriculture; all aristocrats were greedy; the consequence should be a proposition about aristocrats and agriculture which is more interesting and arresting than the caricature that they were stagnant gentlemen farmers

PURCELL 1995, p. 162

The South Etruria survey indicated that during the late Republic and the early/mid Imperial periods there was an extraordinarily dense concentration of settlement in the southern part of the survey area, closer to Rome; rural settlement became more intensive the further one moves southwards (Fig. 1)¹. It is clear that the proximity of Rome encouraged settlement here, and it is frequently assumed that farms and villas in this part of the Tiber Valley were engaged in growing flowers, fruit and vegetables to serve the markets of Rome, or in the lucrative practice of *pastio villatica* aimed at supplying the luxury food demand of Rome's elite². However likely this is, until now it has remained largely an assumption, supported in part by scattered literary references which relate more to the south and east of Rome, and by theoretical models predicting optimal land use around urban markets, such as Carandini's use of von Thünen's *Isolated State* model of agricultural location (Fig. 2)³. Von Thünen's model examines the influence of location relative to the market on production costs, transport, and possible profit. It argues that, other considerations being equal, perishable crops (fruit, vegetables, flowers), whose profitability declines rapidly with distance from the market, will be grown on land immediately surrounding urban centres, with the land further out given over to uses where the product's price in the market is more resilient to the effects of transport over greater distances (woodland, arable and ranching). Increasing market demand as a result of increasing urban population allows the zones of cultivation to extend, the higher transport costs being reflected in higher market prices.

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¹ POTTER 1979, figs 27 and 35.

² E.g. POTTER 1979, PURCELL 1995; MORLEY 1996, esp. pp. 58-63, 83-107.

³ E.g. flower growing around Rome: Varr. *rr.* I 16, 3; Cato *agr.* VIII 2. Models: VON THÜNEN 1826, (translated as VON THÜNEN 1966), discussed by CHISHOLM 1979, and applied to Rome by CARANDINI 1985, p. 66, followed by MORLEY 1996.

The model is attractive, and finds some support in the numerous ancient references to intensive horticulture and *pastio villatica*, the large-scale specialised production of luxury foods such as birds or edible dormice. But we know little about the physical landscape of such production. In Varro's satire on the villa (*r.r.* III 2, 1-17), the villa of M. Seius has neither the *urbana ornamenta* (statues, paintings, mosaics) of the luxury villa nor the *membra rustica* (farm equipment, presses and storage facilities) of the productive villa, because it is used for *pastio villatica*. How would we identify this activity in an excavation or field survey? Carandini stresses the archaeological invisibility of orchards and vegetable gardens, and Morley writes: 'Activities like horticulture and *pastio villatica*, prevalent in the sources, would leave few obvious traces for the archaeologist to identify, although the remains of fishponds and dormouse hutches have been found'⁴.

Rural cisterns and irrigated horticulture

There is however a body of evidence which can be used to ground this market-based analysis in the archaeology. The various South Etruria survey projects by the British School, together with the *Forma Italiae* and *Latium Vetust* surveys for the region, list a number of rural sites where evidence of irrigation infrastructure, probably for horticulture, can be deduced from the capacity and design of some of the cisterns⁵. Finding patterns in data from such surveys is an exercise fraught with pitfalls; not only are there the usual problems with interpreting data from surface survey (*e.g.* incompleteness of coverage, possibility of sampling bias, differences in ground visibility, uncertainty or imprecision in dating sites), but as these surveys were carried out by individuals, they are inevitably less complete than more intensive team surveys; they will have found fewer sites, and those sites are more likely to be biased towards the upper, more visible end of the settlement hierarchy⁶. Nevertheless, if we do not push the data too far, they can be very valuable. Here I am concerned chiefly to establish the existence of a particular phenomenon – a class of large cisterns associated with rural sites (usually villas), and to attempt to work out what purpose such cisterns served.

The *Forma Italiae*, *Latium Vetust* and South Etruria survey data do not always give dimensions of cisterns, but dimensions are available or can be estimated for 96 cisterns that seem to have been associated with farms or villas (table 1). Depth measurements are rarely available, and where these are lacking a water depth of 2 m has usually been assumed, based on the example of domestic cisterns from elsewhere. This is probably in many cases an under-estimate – the true figure may be nearer 2.5 m or 3 m for the larger rural cisterns; but I prefer to err on the side of caution. Any argument I establish on the assumption of a depth of 2 m would only be reinforced if the true depth were greater and the cistern capacity increased accordingly. Almost half of the cisterns in table 1 have capacities in the range 6-100 m³, and are probably rainwater catchment cisterns storing water principally for domestic uses; their capacities are similar to domestic cisterns in town houses at sites all over the Mediterranean (frequently 15 to 75 m³). In many cases these cisterns are underground and water must have been lifted out of them manually, implying relatively small-scale use. The cisterns in the range 100-170 m³ may also have supplied water chiefly

⁴ CARANDINI 1985, p. 71; MORLEY 1996, p. 102. For *gliraria* (jars in which edible dormice were fattened up), see CARONNA 1968; MESSINEO 1985, p. 151.

⁵ ANDREUSSI 1977; JONES 1962; 1963; KAHANE *et al.* 1968; MUZZIOLI 1980; OGILVIE 1965; QUILICI - QUILICI GIGLI 1980; 1986.

⁶ On the problems of interpreting such survey data, see for example THOMAS-WILSON 1994, p. 151 and n. 59; MORLEY 1996, pp. 95-97.

for domestic uses, at rural sites with somewhat larger populations, and perhaps have provided some water for animals as well.

But it is the group of 26 cisterns with capacities of over 200 m³ – even up to 700 m³ – that interests us here (Fig. 3). These cisterns are too large to have been fed by rain runoff from the roof of the main villa complex, and are in many cases either only semi-interred (terraced into a hillside - Fig. 4, Fig. 5) or completely freestanding (Fig. 6), sometimes at some distance from or uphill from the villa itself. They must therefore have been fed by some form of aqueduct or small-scale conduit, and indeed such means of supply have been traced in a number of instances (see below). Furthermore, in the case of the freestanding or above-ground cisterns, water need not have been lifted out of them; it could flow out through a ground-level exit, controlled probably by a stopcock⁷. In the context of urban aqueduct networks storage cisterns with capacities of several hundred m³ tend to be found on branches serving public baths, and in Rome they are also often associated with urban or suburban *horti*. In both cases they allowed a private user or a bath establishment, which might only be permitted to draw water from the aqueducts for a few set hours each day, to create a reserve for use during the hours in which water could not be drawn from the aqueduct. Water-demanding activities like bathing or the irrigation of flower and vegetable gardens (*horti*) could therefore operate without making continuous demands on the aqueduct system. Most of the cisterns of the Tiber Valley villas, though, were not fed from the Rome city aqueducts; although it is possible that one or two were fed from shared aqueduct systems or aqueducts for local towns (see below)⁸, in most cases we seem to be dealing with a simple small-scale aqueduct feeding a single estate. The question of water scheduling does not therefore arise. Presumably, therefore, these cisterns were intended to store water arriving through the aqueduct in a period when water was not being used, to make more available during a period of use than the aqueduct would normally provide. The most obvious way in which this might work is if water was normally used during the day but not at night, when the cistern would fill up; the full 24-hour delivery of the aqueduct would then become available for, say, a 12-hour period of daytime use, effectively doubling the usable capacity of the aqueduct.

The two main purposes that might require several hundred cubic metres of water per day, as the capacity of these rural cisterns seems to imply, are bathing and irrigation. Baths became common in villas of the imperial period, and the role of bathing facilities as providing the essential features of urban culture in the rural setting of the villa is well brought out by an inscription from a villa on the Via Nomentana 8 miles from Rome, near Ficulea (*CIL* XIV 4015). The text, carved on a marble slab in large but careless lettering, reads:

In [hi]s praedis Aure/liae Faustinianae / balineus lavat mo/re urbico et omnis / humanitas praest/itur

‘In these estates of Aurelia Faustiana the bath washes [you] in the urban fashion and all the trappings of civilization are provided’⁹.

But while there is no denying the importance of villa bath suites, or their need for water, the capacity figures of the larger cisterns seem excessive even for baths – at least, for bath suites even in luxury rural villas, although some of the larger *thermae* of the city of

⁷ For urban parallels of storage reservoir cisterns with outflow controlled by stopcocks, see WILSON 2001.

⁸ THOMAS-WILSON 1994; WILSON 1999.

⁹ *CIL* proposes reading *lavat(ur)* in l. 3, but this seems unnecessary.

Rome could easily have consumed several times those quantities. The needs of a bath suite would vary according to whether water flowed into the pools continuously, and continuously overflowed from them, or whether the pools were filled and emptied at intervals. This is partly a function of the number of users of the bath. In urban contexts both modes of operation can be demonstrated, with continuous inflow and overflow apparently being normal for the larger baths and imperial *thermae*, and periodic changing of the water customary for smaller and medium sized baths¹⁰. Villa baths, with fewer users than urban public baths, are more likely to have been filled as and when required. A bath suite with three pools, each of 6 m³ (3 by 2 by 1 m deep) would require 72 m³ if filled and emptied four times per day (surely an excessive number of times for baths serving an extended family plus occasional guests; slaves and rustic staff may not have bathed daily); but even allowing extra water for sluicing down floors and cleaning the pools, it is difficult to envisage them requiring several hundred cubic metres per day. It would seem, therefore, that although the large rural cisterns of the Tiber Valley may well have supplied baths as one of their functions, that can hardly have been their sole purpose.

