

# Wareham West Walls

*Excavations by the Royal Commission on Historical Monuments (England)*

THE defences of Wareham, Dorset, as now visible, consist of a massive bank, 55 ft. wide and 17 ft. high where best preserved, surrounding three sides of the town and enclosing between 80 and 90 acres.<sup>1</sup> Their date has long been uncertain, and they have been assigned to every period from the Early Iron Age to the twelfth century. In view of their special interest as early medieval defences, whatever their date of origin, the Royal Commission on Historical Monuments considered that an attempt should be made to secure by excavation further information on the structure and date of these formidable ramparts. Accordingly in 1952, 1953 and 1954 excavations were undertaken by members of the staff of the Commission.<sup>2</sup>

## MEDIEVAL HISTORY OF WAREHAM AND ITS DEFENCES

Between two rivers, the Piddle and the Frome, which run parallel to each other, joining about a mile east of the town, is a peninsula of land with a steep escarpment on the north side and moderate slopes to the east and south; the most vulnerable side is that to the west, for there the adjoining land is of the same height as the remainder of the promontory and there is no river protection.

While some indication of pre-Roman occupation, from Phase A of the Early Iron Age onwards, was obtained in the course of the Royal Commission's excavation, the evidence for Roman occupation is larger and more widespread though still of modest character.<sup>3</sup> The site is likely to have been of some importance to the Romans with its navigable river and its position at the entrance to the shale and 'marble' deposits of Purbeck. So far however, there is nothing to show the character of the settlement.

Five early Christian inscriptions were found during the demolition of the

<sup>1</sup> The southern defences are no longer apparent but presumably followed the scarp of the river terrace. The plan here published for the first time (FIG. 46) shows a second bank and ditch on the east side, recorded before 1773 by John Hutchins, who also mentions what may be a similar feature formerly existing on the west (*History of Dorset*, 3 ed., 1 (1861), 94). The remains of the eastern bank are now no more than 18 in. above its ditch.

<sup>2</sup> The Commissioners are much indebted to the Mayor and Corporation of Wareham, to the Lord of the Manor, Major D. C. D. Ryder, and to the Ministry of Works, for permission to excavate. Mr. E. M. Jope, Mr. G. C. Dunning, Dr. J. N. L. Myres and Mr. J. G. Hurst have given valuable help with problems of pottery discovered. We are indebted to Mr. Jope for the Appendix on p. 138. Dr. F. T. Wainwright has been most generous in his help both at the time of the excavation and with the preparation of the report. Professor F. E. Zeuner has kindly provided soil analyses.

Many members of the staff of the Commission helped with the work, including Dr. E. A. Gee, who was in charge of the excavations in all three years, Miss M. Baldwin, Mr. J. T. Smith, Mr. R. A. H. Farrar and Mr. W. E. J. B. Mercer.

Considerable assistance in many fields was freely given by the late Mr. Harry Burr of Wareham, who helped with the excavation from start to finish.

<sup>3</sup> Roman finds at Wareham have been summarized by R. A. H. Farrar in *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LXXVI (1954), 82-85. Material of the Early Iron Age and of Roman date recovered during the present excavations will be published in a future volume of those *Proceedings*.

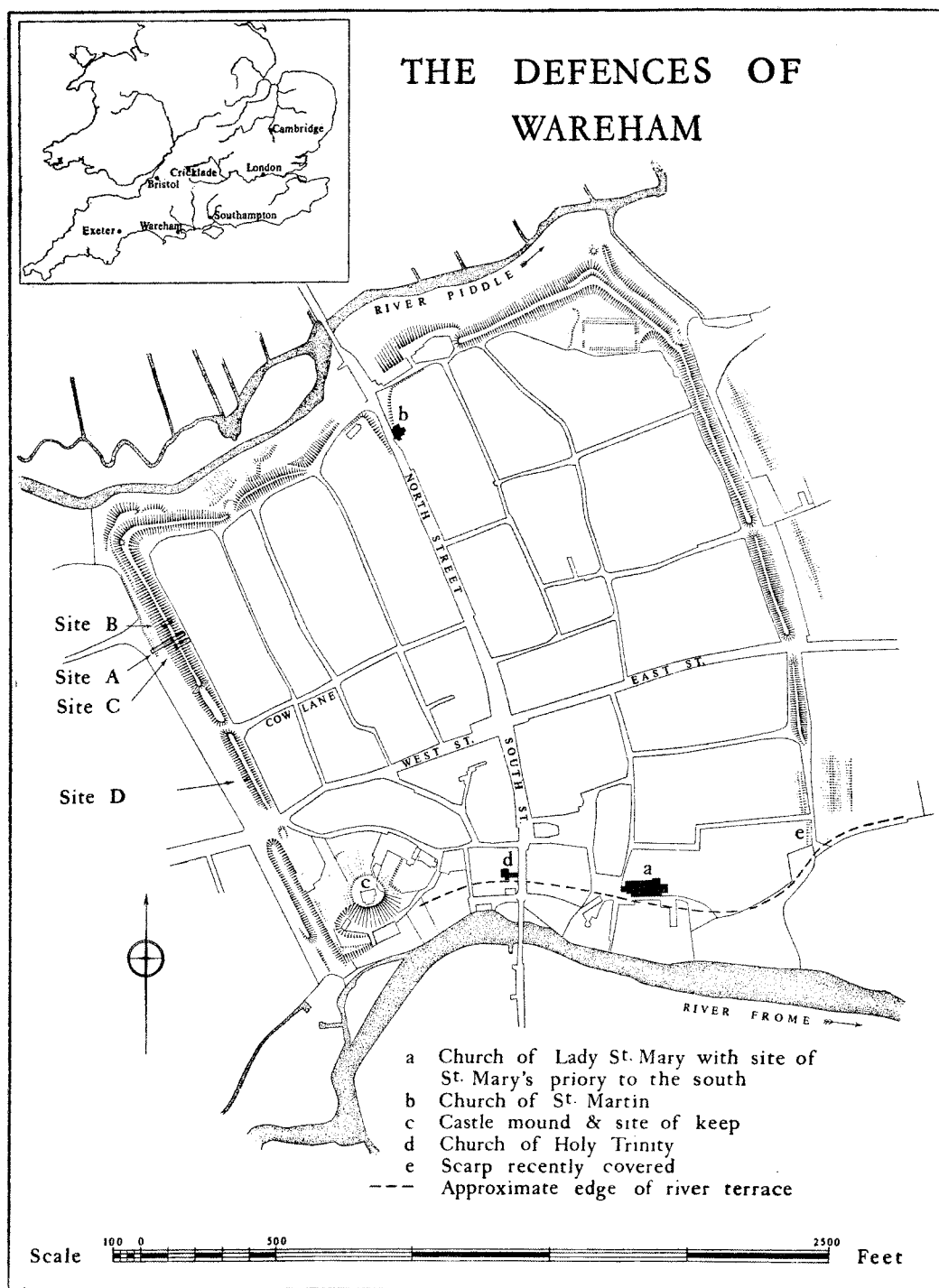


FIG. 46  
 THE DEFENCES OF WAREHAM, DORSET  
 (p. 120)

old church of Lady St. Mary in 1841. Four, ranging in date from the sixth to the eighth century, bear British names<sup>4</sup> and are witnesses to the existence on this site of a church and a cemetery used by the neighbouring British landowners, in the sub-Roman age, before the Saxon conquest. This church was rebuilt by the Saxons *c.* 700,<sup>5</sup> probably soon after their advance into Dorset.<sup>6</sup> Though written evidence of his connexion with the region first appears in the twelfth-century historian, William of Malmesbury,<sup>7</sup> this rebuilding should probably be connected with St. Ealdhelm, the first bishop of Sherborne (705-9). The architectural evidence shows a church on the scale of Brixworth.<sup>8</sup> This scale and the plan indicate the existence of an ecclesiastical community, a deduction borne out by the known existence of a nunnery of which there are contemporary records in the ninth and tenth centuries.<sup>9</sup> The importance of the church is also illustrated by the recorded burial of the West Saxon king, Beorhtric, at Wareham.<sup>10</sup> The evidence therefore shows that Wareham was a place of some importance in the seventh, eighth and ninth centuries and, if we may accept the evidence of William of Malmesbury, a port for cross-channel traffic. It would be a legitimate deduction that it was a centre for the local administration.

