The Roman Port and Fishery of Cosa

A Center of Ancient Trade

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Chapter IV. The Port and Fishery: Description of the Extant Remains and Sequence of Construction

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The purpose of this chapter is to describe fully all the pertinent remains thus far found of the ancient harbor and fishery complex at Cosa and to present a sequence of construction based largely upon the visual evidence. Excluded from this discussion is the one complete architectural unit discovered, the Spring House, which is presented in chapter five by its excavator, J. P. Oleson. However, the material character, structural history, and chronology of the Spring House are integrally related to those of the fishery and port in at least two main periods of their development. The artifacts found within the Spring House, along with the amphora finds from the whole site, will largely provide the dates for the phases of architectural development discussed by McCann in chapter eighteen.

Although the form and function of most of the structures are readily identifiable, some remains pose problems for which the present study cannot offer definitive solutions. These problems are due in part to the fortunes of preservation. Other uncertainties remain because modern construction inhibited excavation in certain critical areas, including the western end of the harbor basin, where it joins the quarry in the cliffs, and the juncture of the northernmost end of the Tagliata channel with the ancient fishing lagoon. Also, the modern drainage canal that cuts through the middle of the lagoon area has destroyed some of the remains of the ancient fishery. In addition, the Torre della Tagliata with the adjacent modern villa, coast guard station, tourist bar, and restaurant-bathing establishment called La Strega are all built upon areas rich in Roman material but beyond the limits of the excavational permit and plan. Since further excavation in these areas might modify the current interpretations, an account as objective as possible of the extant structures in the main sections of the excavated site—the port, the cliffs, and the lagoon—will be given before an interpretation of them is offered. A summary of the evidence for the sequence of building construction in each of these areas will also be included after each descriptive section to prepare the way for the reconstruction and chronological discussions of the site as a whole in chapters seven and eighteen.

The Port Area and Related Coastal Structures

Within the port area of Cosa there still remain impressive ancient structures of varied size and function. The largest among them is the rough limestone breakwater, now completely submerged, upon which two of five large concrete piers, identified here as Piers 1 through 5, were built. Three embankment walls protruding from the beach—one of concrete (Wall M) and a pair of polygonal construction (Walls A and B)—formed part of a system of channels connecting the ancient fishing lagoon to the sea. In antiquity a pair of concrete walls extending into the sea one kilometer to the east of the harbor and a submerged polygonal wall off the Torre di Burano some three kilometers further to the east provided additional links between the long, narrow barrier lagoon and the sea. Finally, two series of parallel walls (O, C, D, E, F), which extend toward the harbor basin on either side of the Torre della Tagliata, and a vaulted cistern nearby attest to the presence of a large, Imperial seaside villa, constructed after at least some of the channel walls (A and B) had gone out of use.

Breakwater

Protecting the cove against the prevailing winds from the south and southwest is a broad breakwater constructed of large boulders quarried from the ad-

jacent limestone cliffs.[1] This breakwater, now completely under water, extends for ca. 110 m almost directly eastward from the promontory (Map 6; Figs. IV-1 to 5). All along the southern (seaward) face of the breakwater the rocks are laid in a straight line, and on the northeastern (inner) face a similar line can be traced for about 70 m from the eastern tip inward toward the shore. This inner face angles sharply toward the beach at about 25° west of north (Fig. IV-4). Beyond the point where a clear line can be traced, rocks spread out in an area to the north of the breakwater, forming an irregular curving contour that ends approximately 23 m to the east of Pier 3. This curved line does not represent the original contour of the breakwater; rather, it appears to be the result of wave action, which spread rocks from the top of the breakwater toward the north and the northeast, and of sand erosion from beneath the boulders. Some dislodging may also have been caused by earthquake activity. Nevertheless, the sharply pointed breakwater was very broad, measuring up to 70 m across in some places.

Today the breakwater lies at 1.5–3.0 m b.s.l. (ca. 0.5–2.0 m below the ancient sea level), and much of its structure is obscured by sand. The boulders are visible at heights varying between 0.5 m and 2.0 m above the sea floor, but they continue downward for at least another 1.5 m.[2] It is not surprising that the largest rocks—some of them measuring ca. 2.0 m x 1.5 m x 1.0 m and weighing up to 2,000 kg—are found along the seaward face of the breakwater. The smallest rocks (ca. 0.5 m x 0.5 m x 0.4 m) are found along the innerside of the breakwater, probably because less protection was needed there and also because waves tumbled the lighter boulders in that direction (Fig. III-14).

Beginning about 15 m to the east of the tip of the breakwater is a series of discontinuous submerged rock mounds (A-F; Fig. IV-5), the visible remains of which differ greatly in dimensions (measured east-west by north-south): (A) 16 m x 13 m; (B) 10 m x 10 m; (C) 8.5 m x 17.0 m; (D) 15 m x 36 m; (E) 6 m x 13 m; and (F) 6 m x 23 m. The mounds, lying at depths that vary between 2 m and 4 m b.s.l., extend eastward in a semicircle for a distance of about 100 m beyond the breakwater. The first four mounds in the series—A, B, C, and F—form a diamond-shaped cluster. A (Fig. IV-6) and B (Fig. IV-7) roughly continue the line of the inner, northeastern face of the breakwater for about 65 m toward the southeast; F (Fig. IV-8), located 23 m northeast of B, begins the return toward shore, which is continued by D (Figs. III-15 to 18; IV-9), situated ca. 43 m farther to the northeast, and by E (Fig. IV-10), which lies ca. 22 m to the northwest of D. In the 85-m space between E and the present shoreline, no other rock mounds were found.