We are thus led to the conclusion that their chief purpose was for irrigation, just as one might suspect from the association of such cisterns with *horti* in an urban or suburban context at Rome. This view is supported by the fact that many of these large cisterns are built above ground, or partly interred if built into a hillside or slope, so that outflow from the base of the cistern could be run onto cultivable land (*e.g.* site 35 in the Crustumerium area)¹¹. A number of the larger cisterns seem to have been uncovered, as there are no dividing walls or piers to support vaults, and the span is too wide to have been roofed by a single vault. An example is Vicus Matrini Site 162, where an above-ground cistern was originally built as an open reservoir (Fig. 7); only in a subsequent phase was it provided with a double barrel vault, supported on an arcaded partition wall in *opus reticulatum* (Fig. 8, Fig. 9). Such open reservoirs could have been used for almost nothing except irrigation, as the water, exposed to the sunlight, would have quickly grown algae and bred insects, rendering it unwholesome for drinking or bathing in.

In an earlier study, R. Thomas and I presented an analysis of ancient irrigation requirements for the Rome region which showed that it was unlikely that there was major irrigation of grains and olives in the area; vines may have been irrigated on a small scale, but the main irrigation requirements would have been for fruit trees, vegetable gardens, and flowers¹². These are relatively high-value crops, in terms of profit per area of land required to grow them, and vegetables, flowers and fruit are precisely the sort of crops that would have had to be grown within a restricted distance of Rome, owing to their perishability, but for which there would have been a ready urban market. We calculated that, on the basis of 200 mm per month required for vegetables, a daily storage reservoir of 72 m³ would be required allow for the irrigation of one hectare of vegetables during a 12-hour day¹³. Rural cisterns of several hundred cubic metres, fed by an aqueduct and providing overnight storage, could therefore allow the irrigation of a few hectares of vegetables, flowers or fruit trees (or a mixture) – the *hortus irriguus* of Cato *agr.* I 7 – as well as perhaps supplying villa baths in some cases.

Two inscriptions from the Ager Capenas seem to confirm this interpretation of the rural cisterns, listing both baths and (irrigable?) land or flower gardens and vineyards in

¹⁰ WILSON 1997, pp. 119-128.

¹¹ QUILICI - QUILICI GIGLI 1980, pp. 205-6; tavv. LXXIV-LXXV.

¹² THOMAS-WILSON 1994, pp. 158-162.

¹³ THOMAS-WILSON 1994, p. 159, table 4.

connection with aqueducts or cisterns. Both come from tomb plots apparently associated with villas, and illustrate the relationship between tombs, ornamental *horti* and productive gardens.¹⁴ The first, from the slopes of Mt Soracte, details the parts of a villa estate that are considered to form part of a funerary monument; a rose garden, little vineyard and yard (or possibly seed bed – *area*) are apparently in proximity to a pool or fishpond (*piscina*), and channel or conduit (*canalis*) and buildings, storehouse and cisterns (*CIL* XI.3895):

Lictoriae Chaerusaë vixit annis XV / mensibus VII diebus V fecer(unt) L. Veturius Pudens / vir et Larcia Aucta mater. huic monumento / cedit rosarium cum viniola (et) sola(rio) suo, fine viniae, / et e region(e) piscinae et canalīs usque ad ariam, et area cum (a)edificiis et horreo, et cisternae in solar(io) et e regione eius usque <at> ad arundinetum cum itin(eribus) qu(a)e sunt determinata; et collige iug(erum).

‘To Lictoria Chaerusa, who lived 15 years 7 months and 5 days, Lucius Veturius Pudens, her husband, and Larcia Aucta, her mother [made this]. To this monument belongs the rose garden with the little vineyard and its sun terrace, the boundary of the vineyard, and from the area of the pool and channel up to the yard, and the yard with buildings and the granary, and the cisterns on the sun terrace and from the area of it as far as the reed bed with the paths that are marked out; in total, one *iugerum*’.

The exact provenance of this inscription is uncertain, but a possible candidate is the Giardino villa (site 217 in Jones’ Ager Capenas survey), the largest villa on the slopes of Mt Soracte. If the Giardino villa was not itself the source of this inscription, its physical remains give a very good idea of the kind of arrangement indicated by the text (Fig. 10). The ruins occupy a series of three terraces on the Giardino spur at the SE end of Mt Soracte; surface finds indicate that the villa may have been built in the first century A.D., with modifications and additions in the second century.¹⁵ The upper and middle terraces are divided by a long cistern (63.50 m long × 4.90 m wide), whose capacity must have been at least *c.* 625 m³ (assuming a water depth of only 2 m); perhaps over 700 m³ (with a depth of 2.5 m). In its original phase this cistern may have been unroofed, as its division into smaller communicating units by means of brick arches appears to be a secondary feature. Along the SE side of the middle terrace was another large cistern, with a capacity of at least 175 m³ (but perhaps as much as 330 m³)¹⁶, and later subdivided into two, and a rectangular structure at the W end of this may have been a distribution or tap chamber, controlling the outflow of water onto the lower terrace. Also on the lower terrace is another group of cisterns, on a different alignment and probably representing a later addition. On the upper terrace remains of a mosaic floor and a hypocausted room indicate the residential part of the villa, apparently equipped with baths – but these lie above all of the cisterns just described and could not have been supplied from them. The cisterns must therefore have served to provide water to the middle terrace (1600 m²) and the lower terrace (9600 m²), a total area of *c.* 1.2 ha (*c.* 4.7 *iugera*), which would have been suitable for flower and vegetable gardens, and a small vineyard¹⁷. Fruit trees could have been planted on the slopes below the

¹⁴ For such productive tomb plots, see PURCELL 1987, esp. pp. 35-36; 1995, 157; MORLEY 1996, pp. 94-95.

¹⁵ JONES 1962, pp. 183-185.

¹⁶ Assuming a water depth of only 2 m. JONES 1962, 185 gives the width as 4.37 m; his plan (fig. 19) shows the length as at least 20 m, but if it continued to join the first group of cisterns as Jones suggests the length would be *c.* 38 m. The true capacity may therefore be much larger.

¹⁷ The middle terrace measured 40 x 40 m. The lower terrace measured 140 x 80 m less the area of the middle terrace, which occupies its SE corner.

terraces to the south, and below the lower terrace, watered by the cisterns on the south side of the middle terrace, and the cisterns of the second phase.

At another site, also from Mt Soracte, the dedication of a mausoleum associates the monument also with baths, adjoining buildings, an aqueduct and four iugera of land (CIL XI 3932 = ILS 5770)¹⁸:

T. Flavio T. f. Quir. Flaviano / aedili, quaestori designato / municipio Capenae foederato / T. Flavius Aug(usti) lib(ertus) Mythus et / Flavia Diogis parentes filio piissimo / fecerunt et sibi et suis libertis libertabusq(ue) / utriusque sexus posterisque eorum / cum balineo et aedificis quae sunt iuncta / ex utraque parte secus viam cum aquae / ductu ex fundo Cutuleniano et iugera / agri Cutuleniani p(lus) m(inus) III ita ut depalatum est. / H(oc) m(onumentum) h(eredi) n(on) s(equitur).

‘To Titus Flavius Flavianus, son of Titus, of the Quirinus tribe, aedile, quaestor designate for the federate town of Capena. Titus Flavius Mythus, freedman of the emperor, and Flavia Diogis, his parents, made this for their most dutiful son, and for themselves and their freedmen and freedwomen of both sexes and their children, with the bathhouse and the buildings which are joined to it, on both sides alongside the road, with the aqueduct from the Cutulenian estate and about 4 iugera of the Cutulenian land as it has been staked out. This monument does not pass to the heir’.

The artificial water supply arrangements referred to in both inscriptions seem to have served irrigation works and baths; as we might expect in the world of the Roman villa, investment in wealth creation, and in the luxury enjoyment of that wealth, go hand in hand. If both *pastio villatica* and profit-oriented viticulture entailed an element of display¹⁹, a programmatic statement about the owner’s scale of investment and strategies for wealth creation²⁰, so too did intensive horticulture and flower growing. The residential section of the Giardino villa commanded views over its irrigated terraces; and doubtless the terraced gardens of the first of the two inscriptions just discussed were simultaneously for the enjoyment of the owner, for impressing visitors, and for productive sale.

The distribution of large rural cisterns in relation to communications routes and villa settlement in generally is shown in Fig. 11. This map is only as good as the data on which it is based, and these vary greatly in quality across the area, as some regional surveys were much more diligent in recording cistern capacity than were others. As a result, some large cisterns are not represented on the distribution map because capacity figures for them were not available. The map thus represents a minimum picture of the distribution of large cisterns, not a complete picture. Nevertheless, two main points emerge. The first is that much of the distribution of large rural cisterns conforms to Von Thünen’s model – there is the expected clustering close to Rome (around Fidenae and Crustumerium), and up the Tiber corridor where cheap riverine transport extends the highest economic rent band northwards along the river valley. The grouping of large cisterns in the right-hand part of the figure (essentially, east of a north-south line drawn through the middle of Rome) therefore more or less corresponds to the distribution one would expect for irrigated horticulture aimed at the urban market.

¹⁸ Recorded in the church of S. Oreste, near Capena.

¹⁹ On the production of wine in the Roman suburbium in general, and the Nomentanum region in particular, see PURCELL 1985, especially pp. 4-5 and 17-19.

²⁰ PURCELL 1995, pp. 153-154.