Under 876 the *Anglo-Saxon Chronicle*, here a contemporary record, states that the Danish army stole away to Wareham, which it terms a *fiere* of the West Saxons.<sup>11</sup> This has often been translated 'a fortress of the West Saxons', but, as Professor A. H. Smith has kindly informed us, the word need mean no more than 'encampment' or 'place of assembly' (for the *fyrð*). The word does not necessarily imply the existence of a fortification. The passage in Asser, who wrote soon after 890, uses the word *castellum*,<sup>12</sup> which does imply a fortification. In the Burghal Hidage, a document of the early tenth century, Wareham is shown as one of the chain of fortresses guarding the frontier of Wessex.<sup>13</sup> From this and later sources it is clear that Wareham was the most important burh in Dorset. These burhs were organized as a part of the military and administrative reforms begun in the later years of King Alfred (*ob.* 901) and completed under his successor.<sup>14</sup> In some cases—Winchester and Portchester are local examples

<sup>4</sup> R. A. S. Macalister, *Corpus Inscriptionum Insularum Celticarum*, II (1949), 188. The dating here adopted is based on notes kindly supplied by Professor Kenneth Jackson for the Inventory of the Royal Commission on Historical Monuments.

<sup>5</sup> The plan and paintings of the building demolished in 1841 are preserved in the church and will be published in the Inventory of the Royal Commission.

<sup>6</sup> The chronology here adopted is based on the identification of the second battle of Mount Badon (*Annales Cambriae*, *s.a.* 665) with Badbury Rings (K. Jackson in *J. Celtic Studies*, II (Philadelphia, 1953-8), 152-5) and on an assumed parallelism between the advance westward into Somerset after the victory in Pensewood in 658 and into Dorset after the victory at Badon (cf. F. M. Stenton, *Anglo-Saxon England* (1943), p. 63).

<sup>7</sup> William of Malmesbury, *Gesta Pontificum Anglorum*, III, 218, in *Rolls Series*, III (1870), 363-4.

<sup>8</sup> A. W. Clapham, *English Romanesque Architecture before the Conquest* (1930), p. 33.

<sup>9</sup> Asser, *De Rebus Gestis Regis Aelfredi*, cap. 49; *Anglo-Saxon Chronicle*, Cotton Tib. B.I. *s.a.* 982.

<sup>10</sup> *Anglo-Saxon Chronicle*, *s.a.* 784.

<sup>11</sup> *Anglo-Saxon Chronicle*, *s.a.* 876; the passage occurs in all the principal versions with unimportant variations.

<sup>12</sup> Asser, *op. cit.* in note 9, cap. 49.

<sup>13</sup> Text in W. de G. Birch, *Codex Diplomaticus Aevi Saxonici*, III, 671; F. M. Stenton, *Anglo-Saxon England*, p. 262; F. W. Maitland, *Domesday Book and Beyond* (1897), pp. 502-6.

<sup>14</sup> F. M. Stenton, *Anglo-Saxon England*, p. 262.

—the position and plan were probably determined by the existence of ruined Roman walls; in others the fortifications appear to have been erected *de novo*. But earlier ninth-century and even eighth-century documents indicate the existence of isolated strongholds in Saxon England. The fact that the first certain reference to the defences of Wareham occurs at a date that would bring it into connexion with the Alfredian reorganization does not, therefore, rule out the possibility that the Alfredian burh made use, in whole or in part, of pre-existing defences. Wareham continued to be a place of importance in the tenth and eleventh centuries. From this period dates the little church of St. Martin, set within the defences alongside the north gate of the town.

Wareham as a place of strength was superseded from the later eleventh century by the development of the great castle at Corfe, the site of which, a far finer tactical position, had come into the king's hands before 1086.<sup>15</sup> The foundations of a stone tower keep on a site above the river just inside the southern part of the west rampart of Wareham were discovered in 1910 and excavated by Mr. H. J. S. Clark in 1950-1.<sup>16</sup> Wareham figures quite prominently in the wars of King Stephen with the Empress Matilda and Robert earl of Gloucester. As a port on Poole harbour it was of the greatest importance to the party of the Empress, being a link between Normandy and the main centres of Earl Robert's power in the west. The later medieval history of the town is uneventful.

#### POST-MEDIEVAL REFERENCES TO THE RAMPARTS

There are no references which have any value relating to the defences of Wareham until the period of the seventeenth-century Civil War.

At the time of the Civil War the town was held at first by the Parliamentarians, and on 19 August, 1642, £10 was granted for the strengthening of the walls. On 2 September £50 more was advanced for the same purpose.<sup>17</sup>

On 1 February, 1643-4, the town was taken by Sir Ralph Hopton with 300 prisoners,<sup>18</sup> but was later retaken in August 1644, when a battle was fought at the West Gate and 1,200 horse and foot forced an entrance.<sup>19</sup> Proceedings at the Committee of both Kingdoms ordered 'that the letter from Wareham be reported to the Commons, with the opinion of this Committee that the works should not be sleighted'.<sup>20</sup>

On 14 September, 1644, Sir William Waller and Sir Arthur Haselrigg, writing of Wareham to the Committee, said 'we look upon it as a place of great consequence neither can the works be sleighted'.<sup>21</sup> On 21 September following Sir William Waller wrote 'into Wareham I have put between 400/500 men and

<sup>15</sup> R. W. Eyton, *A Key to Domesday etc. with an Analysis and Digest of the Dorset Survey* (London, 1878).

<sup>16</sup> *Builder*, 18th June, 1910; *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LXXII (1950), 82; *id.*, LXXIII (1951), 85.

<sup>17</sup> G. J. Bennett, 'Wareham, its invasions and battles,' *Proc. Dorset Nat. Hist. and Antiq. Field Club*, XIII (1892), 108-9.

<sup>18</sup> *Calendar of State Papers Domestic*, Charles I, 1644, 11.

<sup>19</sup> Bennett, *op. cit.* in note 17, pp. 101, 110.

<sup>20</sup> *Calendar of State Papers Domestic*, 1644, 427.

<sup>21</sup> *Ibid.*, 502.

the same men block up Corfe Castle. But it is impossible to finish the works about Wareham in time if the enemy advance that way'.<sup>22</sup>

Hutchins who died in 1773 gives a detailed description of the walls, noting vanished features which may have been constructed during the Civil War.<sup>23</sup>

Little then happened to the walls until about 1850; in 1899 Bennett recorded that 'a large portion of the west wall is considerably lower than the rest; and it may be as well to mention that about the middle of the present century a large portion of this wall, with the outer rampart which Hutchins mentions, was thrown down to fill up the remarkable ditch at the base of the wall'.<sup>24</sup> The purpose of this operation was to make a road to the present old people's hospital.

### EARLIER EXCAVATIONS

It is recorded by Lt.-Col. C. D. Drew that in about 1910 the Rev. Canon S. Blackett, rector of Wareham, dug in three places into the east wall and found in each a core of roughly-piled blocks of Purbeck stone.

In 1930 Lt.-Col. Drew himself observed an excavation through the west wall close to the north-west angle, partly by tunnel, to put in a sewer pipe; at the same time he was able to cut a section across the ditch. No evidence of date was obtained, but it was apparent that the earth had been taken for the rampart from the interior of the work.<sup>25</sup> The composition and contents of the upper layers of the first phase of the rampart, as distinguished during the Commission's excavations, supports this conclusion.

In 1951, Mr. H. J. S. Clark, whose excavations at the Castle have been mentioned above, dug a trench in the crest of the inturned bank at the south-west angle of the town, exposing substantial rubble and mortar debris of a wall. Part of a retaining wall at the base of the scarp that lies to the south below this feature had been discovered previously.

### THE ROYAL COMMISSION'S EXCAVATIONS

The Royal Commission began their excavations in 1952 at Site A (PL. VI, A and B; FIG. 46), not far to the south of the north-west angle of the defences. The site was chosen to provide a section through both the rampart, at that point nearly but not quite at its highest surviving height, and the ditch at its widest and most accessible. Site B (1953), some 80 ft. north of Site A, where the rampart reaches its highest point, was excavated to get further data from the layers above the footings of the stone wall discovered the year before. Site C, as close as possible to the south side of Site A and reaching from the beginning of the western scarp of the rampart to the tail of the bank at the east, was intended to supplement the data from the upper layers of the two earlier cuts.

<sup>22</sup> *Calendar of State Papers Domestic*, 1644, 523.