The breakwater and associated rock mounds A-F must have been constructed as coordinated parts of the same system of protection for the harbor of Cosa. Today they define a basin of some 25,000 sq. m; measured from the present shoreline to the northern side of extension C, the basin has a diameter of ca. 190 m. Allowing for the rise in sea level of approximately 1 m, the ancient shoreline must have been somewhat farther to the south than the modern beach; thus an ancient harbor basin correspondingly smaller in area must be envisioned. The entrance to the harbor has been established between mounds D and F, where there is an open space of 33 m (Map 6). The depth of the channel in antiquity was approximately 6 m b.s.l.

Construction of the breakwater of the port of Cosa, must have been rapid and economical. The rough boulders of the main breakwater were probably quarried and hauled directly from the nearby cliffs, using a completed section of the broad platform for extending the breakwater eastward. Rocks for the isolated mounds might have been carried on ropes slung between two barges and then dropped directly upon the designated areas. Some of the smaller stones may have been brought in as ballast by ships entering the port.[3]

Other architectural elements closely associated with the breakwater system are the remains of five large concrete piers (1-5), a smaller pier (1.5), and a segment of a concrete wall (M) (Map 6; Fig. IV-3). The badly eroded remains of Piers 4 and 5 appear to

[1] Much of the information presented in this description of the breakwater and harbor remains is derived from yearly excavational reports by McCann and the 1968 and 1969 notebooks of Lewis; McCann and Lewis 1970; Lewis 1973; and McCann 1979. Additional observations and interpretations are based on the present author's first-hand examination of all accessible structures in 1972, 1973, and 1974. Further information relevant to the interpretation of the structures is presented by McCann in chapters three and seven.

[2] For the problem of the present depth of the breakwater, see Lewis 1973, pp. 241-242.

[3] Excavation beneath the rock mounds revealed no traces of timber, which might have indicated that the mounds had been constructed by sinking boats filled with stone, a method used at the harbor of Ostia for the construction of the concrete island and for certain sections of the left mole. A similar method was used at Centumcellae. For Ostia, see Pliny *NH* 16.202; Testaguzza, pp. 105-120; O. Testaguzza, "The Port of Rome," *Archaeology* 17 (1964), pp. 173-179; V. Scrinari, "Strutture portuali relative al 'porto di Claudio' messo in luce durante i lavori dell'Aeroporto Intercontinentale di Fiumicino (Roma)," *Rassegna dei lavori pubblici* 7 (1960), pp. 173-190; Blackman 1982-2, p. 198.

rest on top of the breakwater.[4] Pier 4 is located 40 m to the east of the cliffs, nearly centered on the breakwater, while Pier 5 is situated about 15 m from the tip of the breakwater approximately equidistant from its inner and outer faces (Fig. IV-5). The materials used in the construction of these two piers are tuff (from the Volsinian volcanic complex ca. 60-80 km northeast of Cosa) and pozzolana (from the region of Pozzuoli).[5] The same materials are found in Piers 1, 1.5, 2, and 3 and in Wall M just to the north of Pier 1. Since the same north-northwest/south-southeast axis is repeated in Wall M and Piers 1 through 3, with Pier 4 placed on a parallel axis slightly to the east, it appears that all these concrete structures were designed and built at one time or that they at least formed part of an interrelated plan executed over a period of time.

PIERS 1-5

Piers 1 through 3 are relatively well preserved, no doubt owing to their more sheltered position close to the cliffs and shore (Color Fig. 1; Figs. III-12, 13; IV-11, 12, and 13). The widths (east-west) of the piers (not including the small Pier 1.5, Fig. IV-13) are 6.3 m, 6.8 m, and 7.5 m, respectively. Their preserved lengths (north-south) exhibit somewhat greater variation: 12.6 m, 10.5 m, and 6.4 m. The last measurement given, that of Pier 3, does not represent a finished dimension, for that pier is partially immured in a modern concrete drainage structure. Originally, Pier 3 was comparable in size to Piers 1 and 2. The present dimensions of Pier 4—7.5 m (east-west) by ca. 10 m (north-south)—are closest to those of Pier 2, but the badly eroded condition of Pier 4 indicates that it must have been considerably larger in antiquity (Fig. IV-14). The visible portion of the severely damaged Pier 5 is now only ca. 4.8 m (east-west) by ca. 4.3 m (north-south), with an additional section 1.5 m long extending under the sand to the south (Fig. IV-15). Of all the piers, the best preserved is Pier 1.5, located between Piers 1 and 2 (Fig. IV-3). It measures 2.5 m (east-west) by 5.8 m (north-south) and appears to stand to its full original height at present mean sea level. The full heights of the other piers are not preserved: Piers 1, 2, and 3 rise to 1.75 m, 2.80 m, and 2.72 m a.s.l., respectively; the top of Pier 4 just breaks the water line, and that of Pier 5 is ca. 2.5 m b.s.l. The bottoms of the piers were not located, even though probes made along the southwest side of Pier 1, the southeast side of Pier 1.5, and the east side of Pier 2 reached depths of 1.9 m, 2.05 m, and 2.05 m, respectively. Probing around Piers 4 and 5 suggested that these rest on the rocks of the breakwater, but the precise depth of their foundations could not be determined because of heavy rocks surrounding them.[6]