The second point, though, is that the area north of Lago Bracciano, around Vicus Matrini, seems to have a much higher concentration of large and very large cisterns than one would expect from this model. This area lies some 40 km as the crow flies from Rome, and in fact a little more along the Via Cassia up through Sutrium. This is further than one might expect for the overland transport of perishables such as fruit, flowers and vegetables, although not impossible. Several potential explanations might be put forward:

1. The higher density of large cisterns in this area than elsewhere is more apparent than real. Certainly Andreussi's *Forma Italiae* survey for the Vicus Matrini region more regularly records cistern dimensions than do many other surveys, and may therefore exaggerate the apparent contrast between this region and others. It is possible that a similar pattern of cisterns also appears closer to Rome, but has not been so systematically recorded. If this were the case, and the cisterns in this area were simply a better-recorded extension of a phenomenon also found closer to Rome, it would imply that the market demand generated by Rome was such as to push the prices for irrigated products up to the point where economic rents made it viable to transport them from 40 km away overland.

Alternatively, the difference between the Vicus Matrini region and others is real, and is to be explained by some special feature of this region, such as either:

2. This region's access to coastal transport through harbours such as Civitavecchia, especially after Trajan's improvements to the harbour there. But this area is still some 35 km from the coast, nearly as far as from Rome, and some of these cisterns (e.g. Vicus Matrini site 162) seem to date back to the Republican period.

or:

3. These cisterns supported irrigated horticulture for markets in the Vicus Matrini/Sutrium region, such as Sutrium itself and the aggregate market formed by the fairly numerous villas in this area. The difficulty with this hypothesis is that one would have expected the same phenomenon to have operated even more intensively around Veii, and there is little sign of this.

or:

4. Instead, it is possible that this area was engaged in the production of something that required irrigation but withstood long-distance transport better, and thus had an economic rent allowing production at a greater distance from the market. Wine production on the volcanic soils around the crater lakes of this region is a possibility.

5. Finally, these cisterns may not be for irrigation at all but may have served baths and water displays in luxury residential villas. The problem with this explanation is the presence of cisterns such as Vicus Matrini site 162, whose unroofed early phase and whose topographic location and lack of close association with baths or other high-status villa remains strongly suggests an agricultural purpose.

On balance, explanation 4 is perhaps the most attractive of these hypotheses, but more work is required on the Vicus Matrini region.

Although it is not possible to present precise figures for the density of such irrigation cisterns in different regions, as capacity data are often incomplete and the surveys used here for collating data on cistern sizes are not always closely comparable with each other (owing to differences in diligence of compilation), or with more intensive field surveys in other parts of Italy, it nevertheless seems that the number of large storage cisterns at rural sites in the Tiber Valley area is comparable to much of the rest of Latium to the south and east of Rome²¹, but is abnormally high compared to the rest of Italy or indeed the empire. There is nothing like such a degree of investment in structures for rural water supply in areas of west central Italy such as the Biferno or Sangro Valleys, or even in the large slave villa estates of the Ager Cosanus, which seem to have cultivated crops requiring less irrigation. Outside Italy, relatively few areas seem to have had such a density of rural hydraulic structures; only parts of Spain and Africa Proconsularis, such as the region around Dougga in the Tunisian Tell, seem to come close in terms of rural aqueducts, though not perhaps for cisterns for irrigated horticulture²².

We can conclude, therefore, that the existence of numerous large above-ground cisterns in the Tiber Valley area, and also in the areas to the south and east of Rome, is an archaeological indicator of intensive market gardening, and in some cases perhaps also viticulture, much of it probably destined for the markets of Rome.

Rural aqueduct systems

As already noted, the capacity, location, and often the above-ground construction, of many of the large rural cisterns demands some artificial source of external supply, and numerous traces of small rural aqueduct systems have been identified. These either supplied a single villa or farmstead, or in some cases may have formed part of a system supplying several estates²³.

One of the most common types of such aqueduct is the underground 'cuniculo' – a generic term for a rock-cut tunnel, and employed in the *Forma Italiae* surveys used here to mean either a drainage cuniculus, of the type dug by the Etruscans to divert streams and drain valleys²⁴, or an underground rock-cut tunnel cistern, or – as considered here – a tunnel intended for water supply rather than drainage, perhaps tapping an aquifer towards its upstream end, and lined with *opus signinum* further downstream to prevent water loss by seepage en route. At Settebagni (Crustumerium Site 35) a vaulted underground cistern, containing some 230 m³, was fed by two barrel vaulted cuniculi 0.90 m wide, one short and unfinished, the other of uncertain length and now walled up²⁵. Although the roof of the cistern was some 6 m underground, there was lower-lying ground to the south where the rock face has now fallen away, destroying the south end of the cistern, and the cistern could therefore have irrigated land downhill, towards the fosso di Settebagni²⁶. At Fidenae site 81 two converging cuniculi, lined with *opus signinum*, exposed by quarrying below a villa site, were probably for water supply rather than drainage, while at Fidenae site 157 two converging vaulted cuniculi, for water collection, were probably connected with a small

²¹ Cf. THOMAS-WILSON 1994.

²² North Africa: CARTON 1896a; CARTON 1896b; CARTON 1896c; CARTON 1897; CARTON 1903; BARBERY-DELHOUME 1982. Spain: DUPRÉ 1997.

²³ THOMAS-WILSON 1994, pp. 146-150.

²⁴ See e.g. JUDSON-KAHANE 1963.

²⁵ QUILICI - QUILICI GIGLI 1980, pp. 205-206. Length: > 18.3 m; width 7.48 m, height to spring of vault 1.70 m.

²⁶ QUILICI - QUILICI GIGLI 1980, tav. LXXIII.

villa downhill²⁷. At site 257 in the *Vicus Matrini* area a shaft (90 cm diameter) is said to give access to two cuniculi, of which one leads to the cistern (c. 80 m³) at site 256, some 50 m to the east²⁸.

Built aqueducts, rather than tunnels, are also found: south of Lago di Vico a sizeable aqueduct, with a concrete *specus* (0.54 m wide by over 1 m high) lined with *opus signinum*, is visible for some 117 m, standing to a height of up to 2.30 m above ground level. It was probably connected with the villa at Vicus Matrini site 228, where a cuniculus may be a continuation of it, and the buildings include a large cistern 24 m long by 3.5 m wide²⁹. Another concrete aqueduct in the Vicus Matrini area (site 252), internally accessible for 250 m, has been thought to be the aqueduct for the settlement of Vicus Matrini on the Via Cassia, mentioned in an inscription (CIL XI 3322: *[Au]gusta Iuli[a] [a]quam vicanis* – ‘Augusta Iulia [provided] water for the villagers’); it may also have connected with a cuniculus feeding a cistern at site 177³⁰. Also in the area south of Lago di Vico, at La Casaletta, Cozza and Pasqui in the 19th century noted an aqueduct and other hydraulic structures, which Andreussi was unable to find; these were probably also part of a villa aqueduct³¹.

Just to the south of the Ager Capenas, the modern Autostrada del Sole cut through a small aqueduct consisting of a concrete wall with a U-shaped channel, lined with *opus signinum* and covered with tiles; it supplied a large site near the farm at I Casini (Fig. 12)³². Stretches of built channel conduits (‘condotto idraulico in muratura’) were noted at Fidenae Site 141, a late Republican/early Imperial villa rustica with a cistern, and also at Fidenae Site 146, a villa with a circular cistern³³.

From a villa site at Vicus Matrini site 102 comes a sandstone block in two pieces (total length 1.10 m, height 32 cm, width 20 cm), with a channel cut in upper side, 8 cm wide and 10 cm deep, and an Etruscan inscription on both long sides and two Etruscan letters on one short side. The extremity has traces of *opus signinum*. It seems originally to have belonged to an Etruscan monument and Andreussi suggests it was re-used as a channel block in a Roman fountain. It was found at the mouth of a conduit which came from the slopes of Monte S. Elia and which is still in part used³⁴.

To the east and south-east of Rome there is plentiful evidence for the supply of villas by derivations from the major urban aqueducts³⁵. In the region here under discussion an inscription from near Casale di Galeria on the via Clodia, 15 miles from Porta del Popolo, refers to a derivation from the Aqua Augusta (Aqua Alsietina) called the Forma Mentis CIL VI 31566 = XI 3772a (ILS 5796):

[Imp. Caesar divi f.] / Augustus / [p]ontif(ex) max(imus) / [for]mam Mentis attrib / [r]ivo Aquae Augustae / [q]uae pervenit in / Nemus Caesarum / ex eo rivalibus qui / [b]uccinam accipieb[...]

²⁷ QUILICI - QUILICI GIGLI 1986, pp. 219, 261.

²⁸ ANDREUSSI 1977, p. 94.

²⁹ DUNCAN 1958, pp. 102-103; ANDREUSSI 1977, p. 88.

³⁰ ANDREUSSI 1977, 7pp. 0, 93. The dimensions of the aqueduct channel are given as 1.70 m wide (externally?), and 1.90 m high internally.

³¹ GAMURRINI *et al.* 1972, p. 175, no. 127; ANDREUSSI 1977, p. 90 site 236.

³² JONES 1963, p. 145. The channel measured 0.235 m wide by 0.36 m high.

³³ QUILICI - QUILICI GIGLI 1986, pp. 249, 251 and n. 424. No dimensions are given for the cisterns.

³⁴ ANDREUSSI 1977, p. 44.

³⁵ THOMAS-WILSON 1994; WILSON 1999.

‘[The Emperor Caesar son of the deified (Caesar)] Augustus, pontifex maximus, added the forma Mentis to the channel of the Aqua Augusta which terminates at the Grove of the Caesars, from it to the neighbouring properties which used to receive [water?] at the trumpet signal [...]’