<sup>23</sup> *History of Dorset*, 3 ed., I (1861), 94.

<sup>24</sup> Bennett, 'The Roman occupation of Wareham,' *Proc. Dorset Nat. Hist. and Antiq. Field Club*, xx (1899), 149.

<sup>25</sup> *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LII (1930), lxxxvii-viii.

## PHASE I: THE PRIMARY RAMPART AND OCCUPATION BELOW IT.

In the natural subsoil, which here is gravel on sand, two Early-Iron-Age pits were found, both about  $5\frac{3}{4}$  ft. in diameter and  $5\frac{1}{2}$  ft. deep (FIG. 47). In the eastern pit two layers were observed; the lower (9b) of burnt earth was sterile, the upper (9a) of grey brown soil with some Iron-Age sherds. The western pit also produced Iron-Age sherds. The pottery indicates a late date in the local pre-Roman sequence for these pits.

The natural subsoil which ran flush below the rampart was covered with a thick and fairly uniform layer of black soil (8) (FIG. 47) the top of which formed the ground level at the building of the rampart, and which sealed the Iron-Age pits. In the lower part of this layer, near the east side of the eastern pit, was an area of intense burning with red clay, blackened flints, and some charcoal. Layer 8 was the only layer which showed signs of occupation. It was lighter in colour than the other black layers in the rampart, had less pottery and could not be distinguished stratigraphically from the top layers of the pits. All the pottery was of Iron-Age or Romano-British type in abraded condition, the latest being of the third or fourth century.

*The primary rampart.* The first phase of the defences consisted of an earthen rampart, which survives to a height of 9 ft. above the old ground level (layers 7a, b, c, and d: FIG. 47), though subsequent recutting (p. 128) has removed all trace of the associated ditch which must have existed on the west side. This ditch can hardly have been much inferior in size to the present ditch.

The lower part of the rampart consisted of differently-coloured gravels, earths and sands, all deposited at the same time, but in different layers, lying almost horizontal at the middle and tailing off to the rear. These layers contained a small amount of pottery, mainly of Roman date. The original front of the rampart, however, had been cut off by later scarping and it is impossible to say more about its form except that the horizontality of the existing layers suggests that they were piled against a vertical revetment, presumably of timber.

Over the lower part of the rampart were two layers of black earth (7a and c) containing a large amount of abraded pottery, including some New Forest ware and a few sherds that are apparently post-Roman; these layers were separated by clean gravel (7b). The two black layers were similar in consistency to the layer (8) overlying the natural formation and contained the same sort of pottery, but in greater quantity. It seems that they may have been derived from surface clearing of the occupied area within the wall, whereas the gravel layers represent relatively clean subsoil derived from a ditch on the west side.

The upper black layer exposed in 1952 is described by Professor Zeuner as consisting of predominantly natural material, which may well represent a buried surface with vegetation, on which fires had occurred.<sup>26</sup> If this layer was

<sup>26</sup> Professor Zeuner's report said: 'The acid-insoluble residue contained small crumbs of charcoal, none large enough for identification. In view of the comparatively low phosphate, and humus slightly higher than in the rest of the samples from Wareham, this may well be a buried surface with vegetation, but in view of the presence of charcoal (not necessarily but almost certainly from artificially kindled fires), this conclusion need not connote abandonment of the site. It is not an occupation surface in the sense that it consists largely of human rubbish, but seems predominantly natural.'

not in fact upcast, these conditions imply that the primary rampart remained unaltered for a considerable period. The comparable layers revealed in 1953 and 1954, though differing somewhat in composition and not subjected to analysis, appear to reproduce the same conditions. In Section B (1953) the primary rampart had two black layers separated by gravel over the core, as before, but in Section C (1954) the black layer on top of the rampart was very thick. The dating of this layer was checked in Section C (1954) by digging a pit at a point which was covered by structures of the next phase in order to obtain completely sealed pottery. It proved to be of exactly the same range as the earlier finds, including one sherd of apparently post-Roman date.

In 1953 a trial pit (Site D) was dug into the side of the rampart between the west gate and a road passing through the defences to the north of it, to enable a check to be made on the make-up of the rampart core and in particular to see whether any sealed pottery could be found in it. The tiny sherds this brought to light were of indeterminate character.

The pottery from the primary rampart like that from the underlying layer (8) was in a very worn condition, and besides some Early-Iron-Age pottery, consisted largely of coarse wares ranging from the first to the fourth centuries A.D. Late Roman colour-coated pottery of New Forest type was uncommon but included a worn sherd of a rosette-stamped bowl, which, so far as our knowledge of the New Forest industry extends, implies a date for the rampart at any rate not before *c.* 375 and perhaps appreciably later in view of the condition of the sherd. There is also however a small quantity of pottery for which a post-Roman date is likely and one sherd (FIG. 50, no. 15) for which it is certain. This pottery is described below (p. 130). In view of the subsequent history of the defences, it seems reasonable to regard the rim (no. 15), of approximately Norman age, as an intrusion. The remainder, in view of the small number of sherds and the fact that only one was found in a sealed context, cannot be taken to prove that the date of the rampart was after 700, although the evidence points in that direction (see also Appendix).

#### PHASE II: THE STONE WALL AND SECONDARY RAMPART

Whatever the form of the original front of the primary rampart, it was probably unusable when a stone wall was erected with its front on the crest of what remained. This wall rested at the back on a thick layer of clean silty river-loam.<sup>27</sup> The sequence of construction was as follows:

- a.* A great mass of river-loam (6) was piled on the back of the earlier rampart. It was grey in colour, practically sterile, and had a thin interleaving of yellow gravel and earth in it, showing a phase in the deposit of the layer. Where the loam ran out against the black earth at the top of the rampart the edge was defined in

<sup>27</sup> The material was shown to a local firm who handle clay as part of their business, and they reported that it was not a true clay, but more likely to be derived from the bed of a river. Professor Zeuner's report on the material stated: 'This seems to be chiefly natural. Charcoal was absent. A mechanical analysis shows the material to be predominantly (60%) silty calcareous loam, with only just over 20% clay and 20% sand. It may be floodloam of the river, but the comparatively well-sorted character suggests a considerable proportion of wind-transported dust perhaps redeposited by water. The sample is by no means a clay.'

Section B by a kerb of stones rammed into the earth and forming part of the footings of the wall (PL. VII, B).

*b.* A thick white mortar spill (5) capped the slope of the loam bank behind the wall, and incorporated large flat pieces of limestone and many pieces of flint; it could be builders' debris or a deliberately laid surfacing on the slippery clay to assist building operations. The suggestion that the layer was builders' debris is supported by the fact that animal bones and sherds occurred throughout. In Section B the spill was practically non-existent at the top but was quite thick lower down, while in Section C a band of stones had been set half-way down the bank, as if to prevent movement on the steep slope, and was matched in Section A by a hump of mortar in the same relative position. At the bottom of the slope a band of puddled chalk, found both in 1952 and 1954, limited the spread of mortar and stone downhill.

In Section B a red sand covered the wall-foundation, the mortar spill, and the loam where exposed. This could represent a short interval between the erection of the wall and the provision of the bank behind it.

*c.* The wall-foundation (4) comprised a mortar raft to carry footings over 7 ft. wide (PL. VIII, A). The mortar was light-coloured, rather like puddled chalk in consistency, and contained a considerable quantity of broken Roman tile, including flue tiles. In Section A, at the front of the wall, there was a broad flange of mortar, presumably to throw off water. The flange was present at the back also, but was not so well preserved, and embedded in it were some quite heavy stones.

The flange was well defined to the east in Section B. Under the flange a core of flints was laid in two rows, tilting with the rear slope of the rampart (PL. VII, B). In Section C a mass of gravel (4b) capped with mortar (4a) formed the flange on the inside, but there was a kerb on the outside of the wall, consisting of flat limestone blocks, and clearly intended torevet the wall-foundations towards the ditch (PL. VII, A). A heap of stones and mortar (4) is probably to be regarded as part of the wall-foundation rather than debris in the robber levels. It appears that the line of the wall was first laid out with lines of stones, perhaps to limit the spread of mortar put between them, and that the flanges were made during the building of the wall as a water-proofing fillet. When the wall was robbed of its masonry the break-up of the foundations was more thorough at the front.

*d.* A path (2) rested upon an earth bank (3) piled against the back of the wall. The make-up contained interleavings all much of the same date and containing Iron-Age, Romano-British and later sherds.