The remains of the piers span an overall distance of ca. 150 m along a staggered line, with considerable variation in the spacing between them. The intervals range from ca. 5 m between Wall M and Pier 1 and between Piers 1 and 2, to 6.5 m between Piers 2 and 3, ca. 36 m between Piers 3 and 4, and ca. 55 m between Piers 4 and 5. The small Pier 1.5 blocks the space between Piers 1 and 2, but no evidence was found during the excavation of the harbor area to indicate that other intermediate piers once filled the open expanses between the last three piers. It may be that a plan to construct a continuous line of piers was never completed or that additional piers did exist but were destroyed by the same forces of nature that damaged the breakwater. It seems more likely, however, that a continuous line was never intended.[7]

The lower portions of Piers 1, 2, and 3 show several grooves, holes, and impressions that clearly were left by the formwork used during construction. In excavating along the western side of Pier 1 to a depth of 0.44 m b.s.l., shallow vertical impressions, varying in width from 0.10 m to 0.15 m and in depth from 0.15 m to 0.20 m, were observed (Fig. III-13). These were made by rather thin, narrow planks. The intervals between the impressions are of

[4] See McCann, chapters three and seven for her suggestion that Pier 5 may have served as the base for a lighthouse.

[5] On the identification of the tuff aggregate from Pier 3, see Trigila, chapter sixteen. Professor Mario Fornaseri of the Institute of Geochemistry at the University of Rome examined samples of tuff from the other piers and concluded that all are probably from the Volsinian complex. A comparative analysis of pozzolana mortar from Pier 1 at Cosa and of a pozzolana sample (possibly ancient) taken from the modern pier at Pozzuoli showed the two to be very similar. See D. M. Roy and C. A. Langton, *Longevity of Borehole and Shaft Sealing Materials: 2. Characterization of Cement-Based Ancient Building Materials. A Topical Report for the Office of Nuclear Waste Isolation* Report No. ONWI-202, Materials Research Laboratory, The Pennsylvania State University, University Park, October 31, 1980. In oral communication Langton offered the opinion that both samples derive from the same lava flow but are probably from different levels or from different quarries within it. Given the proximity of pozzolana quarries to the harbor at Pozzuoli and the fame of these quarries in antiquity (see, for example, Vitruvius 2.6.1-4 and 5.12.2), it may be assumed that the pozzolana in both samples is from this region. I am most grateful to Nicholas Hartmann, Research Fellow at MASCA, The University Museum of The University of Pennsylvania, for arranging to have these samples of pozzolana cement analyzed.

[6] McCann, chapter three.

[7] It seems very unlikely that other piers would have disappeared without a trace, as presumed by Brown 1980, p. 60 and fig. 77.

approximately the same width as the impressions themselves (0.11–0.15 m), indicating that the planks overlapped one another. These vertical planks must have been held together on the exterior of the form by some type of horizontal bracing such as that found at Pyrgi; at Cosa, however, none survives.[8] Yet evidence that there were two horizontal braces on the interior of the forms does remain in Piers 2 and 3. Just above the present sea level two squared holes ca. 4 m apart pass through each of the concrete masses in an east-west direction, each at about 3 m from the northern and southern ends of the piers, marking the positions of large beams that have since rotted away (Figs. IV-11, 12). The dimensions of the holes (ca. 0.26 m x 0.25 m) indicate that the beams were slightly less than a Roman foot square (0.296 sq. m) in cross-section. A third hole is now nearly destroyed by the large crack that passes diagonally through Pier 2, dividing the upper portion of the pier in two. Originally the top of the hole was ca. 0.25 m a.s.l., as one small preserved portion of its upper surface attests, but no traces of the lower and side surfaces survive. Today the depth of the crack varies between 0.56 m and 0.68 m b.s.l. and the width between 0.55 m and 0.58 m. It seems likely that this diagonal hole once held a third horizontal brace for the interior of the formwork of Pier 2. At the southern end of Pier 1 a shallow diagonal impression, ca. 0.6 m wide, may mark the position of a similar internal brace (Fig. IV-13, lower center).

In Pier 2, immediately above the level of the beam holes, there are several rounded hollows that have diameters of 0.12–0.14 m (Figs. IV-11, 12). The random arrangement of these hollows and their positions just above the bracing beams suggest that they were left by timbers used either for the reinforcement of the concrete[9] or for scaffolding or other equipment that collapsed or was tossed into the concrete during construction. Such planks, beams, and other construction equipment recall Vitruvius' description of the type of single walled cofferdam to be built when erecting piers in the sea using concrete containing pozzolana from the region of Pozzuoli. Such a cofferdam should be built "with its sides formed of oaken stakes with ties between them . . . to be driven down into the water and firmly propped there; then, the lower surface inside, under the water, must be levelled off and dredged, working from beams laid across; and finally, concrete from the mortar trough . . . must be heaped up until the empty space which was within the cofferdam is filled up by the wall."[10] In the piers at Cosa broken pieces of aggregate rock, varying in length from 0.10 m to 0.30 m, were carefully layered in a large amount of pozzolana mortar, resulting in a very compact mass that has resisted disintegration remarkably well for more than two thousand years.