The inscription had been reused as the cover of a conduit coming from Lago Bracciano; possibly this conduit was the Forma Mentis, if the re-use of the inscription relates to a repair rather than the original construction. The purpose of the derivation was evidently the supply of rural users, the *rivalibus* of the inscription; and given Frontinus’ explicit statement that the water of the Aqua Alsietina (or Augusta) was of such poor quality that it was not used for consumption but, after the filling of the Naumachia, the surplus was devoted to irrigation³⁶, irrigation is here the most likely use. The reference to a trumpet signal probably relates to a system of water scheduling, by which users of the irrigation system were allowed to draw water at set times³⁷.

A water system of this nature is depicted on Fabretti’s drawing of an inscription, now lost, which he saw in the church of S. Maria on the Aventine (Fig. 13). It shows one or two aqueducts or watercourses, with several adjacent properties. For each property is given the name of the estate, the name of the owner, the number of water connections (*aquae*) which that property has, and (usually) the hours during which the estate may draw water from the system. In the case where no time limit is given, it is assumed that the right to draw water is continuous. The plan may represent either one channel, snaking across the preserved part of the plan and appearing at both the top and bottom, or two separate but approximately parallel channels. The fork in the lower right-hand part of the inscription may represent either a division of the channel into branches, or a confluence of tributaries; we do not know in which direction the water flowed. The hours for drawing water suggest a rotation or turn between neighbouring properties; the word *pridie* towards the bottom of the inscription may indicate that the turn runs across more than one day.

Divisions between estates seem to be indicated by breaks in the line representing the channel. The estates of both Thyrsus and Hymetius have symbols connected to the channel line which seem to represent cisterns; these would allow a reserve to be accumulated during the hours of drawing water, which could then be used while the estate was ‘off-line’.

The entries seem to translate as follows:

(Top course)

‘[To the] Squaterian estate of C. Iulius [...] freedman of Caesar [and] C. Bicoleius Rufus, one water connection’

‘To the Ac[...]estate of] M. Vibi[us ... , ...] water connections’

(Bottom course)

‘To the [?]...]quartan estate of [...] Thyrsus, freedman of Augustus, twelve water connections [from the seco]nd [hour] to the [...] hour’

³⁶ Frontin. *de aq.* I 11.

³⁷ THOMAS-WILSON 1994, p. 147; for shared systems see also WILSON 1999.

‘the day before’

‘To the Aufidian estate of C. Iulius Hymetius, two water connections from the second hour to the sixth hour’

‘[To the ...estate] of C. Iulius [...] freedman of Caesar [and] C. Bicoleius [Rufus, ...] water connections from the sixth [hour until sun]set’

The names of the landowners give a clue to the date. C. Iulius [...] who jointly holds two different estates with C. Bicoleius Rufus, is a freedman of Julius Caesar; Thyrsus is a freedman of Augustus. C. Iulius Hymetius is probably the son of a freedman of Caesar, given his praenomen and nomen combined with a Greek cognomen. We can therefore fix the date of the inscription after 27 B.C. (from the mention of Augustus), but within the lifetime of Caesar’s freedmen. If C. Iulius [...] was manumitted in Caesar’s will as a young man in 44 B.C., he is unlikely to have lived long beyond the end of the reign of Augustus; we can therefore date the inscription between 27 B.C. and the early Tiberian period at the latest.

The location where Fabretti saw the inscription, on the Aventine, is not a great help in determining to which aqueduct it might refer, as by the Augustan period the Aventine was heavily built-up, an unlikely location for estates of the kind marked on the plan. It is more likely that the inscription had been brought there from elsewhere, perhaps even from across the Tiber. The Augustan or early Tiberian dating helps narrow down the possibilities: *if* it refers to one of the known urban aqueducts (and not to an otherwise unknown rural system), the chief candidates are the Marcia/Tepula/Julia lines, possibly the Aqua Virgo (although this largely ran underground in the vicinity of Rome), or the Aqua Alsietina. (The Aqua Appia and the Anio Vetus run underground for most of their course in the suburbium, so are unlikely contenders.) Of these, the Alsietina is an attractive possibility, given its Augustan date and its use principally for irrigation – indeed, the system shown here would seem to have close similarities with the type of arrangement implied by the Forma Mens/Aqua Augusta inscription discussed above.

Much simpler rural systems, consisting of terracotta pipes, are also found; in enclosed pipe systems, the gradient does not have to be kept so level as in an open channel conduit, and the course of the aqueduct may rise and fall, providing of course that it never rises as high as the start of the pipeline. This makes surveying the course of the aqueduct simpler, as the gradient does not have to be measured so precisely. Such a pipeline has been found at Vicus Matrini site 227, an area of ruins and sherds (ARS A, C and D), as two stretches (35 m apart) of a water conduit made of terracotta pipes encased in a concrete jacket. At one point three pipes, socketed into each other, could be seen³⁸. The concrete jacket for the pipes may suggest that the water ran under some pressure.

On Monte Sacro near the Ponte Nomentano over the Aniene (Fidenae Site 212) a large villa was fed by several forms of water supply arrangements. An aqueduct, consisting of two parallel walls 0.70 m apart, with *opus signinum* between them, was traced for some 14 m, directly below the site of the villa. Lanciani noted a nymphaeum near the river Aniene, fed by four conduits, probably connected with the aqueduct³⁹. On top of the hill there was a cistern with 2 chambers, each 15.5 x 3.5 m, or a total capacity of c. 110 m³ if the water

³⁸ ANDREUSSI 1977, p. 86: ‘una condotta costituita da una fistula di terracotta e da un rivestimento in opera cementizia’.

³⁹ QUILICI - QUILICI GIGLI 1986, pp. 310-312.

depth was *c.* 2 m. Elsewhere on the site, some 300 m from the Ponte Nomentano, two cuniculi excavated in the bedrock and lined with *opus signinum* seem to have fed a small rectangular brick cistern⁴⁰. A channel with walls built of squared tufa blocks laid on a rock-cut floor may have been a drain. Four terracotta pipes were also found at the site⁴¹.

Lead pipes, many of them stamped, have been found at numerous rural villa sites, again implying a flowing water supply, even under pressure⁴². To judge from parallels in urban water supply systems, lead pipes were probably used chiefly for derivations distributing water from a built conduit or a distribution tank, rather than for the main longer-distance conduit from spring to destination (except in so-called 'inverted siphons', where the aqueduct crossed a depression in a U-shaped pipeline). As with the lead pipes found in the city of Rome, many are inscribed, but the majority of the inscriptions refer to the maker of the pipe, giving a name followed by *fec(it)*, rather than the user of the water as is normal in Rome. Perhaps the reason for this is that in Rome the stamp on the pipe served to distinguish which or whose property was served by one of many branches in a shared network, whereas on a self-contained rural system, which may have been entirely within the bounds of a single estate, there was no such need to distinguish between different users.

Clearly the rural aqueducts that might be built to supply a villa spanned a range from the simple to the elaborate. But the expense involved was not determined simply by the construction type adopted; if there was no spring or water source on the proprietor's own property, he or she would need to buy up land along the route from the source. This is well illustrated by an inscription from Aquae Passeris near Viterbo on the Via Cassia 9 miles from Forum Cassi, a little to the north of the main area under consideration here. The inscription records the construction of a rural aqueduct by a private individual, and was built into the aqueduct at the spring (CIL XI 3003 a, b = ILS 5771)⁴³:

Mummius Niger / Valerius Vegetus consular. / aquam suam Vegetianam, quae / nascitur in fundo Antoniano / maiore P. Tulli Varronis cum eo loco, / in quo is fons est emancipatus, duxi[t] / per millia passuum VDCCCCL in vil/ lam suam Calvisianam, quae est / ad aquas Passerianas suas, compara/ tis et emancipatis sibi locis itineri/ busque eius aquae a possessoribus / sui cuiusque fundi, per quae aqua /

⁴⁰ The cistern measured 7 x 1.22 x 0.9 to spring of vault; capacity 7.7 m³. The cuniculi measured 2 m high by 1 m wide, and 1.80 m high by 0.90 m wide (QUILICI - QUILICI GIGLI 1986, p. 313 nn. 737-8).

⁴¹ QUILICI - QUILICI GIGLI 1986, pp. 313, 316.

⁴² E.g. CIL XI.3816 (imperial villa near Veii): *P. Septimi Getae. CIL XI 7453* (near Viterbo): \ IRENF FEC. CIL XIV 4000 (Marco Simone, Latium): *V. COPONIVS . ORN . S. FEC. CIL XIV.4000a* (Marco Simone, Latium): *I. ERLNM (?) S LVCRLANVS FEC. Vicus Matrini* site 98 (ANDREUSSI 1977, pp. 40-41; PARIBONI 1913), a villa at Pecugliario excavated in 1912-13; baths seem to have been added at a later stage, and there are lead pipes with the inscription *P. Clodius Venerandus fec(it)*. Crustumerium site 123 (QUILICI - QUILICI GIGLI 1980, p. 268 n. 432 and tav. CII.2): a late Republican/early Imperial villa rustica, with fragments of lead pipe (diam. 4.4 x 8 cm), with stamp (reversed) *Q.P.P.P.* Fidenae site 91 (QUILICI - QUILICI GIGLI 1986, p. 224): a late Republican/early Imperial villa, with unstamped lead pipe (int. diam. 4.5-5 cm, thickness 0.7 cm). Fidenae site 236 (QUILICI - QUILICI GIGLI 1986, 339): lead pipe with inscription *Arrelins Agathangelus fecit* (CIL XV 7600). Fidenae site 275 (QUILICI - QUILICI GIGLI 1986, pp. 358-359): 19th-century excavations produced two lead pipes with stamps *Iuli Euctacti*, a third of [...]MAECIL[...] and perhaps a fourth *P. Fabius Abascantus fec(it)* (CIL XIV 4018). LANCIANI 1880, p. 270 nos. 433-435. Two pipes from le Vittorie, near Ficulea: CIL XIV 4016, *L. Funisu Vettoniani*, and (two stamps on the same pipe) CIL XIV 4017a: *Q. Servili Pudentis* and 4017b: *Ti. Claudius Phoenix fec(it)*. For other stamped lead pipes found outside Rome, see LANCIANI 1880, pp. 240-75.