The path behind the wall was formed by a layer of clay and sand (2). In Section A most of it had subsequently been cut away. The capping was seen to best advantage in Section B where the rampart was highest, and it was hard and well-marked. In the centre of the path and running along the rampart was a hollow, which was filled with earth; its east side appeared as a straight line in plan. It probably indicates wear in the footpath. The layer was level for some distance towards the east and then tipped down the back of the rampart. A twelfth-century sherd (FIG. 50, no. 8) was found on the surface near the hollow, but may have reached this position in the operations connected with Phase III.

In Section C the make-up of the bank at the back of the wall was more complicated. The bottom of layer 3d had a certain amount of stone spill and snail shells in it, which could indicate a period of exposure when the wall was being built. Near the top a layer of sand and pebbles (2) would appear to represent the capping of the bank.

Although for the sake of clarity the four features of wall and secondary rampart have been described separately, it is certain that they formed part of a single building programme.



As elsewhere sherds of Roman and pre-Roman age predominate in the deposits associated with Phase II, but with the exception of four fragments either doubtfully or certainly post-Conquest in date but in unreliable contexts, the latest material consists of 16 sherds comparable, as were a few in Phase I, with the middle and late Saxon series identified at sites along the south coast from Kent to Hampshire, and at present dated between the late seventh or early eighth century and the Norman conquest. This material is considered in detail below (p. 130). Its features are too indefinite to permit a closer estimate of its date, but the recovery of 16 miscellaneous sherds from a comparatively restricted area shows that it must have been current for a certain period, bearing out the evidence already quoted concerning the soil layer over the primary rampart. A date as early as the eighth century seems unlikely on the basis of the archaeological evidence.

PHASE III: DESTRUCTION OF THE STONE WALL, RESCARPING AND HEIGHTENING OF RAMPART AND RECUTTING OF THE DITCH

The third phase comprised a complete remodelling of the rampart and ditch after the Norman conquest and not earlier than the twelfth century; the incidents of the phase are not certainly part of one operation but may well be so. They are summarized thus:

*a.* The wall was robbed to its foundation, mainly from the outer side, for although the earlier layers still run up towards the line of the wall on the inner side, they have been removed on the outside. Here, in Sections A and B, was found a spill representing the ruin of the wall (1x) containing heavy limestone blocks tilting downhill, but suddenly ceasing at a point where the fall seemed to have been cut by later rescarping. Normally the stones would have run to the bottom of the slope; the spill that remained indicated that the previous slope was not as steep as the rescarped one. The considerable fall of stones and mortar to the front may have broken the forward flange, and the spill would then become indistinguishable from it except by being rather looser.

The robber trench is clearly seen in Section B (FIG. 47 and PL. VIII, B), for three layers of fill in the trench (1a), above the wall foundation, stopped abruptly at a vertical line on the north side of the cutting, beyond which the bank with the path above still remained. On the south side it was much more ragged, showing a variation in the method of robbing. The impression given was that the wall here was pulled down from the west side and was also robbed from above.

The robber trench in Section C contained five layers, with various mortar patches and some gravel. An attempt was made in digging to expose the exact face of the robber trench, but it failed owing to the looseness of the gravel in the side. This shows that when the stone of the wall was removed the resultant gap was deliberately filled in with earth almost immediately, for the side of the robber trench could not have remained so straight if exposed for any length of time.

*b.* Next the existing ditch was dug, evidently involving a substantial rescarping of the front of the bank, since both features slope conformably, while some of the soil at the base of the primary rampart and in the nearer Iron-Age pit has clearly slipped down the face of the fresh scarp. Some of the material was evidently put on top of the rampart, and in all probability used to fill the scar left by the robbing of the wall. In Sections A and C it was difficult to distinguish the remains of this capping (1) from more recent accumulations above, and from the underlying

remains of the bank of Phase II. In Section B, however, where the rampart stands at its highest, above the strata associated with the robbing of the wall, was a dark sand mixture (1), and on this a level of yellow sand which may represent the cap of this latest rampart. This yellow sand was quite clean except for some root penetration, and probably represents fresh subsoil obtained from below the bottom of the original ditch.

The recut ditch, dug in sand and gravel, was relatively flat-bottomed in the section cut in 1952 (FIG. 47)<sup>28</sup>. The primary silt (d4) was a sterile clean sand over the whole bottom and must have been quite rapid. Above this silt was a deep bed of gravel (d3a) with an interleaving of earth, probably a slip of topsoil from the rampart, on its east side. In this deposit of coarse material we may recognize a fairly rapid accumulation due to weathering of the unstable sides of the ditch. It will be important, however, when considering the implication of pottery found in these levels, to recognize the possibility that ditch maintenance in the years immediately following the cutting of the ditch of Phase III may well have removed earlier deposits of similar character. A deposit of dark soil and gravel (d3) immediately above d3a may in contrast represent a period of relative stability, during which vegetation was able to gain a foothold. Subsequently the ditch appears to have undergone substantial further weathering, evident in a thick deposit of sandy earth (d2), probably in the sixteenth or seventeenth century, as will appear below. Above layer d2 some Purbeck stone rubble was found in the south face of the cutting; its origin is not clear, but it can hardly be associated with the robbing of the wall.

Several depressions in the natural gravel beyond the ditch, some of which are indicated at the extreme west end of Section A, were purely local in character; trees may have existed here. No post-Roman sherds were found in this part of the cutting, except in the uppermost levels, and it may be assumed that the ground surface, by late Roman times, stood about one foot above the natural subsoil at this point; the western lip of the ditch could not be defined, but its approximate position is indicated in Section A.

The material obtained from the levels associated with Phase III must now be considered; notes on the illustrated pieces are provided below (p. 134).

The filling of the robber trench, besides much pottery of the usual kind, contained two scraps of sandy ware, one of which at least should not be dated earlier than the twelfth century. The layers forming the remains of the final bank yielded two larger fragments of hand-made or hand-finished cooking-pots of the same age, and three rims (FIG. 50, nos. 7-9) of similar sandy fabric, which may possibly be as late as the early thirteenth century but which more probably belong to the twelfth.

The primary silt of the ditch was sterile, but immediately on top of it, at the base of the coarse gravel filling (d3a), there were, in addition to derived Romano-British sherds, four side fragments and part of a plain sagging base of sandy fabric, which again are referable to the twelfth rather than the thirteenth century. This filling, however, contained in its earthy middle part a rim (no. 10) datable to the thirteenth rather than the twelfth century, and in its upper part another (no. 11) more certainly of the thirteenth century together with eleven sherds, mostly amorphous but including a piece with applied ornament (no. 12), that need not be later than the twelfth century. The darker relatively humic layer (d3) contained material certainly of the thirteenth century, including, besides

<sup>28</sup> Lt.-Col. Drew's report (see p. 124 above) shows that a few yards to the north the ditch was V-shaped with a gently rounded bottom.

the ridge tile (no. 14) and two rims (no. 13, and a piece from the same vessel as no. 11), four glazed sherds which, in Mr. G. C. Dunning's opinion, should belong to the latter half of the century. The filling (d2) above this level yielded mixed material including one sherd perhaps of the fifteenth or sixteenth century, but in which the latest pieces were three of the sixteenth or seventeenth century, one a piece of a 'Bellarmine' jar. The upper filling (d1) contained sherds of the eighteenth century and later. This evidence is sufficient to show that Phase III should be dated after 1100 and probably in the twelfth century; the ditch shows that it could in any case hardly be much later than 1250. A context in the period of the civil war between Stephen and Matilda would seem reasonable.

## THE POTTERY

### PHASE I

The ambiguous pottery, which is not susceptible of illustration, consists of five small worn sherds of apparently hand-made vessels of a fairly hard but generally brittle black ware, with more or less rough, unburnished surfaces, sometimes with marks of brushing or wiping on the inside before firing. All have much coarse grit in the fabric, and are characteristically pitted in surface and body mainly as a result of dislodgement of the grit, which still includes sharp flint or chert, and quartz, and in one instance a calcareous substance, probably chalk or limestone rather than shell. There is no evidence that the pitting is appreciably due to the burning out of organic matter or to the leaching of calcareous particles. While the sherds resemble in fabric some of the undoubtedly middle and late Saxon wares, of which a few other fragments were found in later contexts, and like them contrast with the general run of pre-Roman Iron-Age wares in the region, they are small and featureless and an Early-Iron-Age origin cannot be ruled out for any individual piece. The evidence for assigning this series as a whole to the class of middle and late Saxon hand-made wares identified by Mr. G. C. Dunning from sites along the south coast from Kent to Hampshire, and for which an initial date of *c.* 700 is at present suggested, appears below in the discussion of the larger series of similar character in levels associated with Phase II.