A distinctly different type of concrete was used to construct the upper parts of Piers 1, 2, and 3; consequently, the seams between the upper and lower portions of these piers are clearly visible (Fig. IV-11). The yellow-brown of the tuff in the lower sections contrasts with the steely gray of the local limestone and the orange of the amphora fragments that constitute the main aggregate materials of the concrete of the upper levels. Mixed in with the broken limestone and amphoras are small quantities of sandstone and an occasional piece of yellow tuff. In Pier 2 four distinct layers, or pours, are visible: the first, or lowest, measures 0.48 m thick, the second 0.53 m, the third ca. 0.42 m, and the fourth is preserved to a maximum thickness of 0.65 m (Fig. IV-12). In each layer the aggregate rock and sherds are laid in relatively neat rows. Body sherds normally curve downward, and other amphora parts, such as rims, handles, and toes, are placed horizontally. The first pour contains fewer terracotta fragments than the other three, but its mortar is comparable to that of the second and includes small bits of yellow tuff along with lime and the local dark sand. By contrast, the mortar of the third and fourth pours contains only sand and lime. The bits of tuff in the mortar of the first two pours probably derive from pozzolana, from the region around Pozzuoli as indicated from the information reported above in footnote 5.

These upper portions of the piers preserve no traces of formwork. It may be that walls of cut limestone were built around the outer sides to act both as formwork for the concrete cores and as protective facings.[11] The high proportion of terracotta fragments in this concrete is very likey due both to the availability of large quantities of amphora sherds and

[8] J. P. Oleson, "Underwater Survey and Excavation in the Port of Pyrgi (Santa Severa), 1974," *JFA* 4 (1977), pp. 305-307, fig. 5.

[9] See Lewis, "Outer Harbour Notebook, 1968," p. 41.

[10] Vitruvius 5.12.3, trans. M. H. Morgan (Cambridge, Mass., 1914). For discussions of the Vitruvian methods of building formwork for underwater construction, see C. Dubois, "Observations sur un passage de Vitruve," *MélRom* 22 (1902) pp. 439-467, and Schläger, "Die Texte Vitruvs" (cited in chapter three, n. 37) pp. 150-161. Cf. Oleson, *StHarbArch I*, and McCann, chapter three, n. 37, above.

[11] The use of cut stone facings for concrete structures was common by the end of the second century B.C., according to Blake 1947, pp. 1-2.

to the belief that terracotta was well suited for hydraulic construction.[12] Immured in the upper portion of Pier 1 is a Sestius-type rim fragment with a rosette or medallion stamp (an early example of Type 4b; Will, Cat. A195), and the upper section of Pier 2 contains toes of amphora Types 4a and 4b (uncatalogued).

The question naturally arises: Do the two types of construction indicate two distinct phases in the history of these concrete structures, or do they represent two stages in the same building program? The evidence provided by the piers themselves is not conclusive but an argument can be made in favor of the first alternative. Although the seams between the two types of concrete in Piers 1 and 2 are at a comparable height (ca. 1.5 m a.s.l.), in Pier 3 that seam is higher and very irregular. At the northwest corner of Pier 3 the tuff-and-pozzolana concrete ends at 2.1 m a.s.l., but toward the center of the pier it continues upward another 0.42 m. This irregularity suggests that the original part of Pier 3, made of imported materials, was damaged and later repaired with concrete composed of local materials.[13] In addition, the manner of laying the amphora fragments in rows within the concrete core recalls a construction technique used elsewhere on the site in a structure of a demonstrably later date than those made of tuff-and-pozzolana concrete.[14] The small quantities of pozzolana and tuff in the concrete of the upper layers of the piers may well have been reused from damaged portions of the original structures.

WALL M

Wall M, 5.12 m to the north of Pier 1, is aligned on an axis parallel to those of Piers 1-3 and, like the lower portions of the piers, is made of concrete whose aggregate is composed of yellow tuff (Fig. IV-16). Impressions of vertical planks on the southern end suggest that the wall was built within wooden forms similar to those used for the piers (Fig. IV-17). Wall M was followed for a distance of 7.43 m into the embankment of the parking lot, but in Trench N, ca. 10 m to the north, no trace of it was found (Figs. III-23; IV-1). Presumably its northern end was destroyed by the modern construction that is very much in evidence in the area. For example, at a point ca. 5.7 m from its southern end, Wall M is intersected by a loosely packed rubble wall or fill of broken limestone. In Probe 4, about 10 m to the northeast of Trench M (Fig. IV-1), a short section of very rough polygonal wall backed by a similar loose limestone fill was located. Although this polygonal wall is parallel to Wall M and to the long axes of the harbor piers, its construction does not appear to be ancient. Moreover, the discovery just to the east of the wall of a modern stone fishing marker inscribed "LIMITE TRA LA PESCA MARITTIMA E FLUVIALE" (Fig. III-2) supports the attribution of the wall to recent times.[15]

The top of Wall M lies at ca. 1 m a.s.l. The bottom was not located, but a probe made alongside the wall indicated that it continues downward for at least another 2.06 m. The upper part of the eastern face of the wall has a smooth surface that slopes at an angle of ca. 45°, and just below this angled surface the wall is 2.44 m thick. On top of the tuff-concrete portion of the wall, ca. 0.38 m from its southern end, is a narrow segment of wall made of limestone rubble and sherds set in a sand and lime mortar (Fig. IV-16). This narrow construction, preserved to a height of 0.26 m, was traced for a distance of 1.3 m. The different building materials and method of construction, and the fact that the original upper surface of Wall M was not prepared for a superstructure, lead to the conclusion that this narrow wall is a later addition. Immured in it was another rim fragment of an amphora of an early Type 4b (uncatalogued) impressed with a rosette or medallion stamp. Subsequently, at an undetermined date, the western side of Wall M, including this later upper portion, was chopped away (Fig. IV-17). If Wall M did originally extend northward to the cliffs, as is likely, it would have intersected the end of a concrete embankment wall on the eastern side of the Tagliata Canal. Such a connection to the canal would imply that Wall M and harbor Piers 1-3, in at least one phase of their use, functioned in connection with the structures in the lagoon.