⁴³ Cf. LANCIANI 1880, pp. 378-379.

s(upra) s(cripta) ducta est, per latitudinem structu/ris pedes decem, fistulis per latitudi/nem pedes sex, per fundos Antonian(um) / maiorem et Antonianum minor(em) / P. Tulli Varronis et Baebianum et / Philinianum Avilei Commodi / et Petronianum P. Tulli Varronis / et Volsonianum Herreni Polybi / et Fundanianum Caetenni Proculi / et Cutilonianum Corneli Latini / et Serranum inferiorem Quintili / Verecundi et Capitonianum Pistrani / Celsi et per crepidinem sinisterior(em) / viae publicae Ferentenses et Scirpi/anum Pistraniae Lepidae et per viam / Cassiam in villam Calvisianam suam, / item per vias limitesque publicos / ex permissu s(enatus) c(onsulto).

‘Mummius Niger Valerius Vegetus, of consular rank, brought his Vegetian aqueduct, which has its origin in the larger Antonian estate of Publius Tullius Varro, having acquired that place in which the spring is, for 5950 paces to his Calvisian villa, which is at his estate of Aquae Passerianae, having bought and acquired for himself the places and course of that aqueduct from the owners of each estate through which the aforementioned aqueduct is led, for a width of 10 feet where on substructures, and for a width of 6 feet where in pipes, through the greater Antonian and lesser Antonian estates of Publius Tullius Varro, and the Baebian and Philinian estates of Avileius Commodus and the Petronian estate of Publius Tullius Varro and the Volsonian estate of Herrenius Polybius and the Fundanian estate of Caetennius Proculus and the Cutilonian estate of Cornelius Latinus and the lower Serran estate of Quintilius Verecundus and the Capitonian estate of Pistranus Celsus, and along the left-hand sidewalk of the Ferentian public road and the Scirpian estate of Pistrania Lepida and along the Via Cassia into his Calvisian villa, also along the public roads and paths by permission by senatorial decree’.

Vegetus has had to negotiate with and buy land from seven different landowners, and obtain senatorial permission to run the aqueduct alongside the public roads. Vegetus himself is, of course, a senator, and *consularis*; several of the other landowners mentioned are also of high status, with senatorial names, notably P. Tullius Varro, who owns several estates and may be the same P. Tullius Varro, governor of Africa, and later Baetica and Further Spain, to whom a dedication was made at Tarquinii (*CIL* XI 3364, cf. p. 513). The inscription suggests a dense landholding pattern; the aqueduct runs through 11 estates in less than six miles, although some of the landowners own two or three estates along its course, and one can see the concentration of originally separate estates, which have kept their former names, into the hands of several wealthy landowners. For comparison, an inscription from Amiternum (S. Vittorino, L’Aquila) lists the route of an urban aqueduct through several rural estates, with the difference that the estates here seem to be drawing water from the urban aqueduct⁴⁴.

Such investment by villa owners in rural water supply schemes is reflected in M. Cetius Faventinus’ building manual (c. A.D. 300), whose proper title was *Artis Architectonicae Privatis Usibus Adbreviatus Liber* (Book of the Art of Building, abbreviated for private use). The title describes exactly what it is – an abridged version of Vitruvius, keeping the material most relevant to villas. The section on conveyance of water (chs 3-7) is taken directly from Vitruvius, but with additions on wooden pipes and small-scale rural channels, precisely the kind of technology of interest to villa owners. This tradition later fed through into Palladius’ *De Re Rustica*, for which Faventinus was the direct source⁴⁵.

⁴⁴ *ILS* 5792 = *CIL* I² 1853; for discussion see BUONOCORE 1994; WILSON 1999, p. 318.

⁴⁵ PLOMMER 1973, pp. 2-3, 5, 20, 86 (title), 92.

Other water management works

The Roman conquest of the Ager Faliscus and the subsequent colonisation of this territory entailed a transformation of the agricultural landscape. It is perhaps in this context that we should see the creation of the Ponte del Ponte, a dam of tufa blocks across the Rio della Tenuta to the north of Corchiano, which formed the offtake point for a rural channel aqueduct, probably for irrigation. Quilici Gigli notes the similarity of the masonry to that of the walls of Falerii Novi, built after 241 B.C., and tentatively assigns it to the second half of the third century B.C., together with related channels and a second dam on the Fossa dei Russi, a tributary of the Tenuta⁴⁶.

In the same general region, but to the south of Corchiano, we see further evidence of landscape improvements in the second century B.C., with investment in works to create irrigated meadows. A pair of masonry dams, with associated channels and diversion *cuniculi*, have been connected with the inscription *CIL XI 7505: C Egnatius Sex f prata faciunda coiravit*. The location of the inscription, on the tufa stream bank by the Via Fallerese, proclaims the investment in the creation of the meadows to passers-by on the road⁴⁷.

Investment in a variety of types of water management infrastructure, for drainage, flood control and irrigation, is illustrated by Quilici and Quilici Gigli's analysis of settlement in the region of Fidenae and Crustumium, immediately to the north of Rome. Some of the earliest indications of investment in agricultural infrastructure are field drainage works of mid or late Republican date discovered at site 185 2.5 km ESE of Fidenae on the Via delle Vigne Nuove. The arrangement of the drains, as a series of parallel channels dug into the tufa, each 0.60 m (2 ft) wide and set 1.10 m (4 ft) apart, corresponds closely to Cato and Columella's instructions for the drainage of a vineyard. Such drainage was necessary given the nature of the bedrock⁴⁸.

After the depopulation of the landscape around Fidenae in the second century B.C., the area saw a revival in the course of the first century B.C., with the growth of villa estates, especially in the valley of the fosso di Settebagni (the ancient Tutia), fertile and well watered, and with direct communication along the fosso to the Tiber, allowing easy access to the markets of Rome. At the mouth of the fosso a large villa of the mid first century B.C. seems to have exploited the agricultural potential of the valley. The largest late Republican villas of the Fidenae region are sited along the main roads and the two chief waterways, the Tiber and the Anio, again for ease of access to the urban market⁴⁹.

In the Imperial period the Fidenae region was a densely settled villa landscape, with even the smaller villas provided with water supply systems, baths and architectural decoration. The density of villa settlement limited the size of estates; 100 ha maximum, but most even of the larger villas had workable estates more of the order of 20 ha (80 iugera), while those of middle rank seem to have controlled usable areas of 10-15 ha (40-60 iugera). This kind of landholding pattern is comparable to that of the *suburbium* proper. The Fidenae region itself is not noted in the literary sources for a particular kind of product, although Crustumium directly to the north was famed, from the late Republic through to late antiquity, for a particular kind of pear, the Crustumina⁵⁰, and was also noted for its

⁴⁶ QUILICI GIGLI 1989a.

⁴⁷ QUILICI GIGLI 1989b.

⁴⁸ QUILICI - QUILICI GIGLI 1986, 403. Cato *agr.* L-LI (43). For other evidence of drainage ditches for vineyards in the Rome suburbium, see QUILICI GIGLI 1987.

⁴⁹ QUILICI - QUILICI GIGLI 1986, pp. 406-407.

⁵⁰ Verg. *georg.* II 87-88; Celsus II 24.2; Colum. V 10.18; Plin. *n.h.* XXIII 115; Macrob. *sat.* III 19, 6; QUILICI - QUILICI GIGLI 1980, p. 24.

large olives⁵¹; and Nomentanum (to the north east) for vines and flower gardens. There is limited evidence of cereal culture in this area (only a few millstone finds, and even these could be for grinding grain imported to the region); by contrast, there is ample evidence of viticulture and olive growing (press equipment, vats and storage areas/dolia). The combination of dense villa settlement, small estate size and evident prosperity leads one to suspect intensive and specialised cultivation of high-value crops besides wine, notably fruit and vegetables, and probably flowers, for the Rome market. Such perishable goods had to be grown within a restricted distance of the market⁵².

Quilici and Quilici Gigli suggest that fruit trees were grown mainly on the upper hills and horticulture was practised in the irrigated valley bottoms. The terraced structures of some villa sites may have been intended for orchards and vineyards, and the many villas have wells, spring catchment works, small scale aqueducts, and large cisterns, including underground ones fed by cuniculi; such works could have been used for the irrigation of fairly restricted areas of intensive horticulture (cf. fig. 11 and the discussion above)⁵³.

Other landscape improvements relate to management of the Tiber flood plain, for the regular drainage of the alluvial soils and the prevention of periodic floods. Varro (*r.r.* I 14, 3) says that the fields around Crustumium have banks and ditches to protect them from the flooding of the Tiber:

Agger is bonus qui intrinsecus iunctus fossa aut ita arduus, ut eum transcendere non sit facile. Hoc genus saepes fieri secundum vias publicas solent et secundum amnes. ad viam Salariam in agro Crustumino videre licet locis aliquot coniunctos aggeres cum fossis, ne flumen agris noceat.