The single sherd for which a post-Roman date is quite certain is the rim of a hand-made or hand-finished cooking-pot of hard sandy grey ware, with some larger quartz grit (FIG. 50, no. 15). The outer surface is brown and pimply, resembling the finish of early post-Conquest wares in the region, and although the sherd is irregular and the illustrated section perhaps not altogether typical, a date centring upon 1100 would be regarded as reasonable in the light of present knowledge. This sherd, however, although found in the lower part of the primary rampart, was not in a position that would preclude the possibility of subsequent intrusion through natural or other agencies.

### PHASE II

Amidst the bulk of earlier pottery found in the levels contemporary with the stone wall of Phase II, 16 sherds apparently from hand-made vessels stand

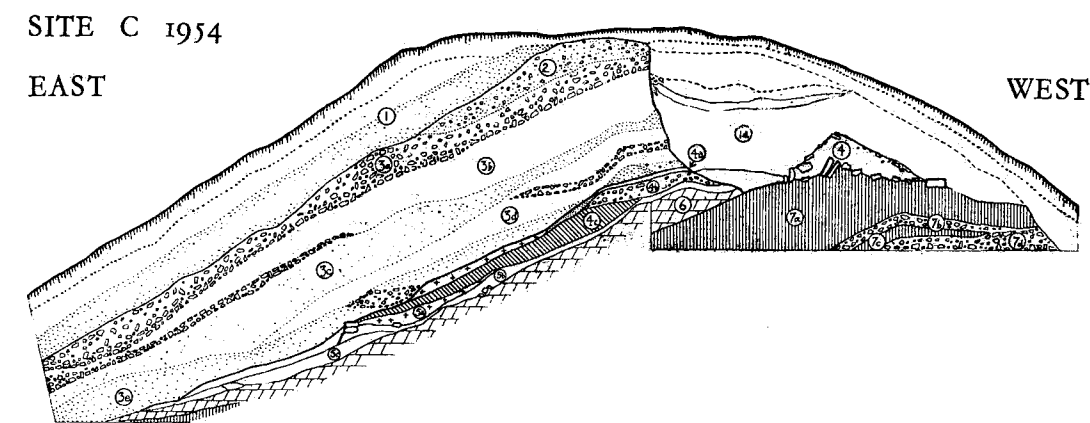
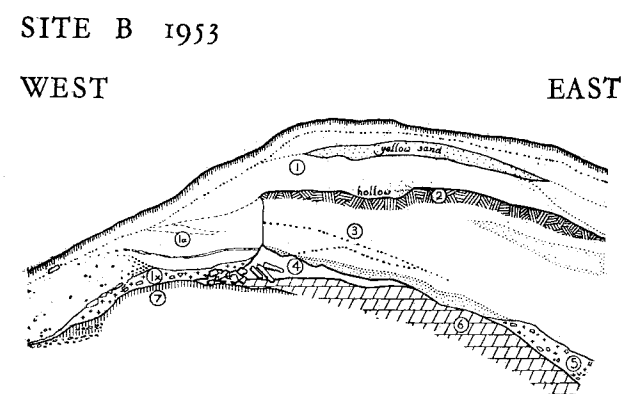
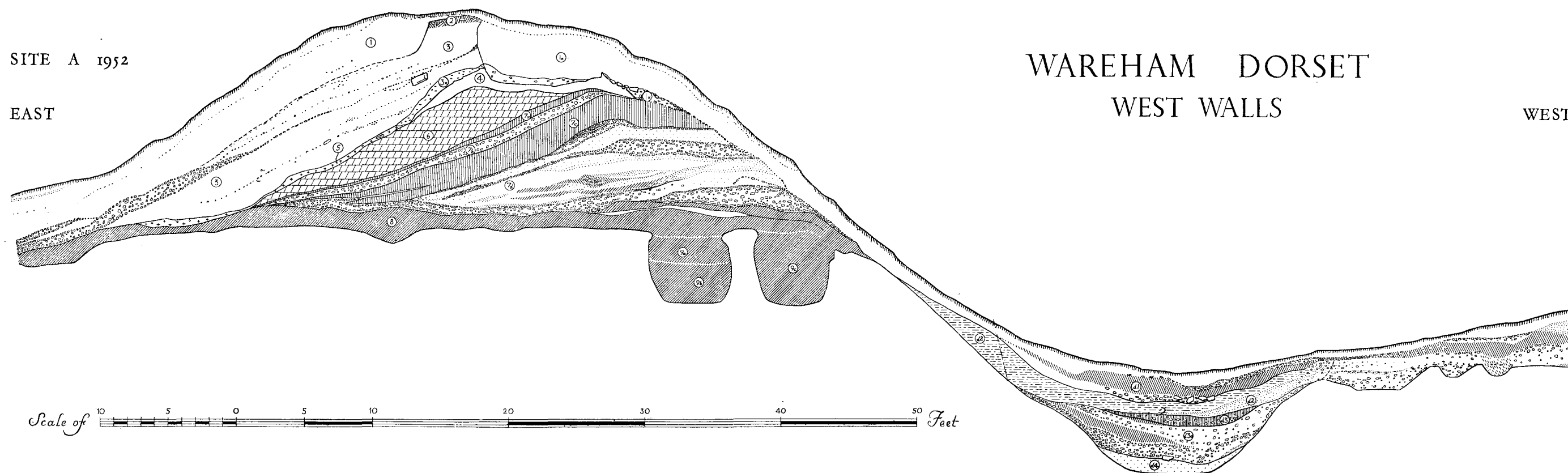


FIG. 47  
WAREHAM WEST WALLS, DORSET  
Sections of the bank and ditch (pp. 125 ff.)



out as of post-Roman date.<sup>29</sup> Four of these are illustrated in FIG. 48, nos. 1-4, the remainder being featureless and generally small and worn. With the exception of the decorated base or lid (no. 1), to which we shall return later, these form a homogeneous series contrasting with the hand-made wares of the Early Iron Age in the region, although more notably in fabric and finish than in form. They are matched by the five amorphous sherds from the primary rampart already described in the preceding paragraphs, and also by a further series of 24 sherds, amorphous save for two small rim pieces similar to nos. 2 and 3, found, no doubt as rubbish survivals, in the post-Conquest deposits associated with Phase III. There is no need to repeat the description already given for this ware, but examination of the larger series from Phases II and III enables it to be amplified; occasional fragments of shell occur in the paste, a few sherds show a relatively smooth but still unburnished outer face, while several have been fired to an uneven dark brown colour; marks of brushing or wiping occasionally appear on the outside as well as the inside.

This assemblage may be compared with the groups of middle and late Saxon wares identified at several sites along the south coast by Mr. G. C. Dunning, even though close correspondence in fabric need not be expected in wares that were probably of local manufacture and restricted distribution. The two rims and the neck (nos. 2-4) are of the typical pitted fabric of the Wareham series, and appear to belong to hand-made cooking-pots of medium size, with a curved or flaring neck, and plain rounded rim sometimes tending to angularity. These may be compared with the hand-made vessels, characteristically with sagging base and rounded base angle, found at Selsey (Sussex),<sup>30</sup> Canterbury,<sup>31</sup> and Hamwih (Southampton),<sup>32</sup> where there is reason to suppose a date in the eighth or ninth century, and at Chichester (Sussex) where, as at Pevensey Castle (Sussex), there is evidence for the continuance of this sort of hand-made pottery into Norman times.<sup>33</sup> To this series, although its fabric is not apparently pitted, a larger piece of a cooking-pot with flared rim (FIG. 49, p. 138), which was found near Site D in 1947, undoubtedly belongs.

These native Saxon wares in southern England have been shown to fall broadly between about 700 and the Norman conquest. It is however impossible with this coarse hand-made ware of local origin<sup>34</sup> to define a typological sequence or to date individual sherds or series at all narrowly on form alone. Thus, while

<sup>29</sup> In addition, one very small sherd suggestive of post-Conquest fabric, but in the opinion of Mr. G. C. Dunning possibly Saxon, was found beneath the path (2). Two small sherds of twelfth/thirteenth-century ware, and a larger piece from a glazed bowl hardly earlier than the late thirteenth century, were found in the tail of the bank, ostensibly in the gravel layer (3), but lack of definition in the stratification here precludes their consideration as reliable dating evidence.