WALLS A AND B

Two polygonal walls that define another channel are located to the east of Wall M: Wall A at a dis-

[12] For example, crushed terracotta was commonly mixed with pozzolana and lime to make waterproof linings for cisterns, such as that of the Spring House cistern at Cosa (Oleson, chapter five). Vitruvius (2.5.1) recommends that ground-up bricks be added to mortars containing river or sea sand and lime in order to obtain a better composition.

[13] It should also be noted that some areas of the uppermost preserved surface of Pier 3 are modern. For example, a two-holed brick of recent manufacture and two iron clamps are immured, and there are small patches of concrete that differ in appearance from the surrounding limestone and sherd construction. Also see Lewis 1973, p. 235, who suggests that the upper sections of these piers represent later repairs to the original structures.

[14] One may compare Wall F of the harborside villa.

[15] See McCann, chapter three, for discussion of the post-Roman use of the site.

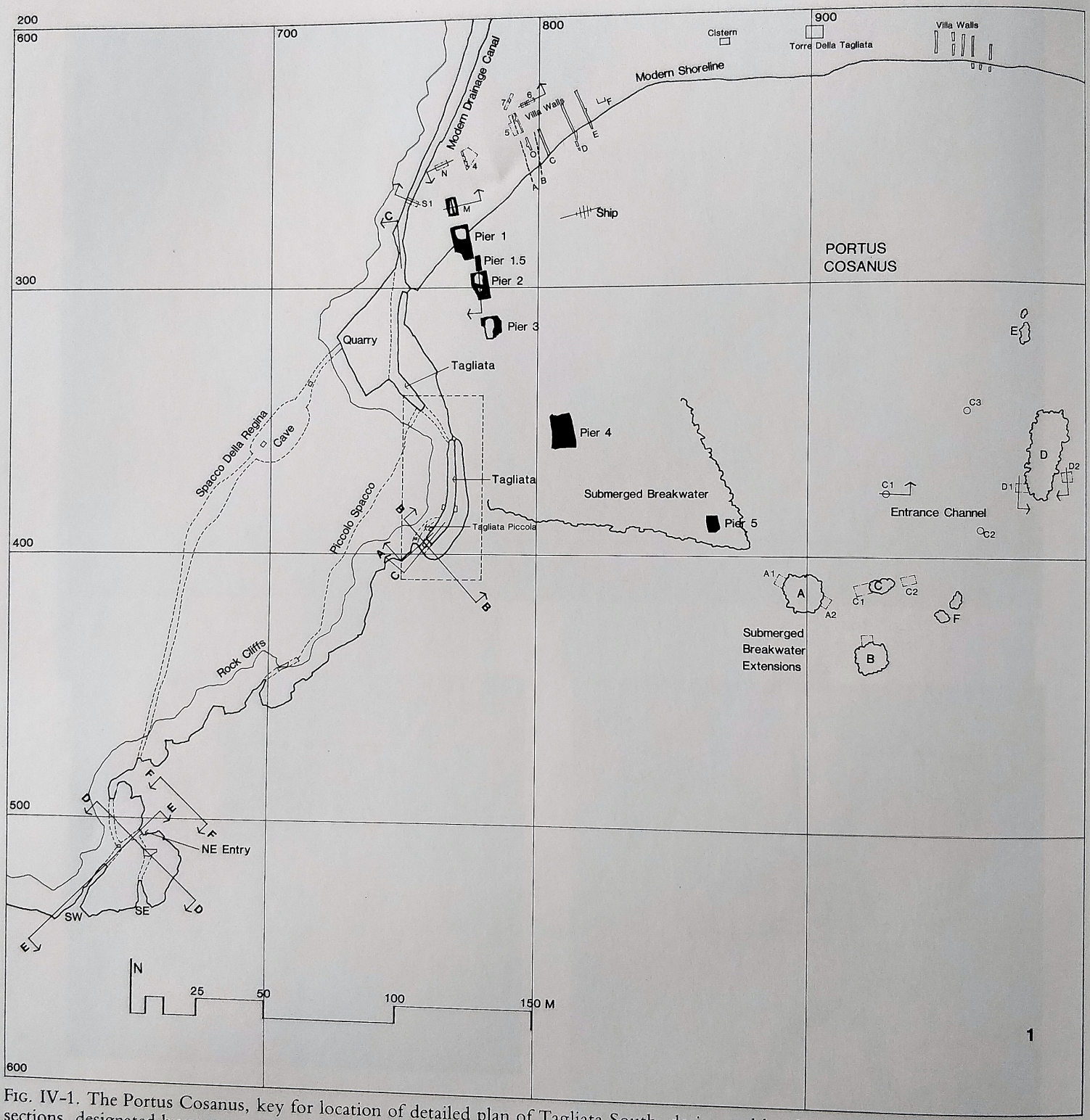
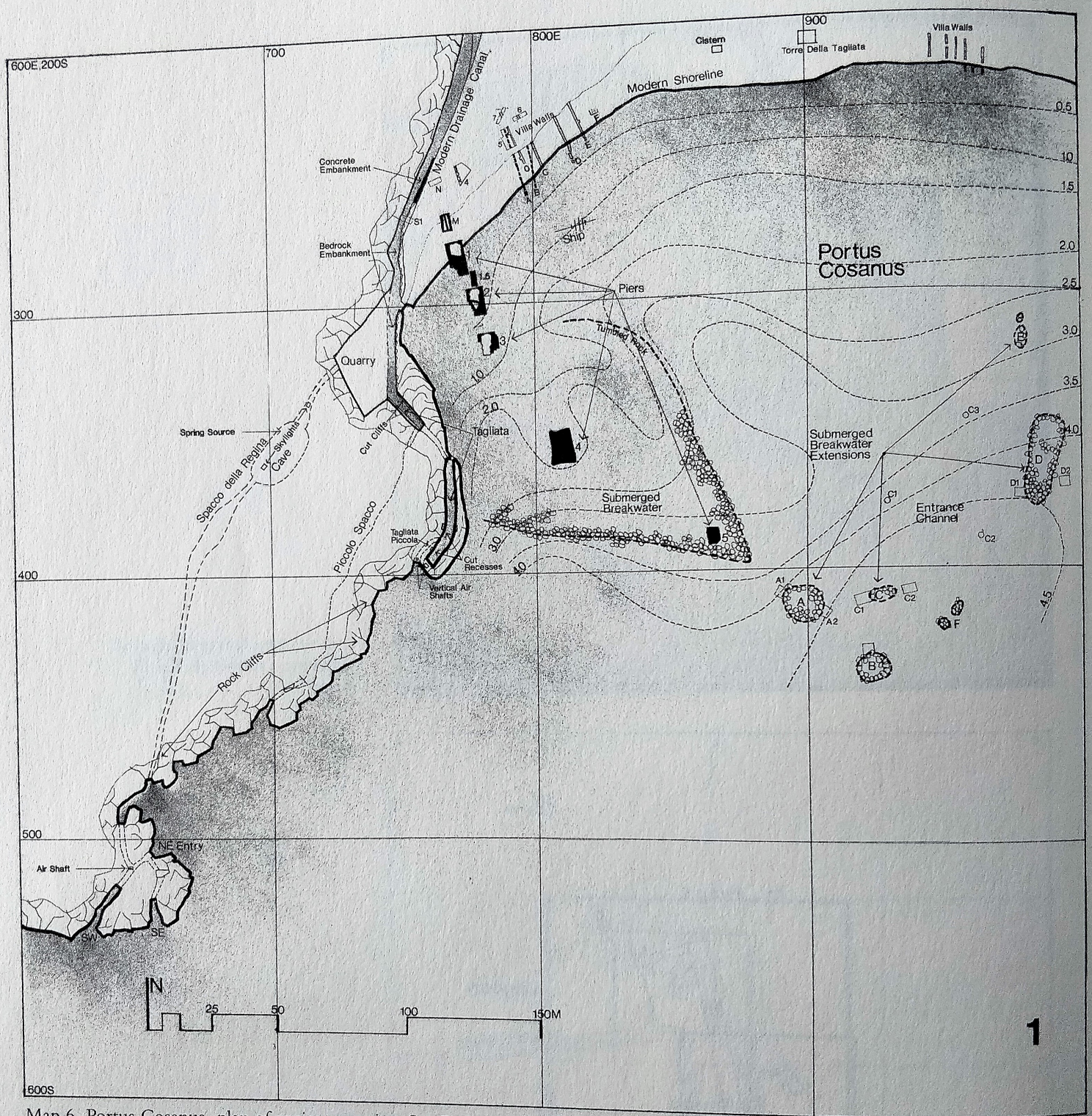