‘A good bank is flanked on the inside by a ditch or is so steep that it is not easy to cross it. This type of barrier tends to be made along public roads and along streams. By the via Salaria in the area of Crustumium one can see in places banks sometimes combined with ditches, to prevent the river damaging the fields’.

Regular networks of such drainage channels have indeed been recorded along the via Salaria, with two parallel channels 3000 feet apart, and between them 5 transverse channels each 1000 feet apart⁵⁴. Quilici and Quilici Gigli suggest that these measures for the drainage of the Tiber floodplain enabled the cultivation of reeds, osier beds, poplars and elms⁵⁵.

Conclusion

The dense villa settlement in the southern part of the South Etruria survey area implies small estate sizes. The landholding pattern suggests that crops with a high value per unit area were being grown under the market stimulus of Rome. The growing of perishable crops that could not be transported too far to market – flowers, fruit and vegetables – seems a very likely activity; but these would need irrigation. The archaeological indications of substantial investment in hydraulic infrastructure – large cisterns and rural aqueducts – to support such irrigated horticulture appear to confirm this model, and they give us a diagnostic means of identifying intensive horticulture that we had formerly thought was

⁵¹ Isid. *etym.* XVII 7, 67; QUILICI - QUILICI GIGLI 1980, p. 25.

⁵² QUILICI - QUILICI GIGLI 1986, pp. 415-418.

⁵³ QUILICI - QUILICI GIGLI 1986, p. 418.

⁵⁴ QUILICI - QUILICI GIGLI 1980, pp. 161-4, 297-8; QUILICI GIGLI 1997, p. 207.

⁵⁵ QUILICI - QUILICI GIGLI 1986, p. 419; cf. Cato *agr.* I 6, 3; Varr. *r.r.* I 15.

archaeologically invisible. The extensive traces of the irrigation infrastructure for intensive horticulture throughout the Roman suburbium and for some distance northwards up the Tiber Valley are an eloquent comment on the size and aggregate purchasing power of the Roman market for fruit, vegetables and flowers. The extension of the horticultural zone northwards along the Tiber Valley looks like a classic illustration of von Thünen's discussion of the effects of an improved transport corridor, such as a canal or river, on the ideal concentric rings of land use in his model (Fig. 2). Clearly the villas in this region also served as suburban or country retreats; and where it is possible to analyse their layout in some detail, it appears that irrigated and terraced gardens combined the functions of lucrative revenue generation and productive display so typical of the Roman villa phenomenon.

Abstract

The South Etruria survey results indicated a much denser concentration of settlement in the southern part of the survey area, closer to Rome. It seems clear that the proximity of Rome encouraged settlement here, and it is frequently assumed that farms and villas in this area were engaged in growing fruit and vegetables to serve the markets of Rome (Potter, Changing Landscape; Morley, Metropolis and Hinterland). However likely this is, until now it has remained largely an assumption, supported in part by literary sources which relate more to the south and east of Rome (Tibur etc.) than to the Tiber Valley to the north; and by theoretical models. There is however a mass of data in the Tiber Valley survey archives and in published material (Forma Italiae etc.) which can be used to ground this analysis in the archaeology. Irrigation and drainage schemes demonstrate investment in land improvement for some form of agriculture, and one class of structures provides a clue as to the kinds of products grown. A number of rural sites possess large cisterns (200-700 m³) far exceeding the water-supply needs of the farm or villa, and in many cases these are not associated with villa baths. Such cisterns are most plausibly interpreted as being for irrigation: a study carried out on similar hydraulic features to the east of Rome (Thomas and Wilson, PBSR 1994), using software to estimate irrigation needs for different crops in various kinds of soils, suggested that the capacity of such cisterns was insufficient for irrigating significant areas of wheat or vines, but would have suited the irrigation needs of vegetable gardens or fruit orchards. The scant epigraphic evidence seems also to support the use of cisterns of this type for irrigated horticulture. We have here a suggestive indicator to support the hypothesis of settlement in the immediate vicinity of Rome being geared to growing perishable crops which could not be transported too far to market, and indications of substantial investment in hydraulic infrastructure to support this irrigated horticulture.

I risultati del South Etruria survey delineano una maggiore concentrazione di insediamenti nel settore meridionale, quello più vicino a Roma, dell'area ricognita. Sembra chiaro che la vicinanza a Roma favorì lo sviluppo insediativo, ed è stato spesso sottolineato che le fattorie e le ville in quest'area erano impegnate a rifornire di frutta e ortaggi i mercati di Roma (Potter, Changing Landscape; Morley, Metropolis and Hinterland). Per quanto verosimile, questo assunto è rimasto fino ad ora un'ipotesi, supportata in parte - oltre che da modelli teorici - dalle fonti letterarie che però riguardano essenzialmente le aree a sud e a est di Roma (Tibur etc.) e non la valle del Tevere. Esiste comunque una massa di dati negli archivi del Tiber valley survey e nelle pubblicazioni (Forma Italiae etc.) che può essere utilizzata per supportare a livello archeologico tale analisi. Gli impianti di irrigazione e di drenaggio indicano investimenti volti a migliorare le potenzialità agricole del territorio, ed una tipologia di strutture sembra costituire lo specchio del tipo di sfruttamento del suolo. Un certo numero di siti rurali possiede grandi cisterne (200-700 m³) assolutamente sproporzionate per i bisogni di una fattoria o di una villa, ed in molti casi esse non sono associate ad impianti termali. Tali cisterne dovevano dunque essere utilizzate per l'irrigazione: uno studio di questo tipo su simili apprestamenti idraulici ad est di Roma (Thomas and Wilson, PBSR 1994), condotto utilizzando stime di calcolo per il fabbisogno d'acqua dei vari tipi di coltivazioni e di suoli, suggerisce che la capacità di queste cisterne era insufficiente per irrigare vaste coltivazioni di grano o vigneti, ma avrebbe potuto supplire ai bisogni di orti e frutteti. La scarsa documentazione epigrafica sembra anch'essa confermare l'uso di questo tipo di cisterne per l'orticoltura. Abbiamo quindi un importante indicatore a sostegno dell'ipotesi che le tenute agricole vicine a Roma erano destinate alla coltivazione di prodotti altamente deperibili che non potevano essere trasportati da troppo lontano, ed indicazioni di consistenti investimenti verso le infrastrutture idrauliche destinate a supportare tali forme di orticoltura.

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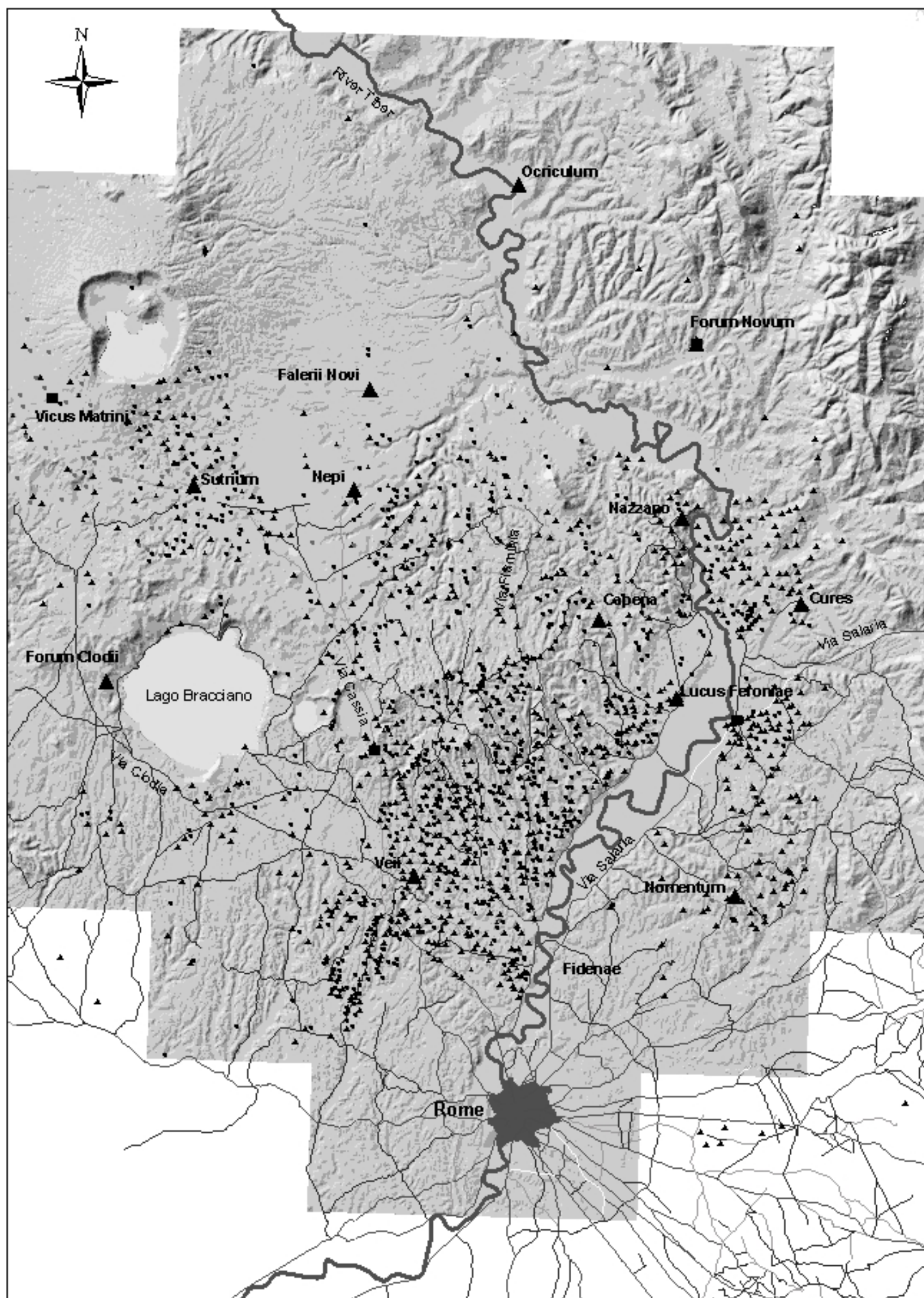
Figures