<sup>30</sup> G. M. White, *Antiq. J.*, xiv (1934), 395-6, fig. 2.

<sup>31</sup> S. Frere, *Archaeol. Cantiana*, lxxviii (1955), 124-5, fig. 12, especially no. 112, although the base is missing; cf. vessel with rounded base from a Saxon cemetery at Holborough (Kent), *ibid.*, lxx (1957), 104, fig. 20.

<sup>32</sup> Information from Mr. M. R. Maitland Muller, according to whom native pottery definitely associated with tenth-century occupation at Hamwih is still to seek.

<sup>33</sup> G. C. Dunning, *Archaeol. News Letter*, 1, no. 10 (1949), 2; *Sussex Archaeol. Colls.*, xci (1953), 144-7, fig. 3.

<sup>34</sup> Comparison of the Wareham series with sherds from Hamwih, for example, emphasizes its regional character.

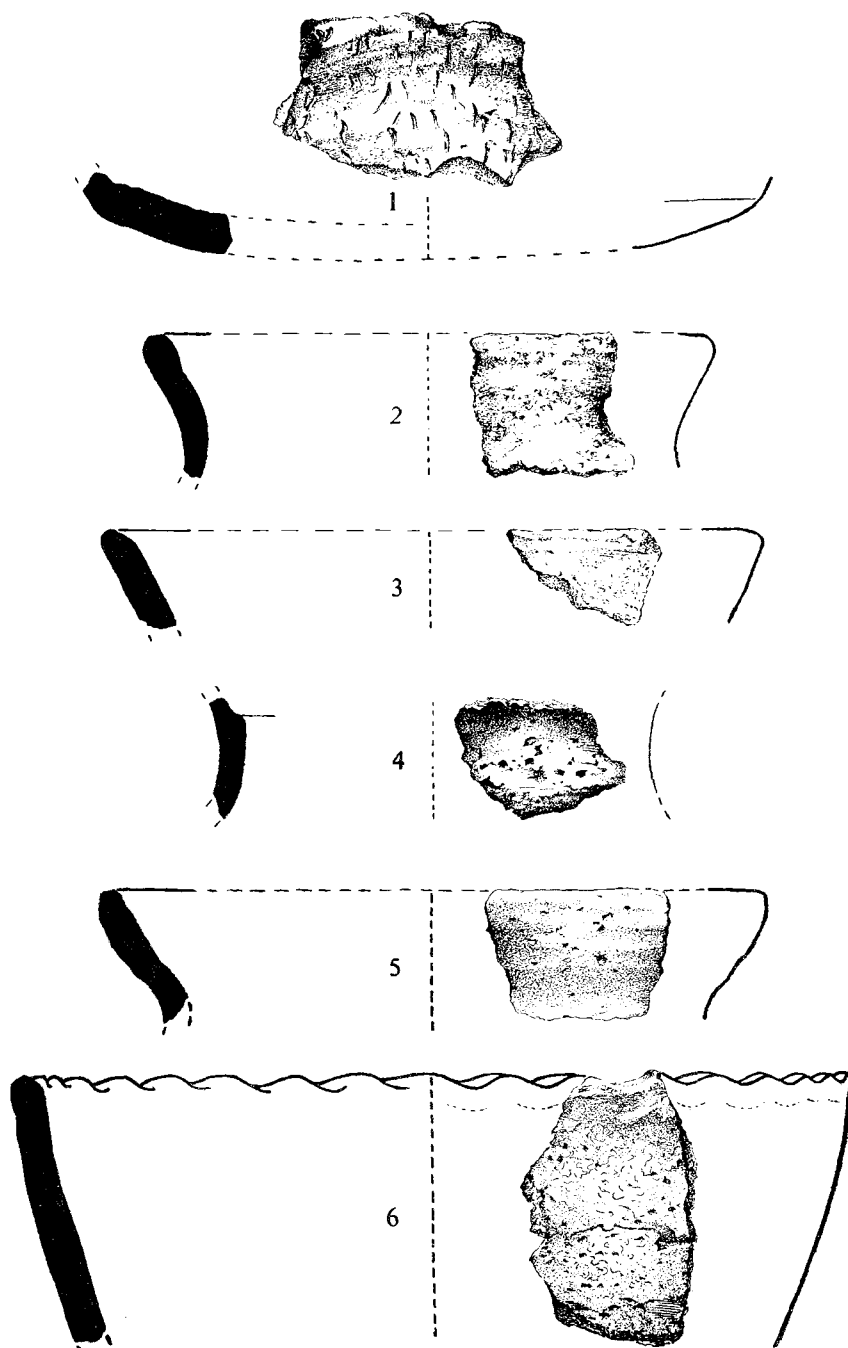


FIG. 48

WAREHAM WEST WALLS, DORSET  
 Saxon and Saxo-Norman pottery (pp. 131 ff.). Sc.  $\frac{1}{2}$

the closest reliably dated parallels to the rims, nos. 2-3, may be found amongst the late Saxon series at East Pallant (Chichester),<sup>35</sup> a comparable form appears at Selsey,<sup>36</sup> where there is no evidence that it need be later than the ninth or indeed the eighth century.

Two sherds from unstratified contexts may be noticed, since both are of fabrics identical or comparable with that of the middle and late Saxon sherds discussed above. Neither, however, need be of pre-Conquest date. No. 5, a somewhat flat-topped rim of relatively sophisticated bell-shaped profile, might be at home in the twelfth century;<sup>37</sup> it may have been wheel-made, although certainly hand-finished, but its fabric compares closely with that of the denser and harder pieces in the Saxon series, especially with no. 2. No. 6 has a wavy rim produced by pressure

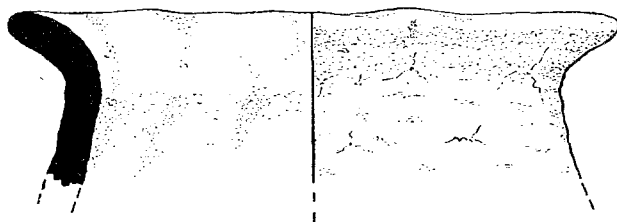


FIG. 49

## WAREHAM WEST WALLS, DORSET

Saxon cooking-pot rim found in 1947 (p. 138). Sc.  $\frac{1}{2}$

with thumb or finger, but the pitch of the sherd is uncertain. The analogies for the form appear to lie in the eleventh or twelfth centuries, whether the vessel was barrel-shaped<sup>38</sup> or, as conjectured in the illustration, an open bowl of the type found at Chichester and dated there to the early twelfth century.<sup>39</sup> The fabric, however, is apparently identical with that of the Saxon series on the site.

It remains to consider one sherd (no. 1) found in the bank of Phase II. This is not of the brittle, pitted fabric characteristic of the middle and late Saxon series at Wareham as so far recognized, and appears to belong to a hand-made sagging base with a rounded but distinct angle. The position of the decoration, however, suggests that it may be part of a lid. The ware is sandy and fairly hard, with some coarse white quartz grit, and is grey with darker unsmoothed surfaces, very irregular inside, with traces of brushing or wiping; the decoration is a haphazard overall grouping of neat finger-nail impressions. Mr. G. C. Dunning has compared the sherd in form and fabric, if it is a base, with the Richborough (Kent) pitcher, of Frankish inspiration and assigned to the eighth or ninth century.<sup>40</sup>

<sup>35</sup> G. C. Dunning, *Sussex Archaeol. Colls.*, xci (1953), 146-7, fig. 3.

<sup>36</sup> G. M. White, *op. cit.* in note 30, fig. 2, no. 6.

<sup>37</sup> Compare for shape a rim from Sherborne Castle, *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, lxxiii (1952), 108, fig. 2, no. 6.

<sup>38</sup> Mr. Dunning cites an unpublished parallel in the Winchester City Museum.

<sup>39</sup> G. C. Dunning, *op. cit.* in note 35, pp. 147-8, fig. 9.

<sup>40</sup> J. P. Bushe-Fox, *Excavations at Richborough, Kent*, iii (*Res. Rept. Soc. Antiq.*, x, 1932), 186, pl. xlii, no. 362.