FIG. IV-1. The Portus Cosanus, key for location of detailed plan of Tagliata South, designated by dotted rectangle and sections, designated by arrows.



Map 6. Portus Cosanus, plan of ancient remains. See Fig. IV-1 for key to locations of detailed plans and sections.

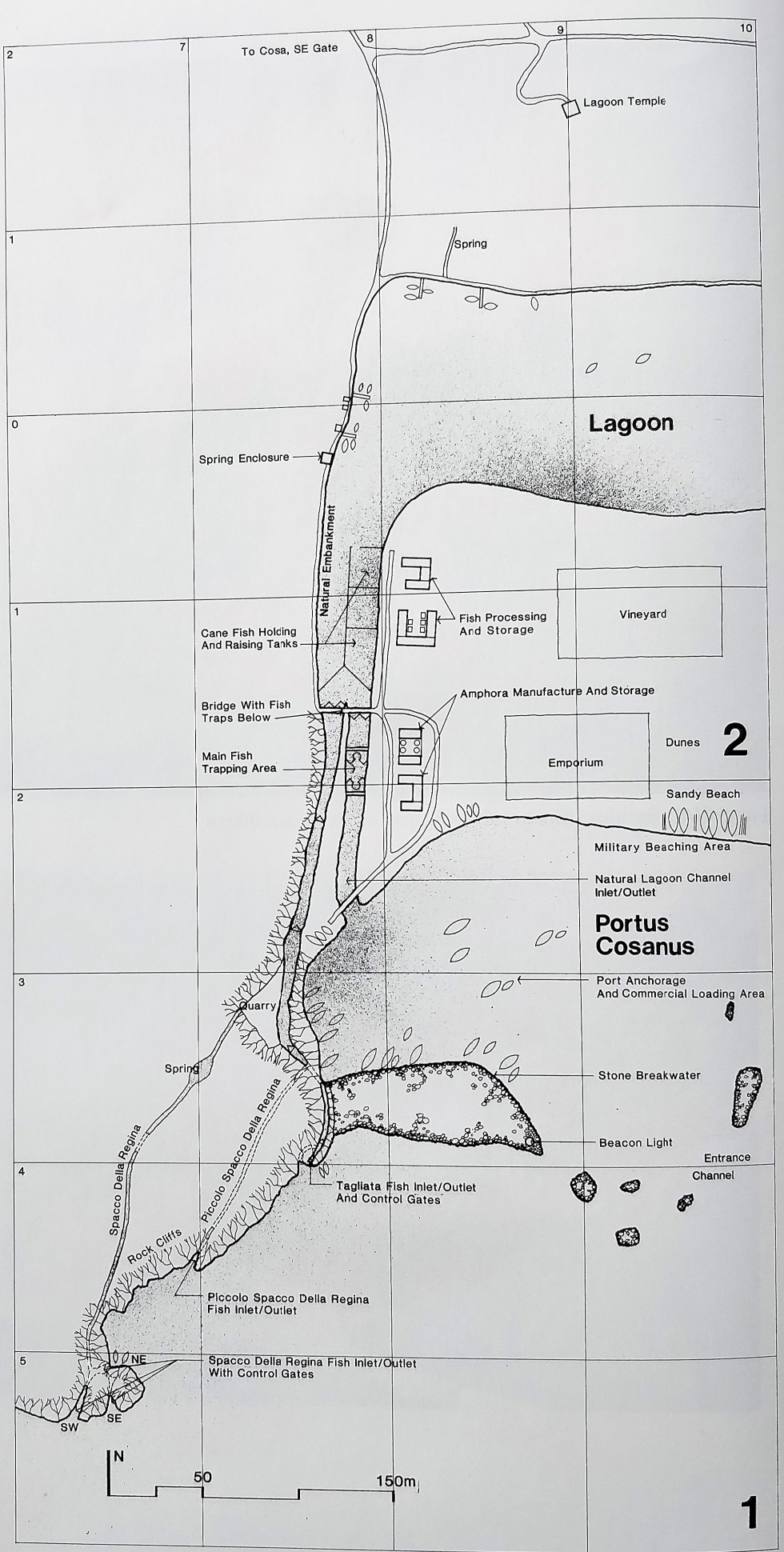


FIG. VII-9. Schematic plan, Phase 1, the Portus Cosanus and lagoon, later third and second centuries B.C.