- Fig. 1: Imperial period settlement in South Etruria and the Tiber Valley. Source: Data from the Tiber Valley Project GIS (courtesy of the British School at Rome).
- Fig. 2: Von Thünen's model of agricultural location. The upper half of the diagram shows concentric rings of profit-maximising land-use around an urban market; the lower part introduces the effects of complicating factors, such as an inland waterway along which transport is cheaper, and other towns within the region. (CHISHOLM 1979, fig. 2)
- Fig. 3: Capacities of rural cisterns in South Etruria and the Tiber Valley.
- Fig. 4: Cistern at Grotte Vecchiarelli, Ager Veientanus site 377. (KAHANE ET AL. 1968 pl. XXIV b)
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- Fig. 7: Freestanding, buttressed cistern at Vicus Matrini Site 162. (Photo: A. Wilson)
- Fig. 8: The interior of the cistern at Vicus Matrini Site 162. The cistern was originally not roofed; the *opus reticulatum* wall dividing the cistern into two chamber was added later to carry a barrel vault. (Photo: A. Wilson)
- Fig. 9: Plan of the cistern at Vicus Matrini Site 162. (ANDREUSSI 1977, fig. 117)
- Fig. 10: Plan of the villa at Giardino (JONES 1962 fig. 19).
- Fig. 11: Distribution of large cisterns and other settlements of the Imperial period in the Tiber Valley study area. Source: Data from the Tiber Valley Project GIS (courtesy of the British School at Rome), with additions on cistern capacity from Table 1.
- Fig. 12: Section of a rural aqueduct at I Casini. (JONES 1963 fig. 16)
- Fig. 13: Inscription (now lost) showing part of an aqueduct or irrigation system, listing rights of water usage (CIL VI.1261).

TVP ID	<i>Forma Italiae</i> or <i>Latium Vetus</i> Region	ID	Capacity	Date
	Vicus Matrini	40	> 700 ?	
	Fidenae	197	> 650	
2541	Ager Capenas	217	622.3	
	Cures Sabini	58	552	Late Republican/Early Imperial
	Cures Sabini	184	497	Late Republican
	Cures Sabini	51	450	Early Imperial
	Vicus Matrini	162	443	
103			442	
	Fidenae	8	437	
	Vicus Matrini	134	425	
	Vicus Matrini	35	> 420	
	Vicus Matrini	180	c. 400	
	Cures Sabini	148	370	Early Imperial
2533	Ager Capenas	216	364.32	
2671	Ager Veientanus	401	345	
	Vicus Matrini	176	336 ?	
3504	Ager Capenas	278	335	
2717			296	
	Cures Sabini	266 B	294	Late Republican/Early Imperial
376	Vicus Matrini	217	> 288	
	Vicus Matrini	5	272	
	Vicus Matrini	76	> 272	
	Vicus Matrini	13	254.56	
	Vicus Matrini	137	> 252	
	Crustumium	35	233	
	Ager Capenas	345	223	Julio-Claudian
	Vicus Matrini	139	> 216	
	Vicus Matrini	43	> 180 ?	
2739			177	
	Cures Sabini	216	> 171.5	Late Republican/Early Imperial
	Cures Sabini	50	171	Late Republican
	Cures Sabini	37	170	Early Imperial
388	Vicus Matrini	228	168	
	Vicus Matrini	58	166 ?	
	Crustumium	34	164	
	Cures Sabini	126	158	Late Republican/Early Imperial
2315			156	
	Vicus Matrini	191	147 ?	
	Cures Sabini	121	130	Undated
3669			126	
	Vicus Matrini	181	125	
	Cures Sabini	40	120	Late Republican
1648			111	
	Fidenae	212 A	110	
47	Vicus Matrini	64	110	
2753			108	
2395			106.25	
	Vicus Matrini	113	105 ?	
	Fidenae	182	100	
	Cures Sabini	38	94	Late Republican/Early Imperial
	Vicus Matrini	251	90 ?	
2385			84.6	
	Vicus Matrini	85	> 80 ?	
	Vicus Matrini	256	80 ?	
322			80	
1899			78.175	
	Vicus Matrini	237	78	

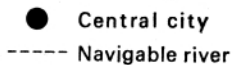
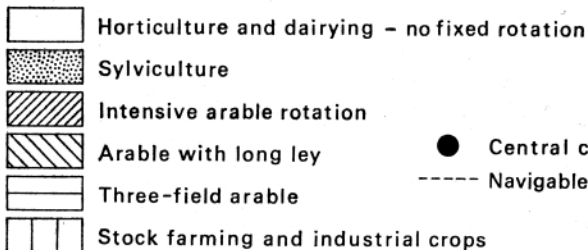
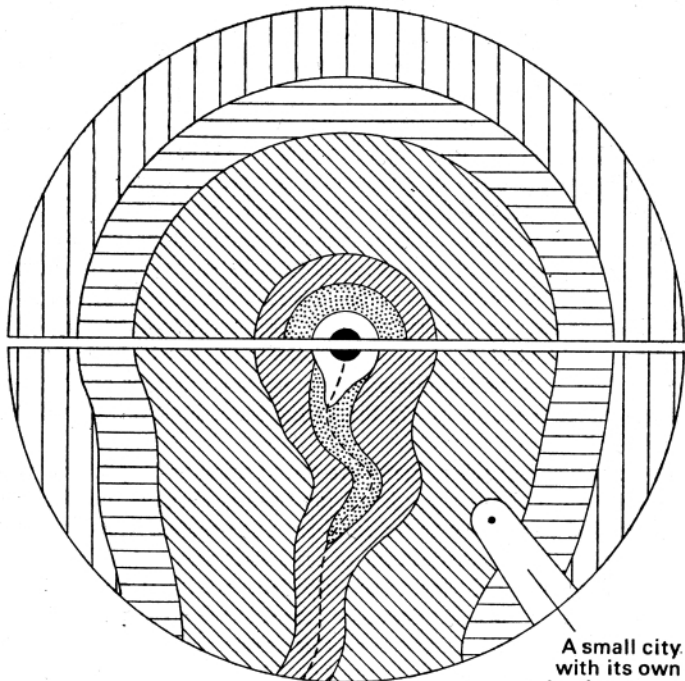
	Vicus Matrini	105 A	77 ?	
3456	Ager Capenas	188	73.059	
	Cures Sabini	266 A	72	Late Republican/Early Imperial
3463	Ager Capenas	206	72.45	
2732			72	
	Vicus Matrini	238	71	
	Vicus Matrini	218	70 ?	
2747			70	
	Vicus Matrini	199	> 69	
	Vicus Matrini	105 B	68 ?	
	Vicus Matrini	61	63 ?	
	Ager Capenas	296	62	
	Vicus Matrini	125	58 ?	
	Vicus Matrini	115	> 56	
	Vicus Matrini	208	> 56	
2734			56	
2723			48	
369			46.11	
2286			42.72	
2567	Ager Capenas		42.3	
	Cures Sabini	120	42	Early Imperial
3394	Ager Capenas		40.5	
1217			40	
2696			32	
	Vicus Matrini	66	> 31.5	
	Cures Sabini	122	30	Late Republican/Early Imperial
	Ager Capenas	200	26.68	
3500	Ager Capenas	274	26	
	Cures Sabini	49	25	Republican
3512	Ager Capenas	290	22.4	
3512			22.4	
	Vicus Matrini	57	21?	
2536	Ager Capenas		18	
2730			17.875	
821			15.4	
	Vicus Matrini	97	> 11	
	Vicus Matrini	151	9 ?	
	Fidenae	212 B	7.7	
	Vicus Matrini	114	> 6	

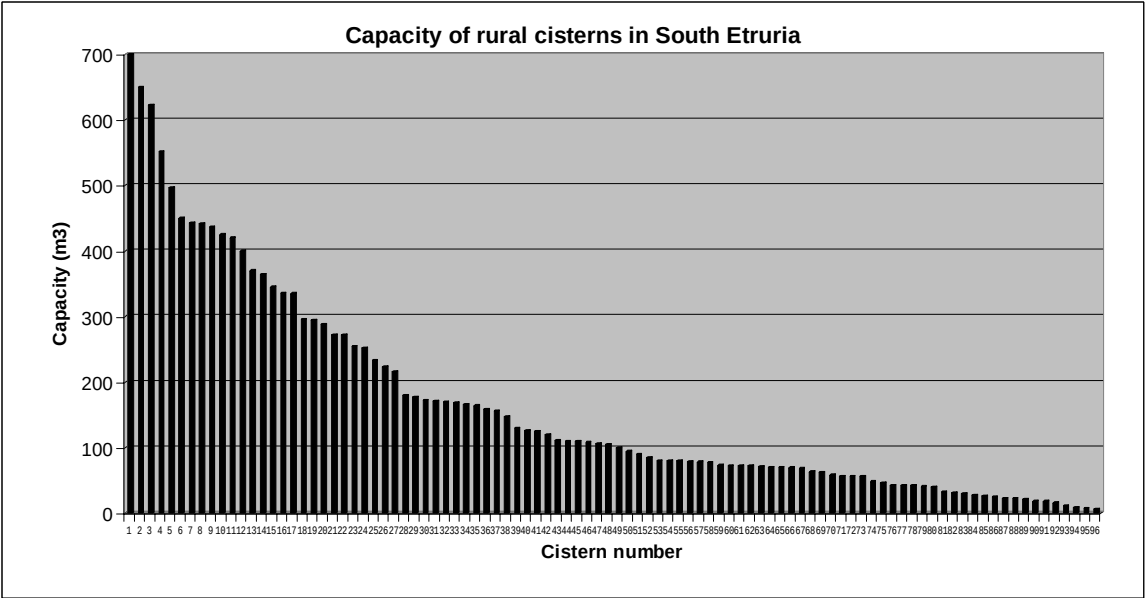
Table 1: Capacities of rural cisterns in the Tiber Valley Project study area.