In view of the uncertainty as to the form, and the existence of wares with similar decoration in pagan Saxon contexts,<sup>41</sup> it would be unwise to regard this sherd as contributing to the discussion of the middle and late Saxon pottery at Wareham.

### PHASE III

The latest pottery<sup>42</sup> in this phase, like most of the material from the site, was in worn condition, and consisted of 45 medieval fragments, distributed as follows: robber levels—2; final bank—5; ditch filling 3a—18; ditch filling 3—20. Of these, 8 pieces, including part of a ridge-tile, are worthy of description (FIG. 50, nos. 7-14); the remainder has been adequately noted in the discussion above (p. 129). The quantity of pottery is insufficient to permit a general description and comparison with wares outside the region, but it may be noted here that the backing consists mainly of fairly coarse quartz sand, with occasional large grits, but without shell;<sup>43</sup> the surfaces are characteristically rough or pimply owing to protrusion of the grit. The rim diameters are approximate in all but one instance (no. 9).

#### *Final bank*

7. Cooking-pot rim, everted with bead on inner edge; probably wheel-made. Fairly hard reddish-brown ware. The type occurs at Corfe Castle (unpublished) in a deposit of c. 1100, and a comparable form is recorded from Portland (Dorset); *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LXXII (1950), 85, fig. 1, no. 6. Twelfth century, hardly later.
8. Cooking-pot rim, everted, thickened and bevelled externally with concave inner face; hand-made or finished. Fairly hard ware, grey core with pinkish brown surfaces. Cf. Portland, *loc. cit.*, no. 9, but not truly bell-mouthed as there suggested. Twelfth century rather than thirteenth.
9. Pan or cooking-pot rim, everted but with slightly inbent lip; irregular but apparently wheel-made. Hard ware, grey core, with generally finer sand backing, and relatively smooth brown surfaces. Cf. pans and cooking-pots of twelfth-century type at Sherborne (Dorset); *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LXXIII (1951), 108, fig. 2.

#### *Ditch, d3a*

10. Pan or dish rim of hammer-head form, hand-made or finished. Fairly hard ware, somewhat coarse and laminated, of dark grey paste fired brown on the inner surface and on top of the flange. The vessel may be dated to the twelfth or, as Mr. Dunning has suggested, to the thirteenth century, but it is uncertain whether the sherd belongs to a variant form of the deep pans of West-Country type with flaring rim, or to a convex-sided dish such as those occurring widely in twelfth-century and thirteenth-century contexts; *Proc. Somerset Archaeol. and Nat. Hist. Soc.*, LXXXV (1939), 123, and *Berkshire Archaeol. J.*, I (1947), 58.

<sup>41</sup> J. W. Brailsford, *Antiq. J.*, xxviii (1948), 186-9, fig. 2. The correspondence between the Wareham sherd and a piece of a sagging base with finger-nail 'rustication' found with Belgic, Romano-British and mid-fifth-century Saxon pottery at Northfleet, Kent (*ibid.*, fig. 2b), is particularly close. The sagging base, although not attested as a type feature before the eighth century, might well occur sporadically in earlier contexts by accident if not by design. The decoration, although of a general type occurring widely in prehistoric pottery, has not yet apparently been found on post-pagan Saxon ware. Mr. R. L. S. Bruce-Mitford has kindly furnished a list of finger-nail 'rusticated' and associated rim-lug pottery in pagan Saxon contexts, which amplifies that published by Brailsford.

<sup>42</sup> Thanks are particularly due to Mr. G. C. Dunning for help with the dating.

<sup>43</sup> Cf. *Proc. Dorset Nat. Hist. and Archaeol. Soc.*, LXXII (1950), 86.

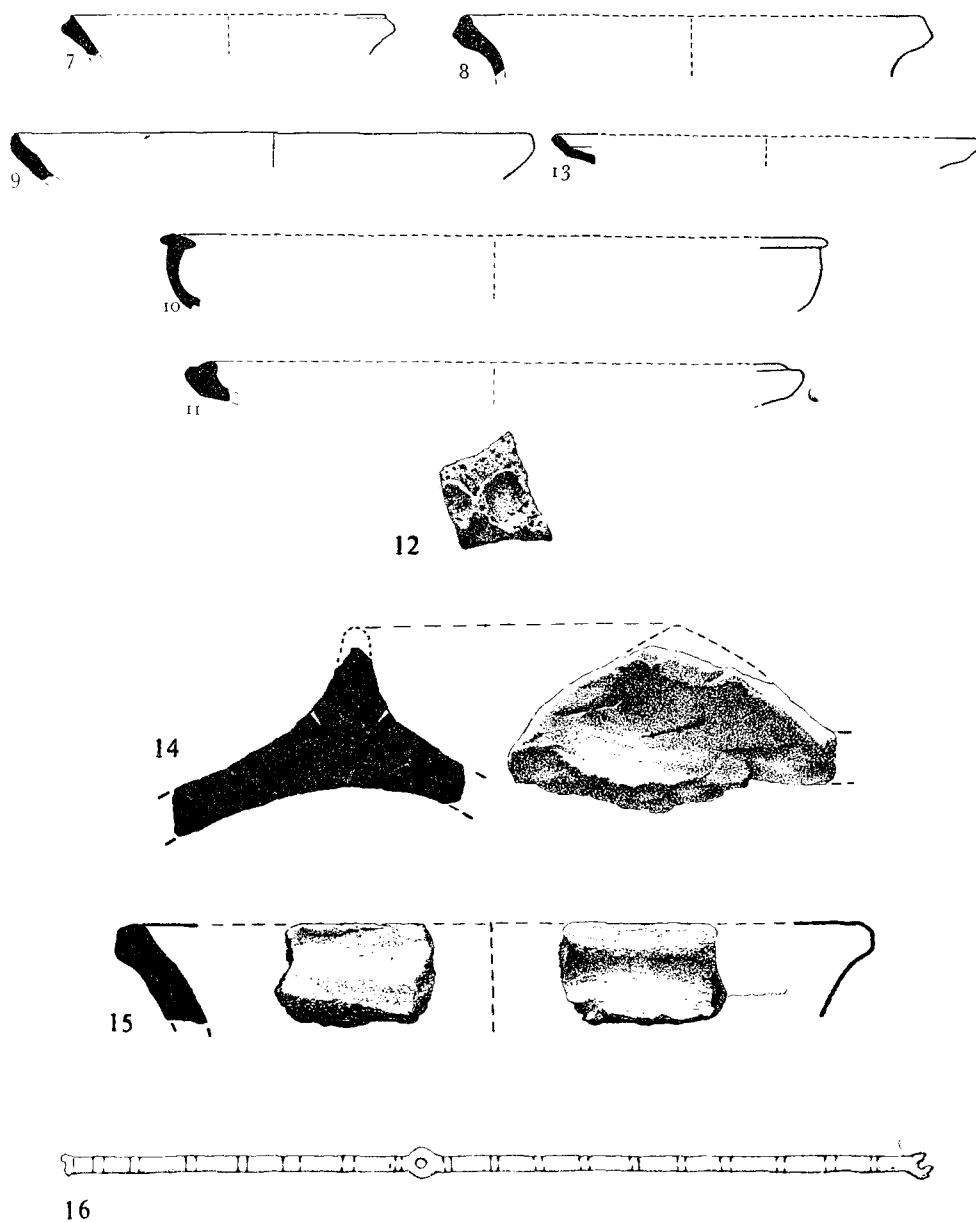


FIG. 50

## WAREHAM WEST WALLS, DORSET

12th-13th-century pottery and metal binding-strip (pp. 130, 134-6).

Sc.: no. 7-11, 13— $\frac{1}{4}$ ; nos. 12, 14-16— $\frac{1}{2}$

11. Heavy, somewhat angular rim, presumably of pan or dish, with grooved top and slight internal thickening. Fairly hard ware, grey core, fired brown all over but with a grey tinge or discolouration on the outside. Thirteenth rather than twelfth century.
12. Side fragment with remains of an applied thumb-pressed strip. Hard ware without sand, although some fairly coarse quartz grits are evident and the fragment is vesicular throughout the body. Twelfth rather than thirteenth century.