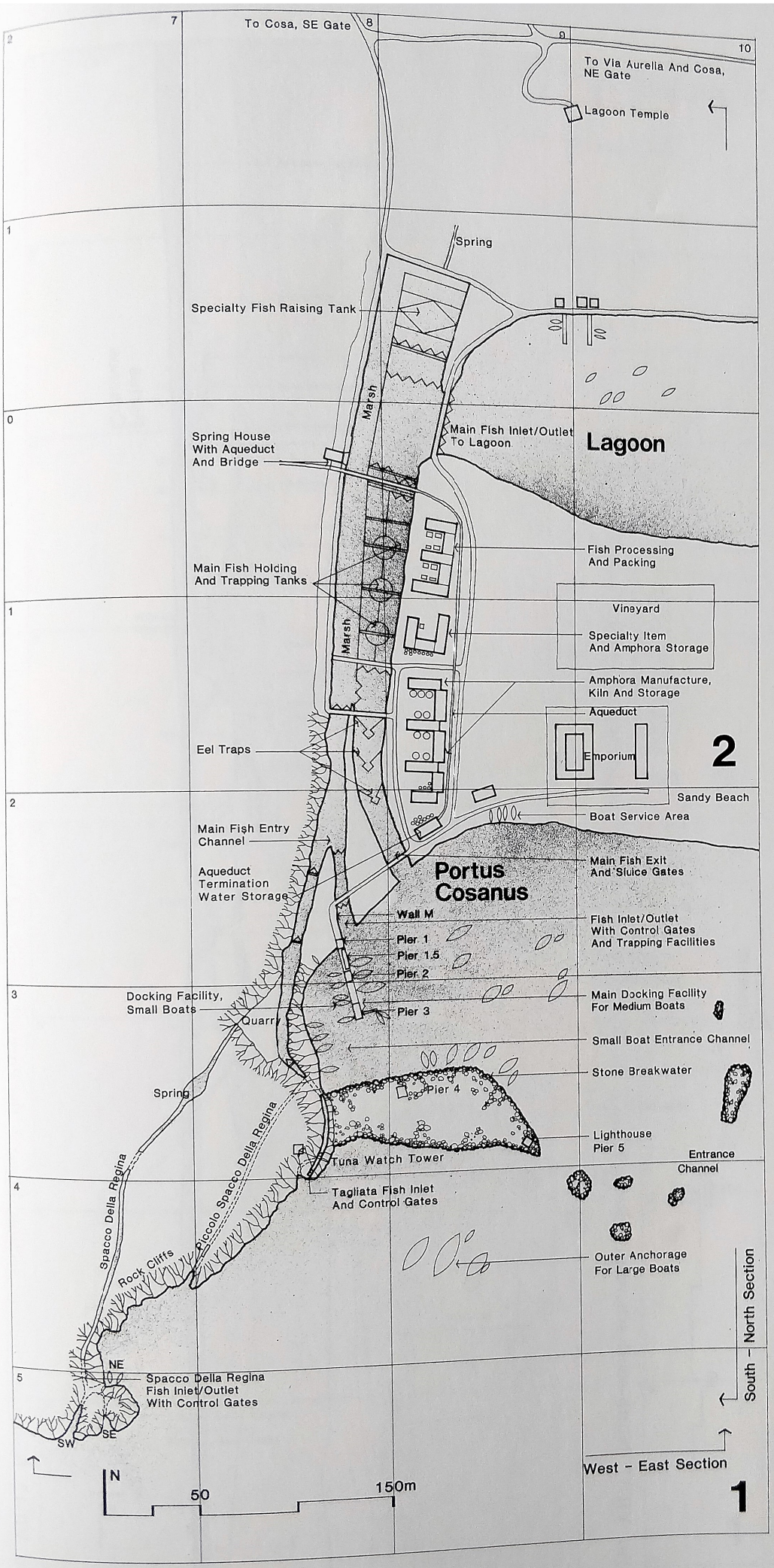


FIG. VII-10. Schematic plan, Phase 2, the Portus Cosanus and lagoon, late second and first centuries B.C.

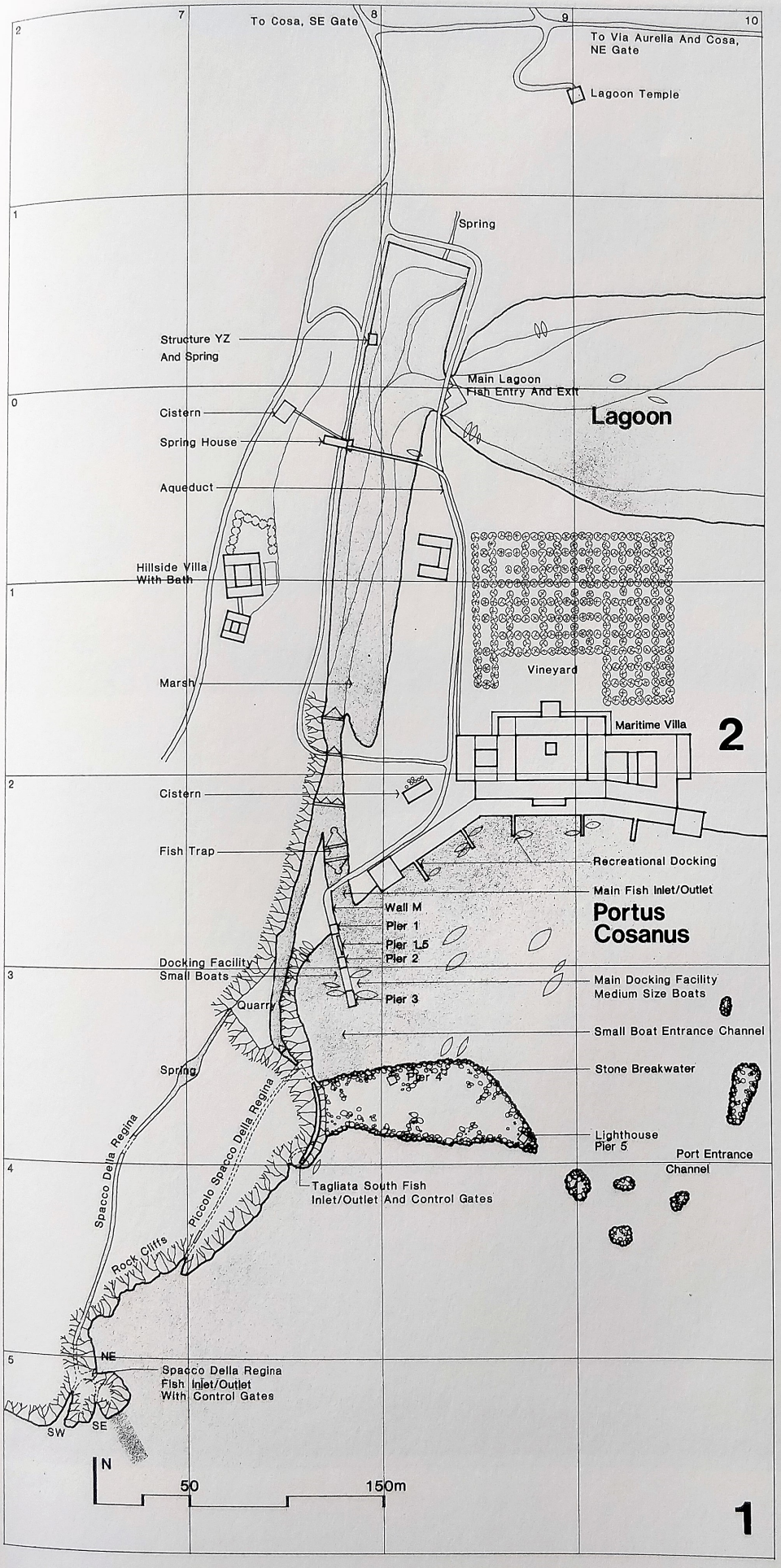


FIG. VII-13. Schematic Plan, Phase 3, the Portus Cosanus and lagoon, Imperial period, late first to third century A.D.