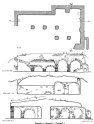
SETTLEMENT

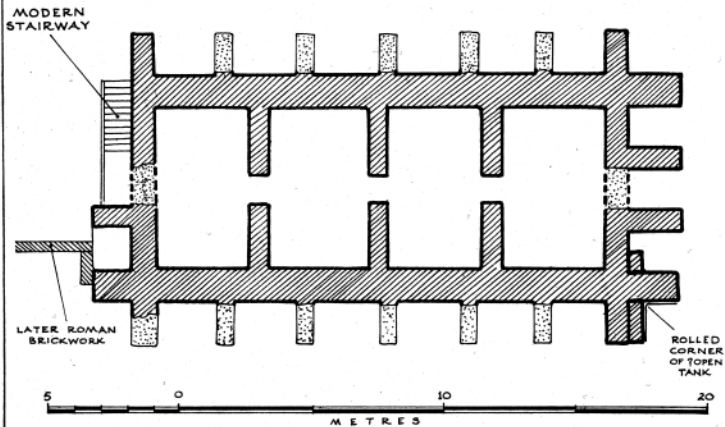
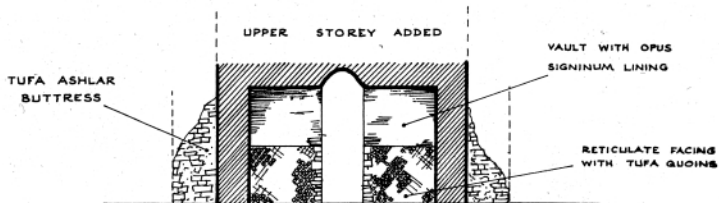
- Cistern
- Farm
- ◆ Sanctuary
- ▲ Town
- ▲ Villa
- ▲ Villa rustica
- Village





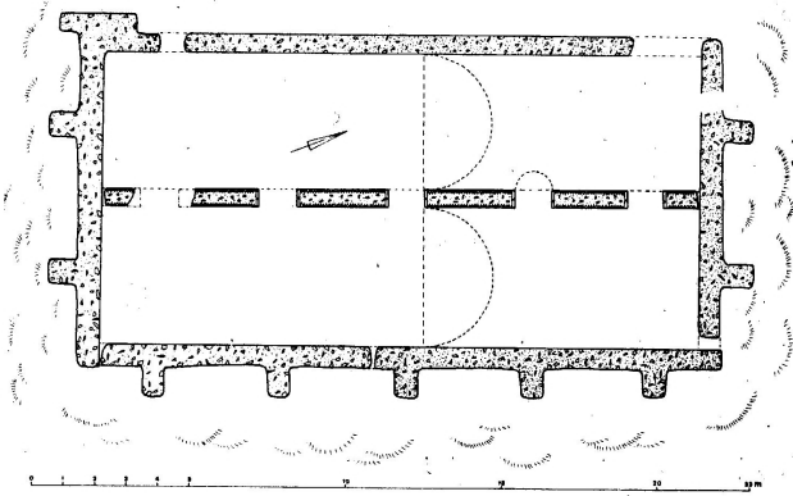












UPPER
TERRACE

Mosaic Floor

Room with
Hypocaust

MIDDLE
TERRACE

Retaining Walls

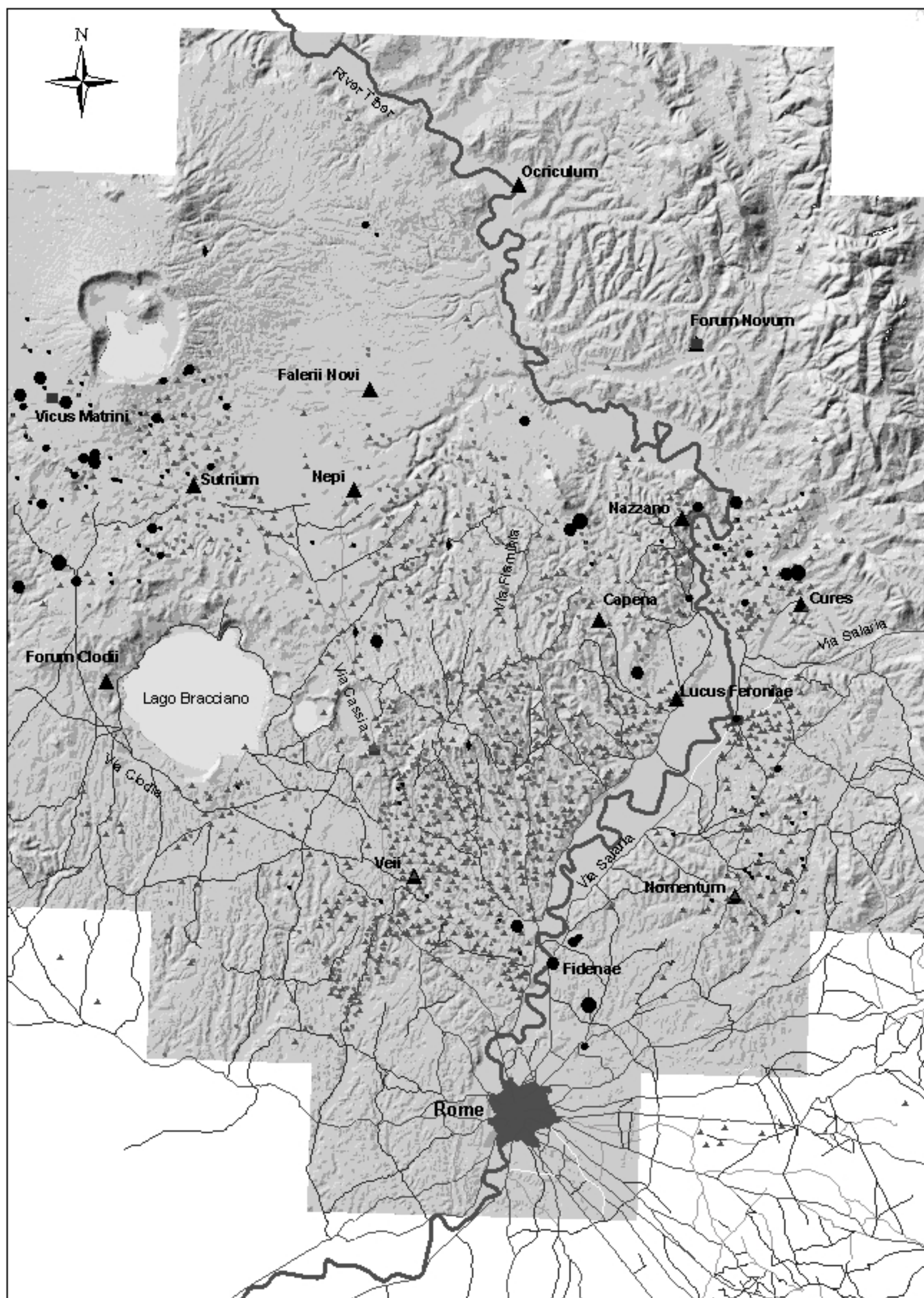
LOWER
TERRACE

C = CISTERN



0 20 40 60 80 100
METRES

PRESENT
LAND



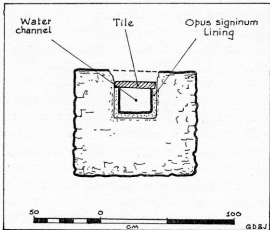
SETTLEMENT

- Cistern
- Farm
- ♦ Sanctuary
- ▲ Town
- ▲ Villa
- ▲ Villa rustica
- Village

CISTERN_SIZE

- 0.00 - 100.00
- 100.01 - 177.00
- 177.01 - 300.00
- 300.01 - 450.00
- 450.01 - 700.00

0 5 10 20 30 Kilometers



I CASINI : SECTION ACROSS AQUEDUCT

a

AVGVSTI L THYRSI
AQVAE DECEM DVAE
SECUNDA ADHORAM
... QUARTO FRIDIE

b

C · IVLI · CAESAR is l . . .
C · BICOLEI · RVFI
SQVATERIAN
AQVA · VNA

C · IVLI · HYMETI
AVFIDIANO
AQVAE DVAE
AB HORA SECVND
AD HORAM SEXTAM

c

AC
M · VIB
AQVAE
C · IVLI · CAESAR is l
C · BICOLEI ·
AQVae . . . ab hora
SEXta ad
OCCA sum solis