*Ditch, d3*

13. Small dish or lid rim, plain but slightly angular; wheel-made. Hard ware with fine sand and relatively smooth finish, grey core with fired reddish-brown surfaces. Thirteenth rather than twelfth century.
14. End of ridge-tile, apparently of half-round section, with moderately high peaked crest and oblique slashes below. Hard ware with fairly fine sand backing, greyish-brown to purple surfaces, brick-red with grey core in fracture. Spots of mottled rather poor mid-green glaze occur on the sides of the crest and large patches below. Although damaged the crest is almost certainly hand-moulded rather than knife-cut. Although some local typological sequences have been attempted for medieval ridge-tiles,<sup>44</sup> it is evident that there is room for local variation in type and date, and each series should be considered on its merits; nevertheless there is some evidence that tiles with hand-moulded peaks preceded those cut with a knife. This change in technique has been put about the end of the thirteenth century in the Oxford region, a little later in Wales. A date in the thirteenth century would fit the present example.

GILT BRONZE OR COPPER BINDING-STRIP (FIG. 50, no. 16)

This fragment, bent now, but originally straight, as drawn, was found below the tail of the rampart, ostensibly in the underlying layer of dark soil (8), but is evidently an intrusion. The strip is generally rather more than 2 mm. thick, with slightly convex gilt top and flat back and sides, the decoration consisting of double nicks punched from the sides. It was presumably cast, and although the ungilt surfaces are corroded there are signs that the sides were filed. The strip thins at the splay of the extreme remaining holes, but not appreciably at the middle hole, which seems to have been perforated from underneath.

Such gilt bronze or copper strips are not uncommon in twelfth-century and thirteenth-century contexts,<sup>45</sup> particularly on domestic sites, as at Rayleigh (Essex)<sup>46</sup> and Castle Hill, Folkestone (Kent).<sup>47</sup> They are clearly decorative bindings attached to wooden or perhaps leather-covered surfaces of appreciable size, not necessarily at the edges since some pieces have forked terminals or branch into curved<sup>48</sup> or diamond-shaped<sup>49</sup> loops. Other pieces of gilt metalwork at Rayleigh and Castle Hill, Folkestone, thought to belong to the same category,

<sup>44</sup> See *Oxoniensia*, xvi (1951), 86-8, and references therein, also *Antiq. J.*, xv (1935), 326.

<sup>45</sup> Their distribution has been studied by Mr. E. M. Jope, *Antiq. J.*, xxxix (1959), 267-8.

<sup>46</sup> *Trans. Essex Archaeol. Soc.*, xii (1913), 165.

<sup>47</sup> *Archaeologia*, xlvii (1883), 437-8, 447-8, pl. xix.

<sup>48</sup> Cf. an unpublished fragment from Powerstock Castle (Dorset), 1905, in Dorset County Museum.

<sup>49</sup> Cf. an example in Saffron Walden (Essex) Museum (information from Mr. G. C. Dunning).

are slender handles, which suggests the use of these strips as casket or cabinet fittings, although it is possible that they were applied to a variety of objects.

### CONCLUSIONS

Purely archaeological considerations arising from the excavations show that Phase I, a rampart probably with an outer face of timber and certainly a ditch, dates from after the end of the Roman period and possibly after *c.* 700.<sup>50</sup> This rampart is shown to have remained unaltered in all probability for a considerable period. Phase II, the heightening of the bank with a wall of stone set above the earlier rampart, is shown to lie within the period from the eighth to the eleventh century. Phase III, the robbing of the wall, is certainly post-conquest. The excavations carried out by Dr. F. T. Wainwright at Cricklade (Wilts.) have also brought to light an earth rampart with an outer facing of stone. The preliminary report<sup>51</sup> suggested that this might be a unitary construction, but the excavator does not now consider that this conclusion is established, or rule out the possibility of a stone facing to an earlier bank. If this should prove to be so the sequence would be very like that at Wareham. At Cricklade there is no reason to doubt that the primary defences are those of Alfred's burh.

The archaeological evidence from the continent points in the same direction. The curtilage that formed the mid-ninth-century bishop's fortress and became the nucleus of the later city of Hamburg was protected with an earthen bank with an outer facing of timber.<sup>52</sup> This was erected after the Carolingian penetration to the Elbe and was intended to serve as a frontier fortress against the Slavs and the Danes. In west Germany the imperial centres seem originally to have been unfortified. The wall at Frankfurt-am-Main, surrounding the palace erected by Louis the Pious in 821, was an addition. It is thought to date either from the time of the Carolingian civil war about 840 or more probably from the time of the Hungarian threat in the middle of the tenth century.<sup>53</sup> To the latter period belong also the fortifications in stone surrounding the imperial palaces at Aachen and Ingelheim.

In the light of the evidence and of the analogies outlined above it seems reasonable to conclude that Phase I of the defences at Wareham represents the burh existing in Alfred's day, and that Phase II, with the stone-faced rampart, belongs to an unrecorded strengthening at some pre-Conquest date.<sup>54</sup>

Either the renewed Danish threat in the reign of Aethelred II (979-1013) or the period of peace during the long reign of Knut (1016-1037) would prove a suitable setting for such a work.

<sup>50</sup> The sherd of Norman character found stratified within the primary bank has been ignored. The cracking of banks in hot weather and their subsequent expansion in the wet would afford a sufficient explanation for the occasional penetration of later sherds.

<sup>51</sup> *Wilts. Archaeol. Mag.*, lvi (1955-6), 162.

<sup>52</sup> W. Krämer (ed.), *Neue Ausgrabungen in Deutschland* (1958), p. 596.

<sup>53</sup> *Germania*, xxxiii (1955), 399. Professor Bersu informs us that more recent excavations, not yet published, make the later date almost certain.

<sup>54</sup> There is no record of any later refortification before 1066, but the evidence is not such that any reliance can be placed on an *argumentum e silentio*.

## APPENDIX

NOTE ON POTTERY FOUND IN THE PRIMARY MATERIAL OF THE RAMPART IN 1940 AND 1947

by E. M. JOPE

A piece of the rim and upper part of a hand-made cooking-pot with outflared rim-flange (FIG. 49) was found in 1947 by Professor Stuart Piggott in the primary material of the rampart where this had been scarped back on the sector near Site D.<sup>55</sup> Five other sherds from the same or a similar pot (one with abraded surface) had previously been found by him at this point, in 1940, as well as a number of abraded Romano-British sherds.

This pot is of soft clayey fabric (markable with the finger-nail), containing angular but rolled quartz fragments, mostly up to 1 mm. across (a few of 2 mm. or more), i.e. a fairly coarse sand. It has a few similar-sized particles of carbonized matter, but no calcareous material. It has a blackened surface and fracture, a brownish tinge remaining in places, and has a carbonized deposit on the outside. The lumpy surface has cracks radiating from some of the quartz grits.

This pottery may be compared with that from Medmerry,<sup>56</sup> Selsey, found with bun-shaped loom-weights (which were most commonly in use from the ninth century onwards, though not unknown earlier),<sup>57</sup> and with some from Canterbury considered to be of the seventh-ninth centuries:<sup>58</sup> comparable pottery occurs at Hamwiĥ (Southampton) in middle and later Saxon contexts,<sup>59</sup> and at Pevensey Castle such pots were found in a context of the later eleventh century.<sup>60</sup> This widely outflanged rim would seem fairly far removed from the pagan-Saxon cooking-pot tradition, and we should therefore consider it unlikely to be older than the eighth century.

<sup>55</sup> I am grateful to Professor Piggott for providing the details of finding.

<sup>56</sup> *Antiq. J.*, xiv (1934), 398.

<sup>57</sup> E.g. the remarkable series with annular loom-weights on a pagan-Saxon site at Pakenham (G. M. Knocker in *Proc. Suffolk Inst. Archaeol.*, xxvi (1955), 198-9, pl. xxiv). Cp. also J. G. Hurst's discussion, pp. 23 ff, *supra*. In Denmark bun-shaped loom-weights were already in use in the Roman Iron Age.

<sup>58</sup> *Archaeol. Cantiana*, LXVIII (1954), 123-5, fig. 12, nos. 112, 114, 115.

<sup>59</sup> I am most grateful to Mr. D. M. Waterman for showing me the bulk of the Hamwiĥ material.

<sup>60</sup> Unpublished; shown to me by Mr. F. Cottrill.

## NOTE

*The Society is much indebted to the Royal Commission on Historical Monuments (England) for a grant towards the cost of publishing this paper.*