CHAPTER 1

REPORT ON THE 1987 EXCAVATIONS
A LARGE WELL BESIDE BUILDING Q48.4

Site supervisor: Ahmed Galal

1.1 Introduction

The decision to investigate this well and its environs arose logically from the fieldwork of the previous season. As reported in *AR* IV, Chapter 9, the sherd survey of Pamela Rose and Dr. Paul Nicholson had defined through sherd scatters the route of the water supply to the Workmen's Village, its point of origin being the site that forms the basis of this and the ensuing chapter. It seemed only logical to take advantage of the direct physical link between Workmen's Village and Main City and to undertake an excavation of the whole site, to which the designation Q48.4 was given.

The surface features of the well were a classic of their kind. The position of the well shaft was given by the roughly circular shallow depression, about 15 m in diameter, with a surface of pale sand and silt on which small bushes grew (Figure 2.1). Beside it to the north-east stood an isolated symmetrical crescentic mound of sand and gravel sloping up gradually from the depression to a curving ridge, and then steeply down the other side — clearly a spoil heap from the original digging of the well. The only signs of modern disturbance were a shallow trench cut across the gravel mound, evidently an exploratory trench by earlier archaeologists (it appears on an aerial photograph taken in 1922, so the archaeologist was probably Borchardt), and a small area of shallow modern digging on the eastern side of the southern slope of the mound where sherds abound on the surface. The exploratory trench had cut into the mound along the edge of this sherd cover and had exposed that it was not part of a deeper and more varied deposit. This sherd area had, in 1986, been sampled by the Sherd Survey of Pamela Rose and Paul Nicholson. It is their sample area no. 23 and was notable for the abundance of amphorae of Group 20 Canaanite-type amphora form (*AR* IV: 124–126, and 94).

One further surface feature deserves to be noted. The depression which marks the well mouth is approached from both east and west by shallow channels, the eastern channel filled with the same pale sand and silt that covers the floor of the well depression. Our excavation of the well has brought an explanation for both of them. The western channel appears to be nothing more than a natural depression which served as a conduit into the well during flash floods. The eastern channel, by contrast, marks the existence of the artificial gully [3831] which anciently led down into the well and formed its principal means of access (Figure 1.1).

A common excavation grid of five-metre squares, Grid no. 1, was used both for the factory site (see next chapter) and for the well. One of the north–south grid lines (G–H) came close to bisecting the well depression and at first served as one side of a broad trench consisting of squares G12–G14. As the excavation proceeded, the face exposed along this line became the reference stratigraphic section (Figures 1.1, 1.3a, 1.5), but in time the strategy pursued was modified in an attempt to satisfy three objectives. One was to reach as deeply as possible and to maintain a record of the vertical stratigraphy along the chosen section line; another was to safeguard those involved in the digging against the dangers of collapse; the third was to explore the full outline of the well in the search for evidence as to how it had been worked. The strategy chosen was to restrict the vertical exploration to squares G12 and G13 and to alternate between work on this and the whole block of nine squares which covered the well depression entirely. Consequently the section drawing had to be done in several stages.

By the end of the season, as a result of great exertion on the part of Ahmed Galal and his team of workmen, much of what we set out to determine was revealed and recorded, although it would still be worthwhile to carry out further clearance of the well shaft, concentrating on the lower reaches of the access ramp on the north side. The vertical probing was taken down to the level at which ground water appeared, 8.80 m below the top of the stratigraphic column, thus around 42.60 m a.s.l. (the present Nile level in the area is about 39.00 m a.s.l.). Ground water is

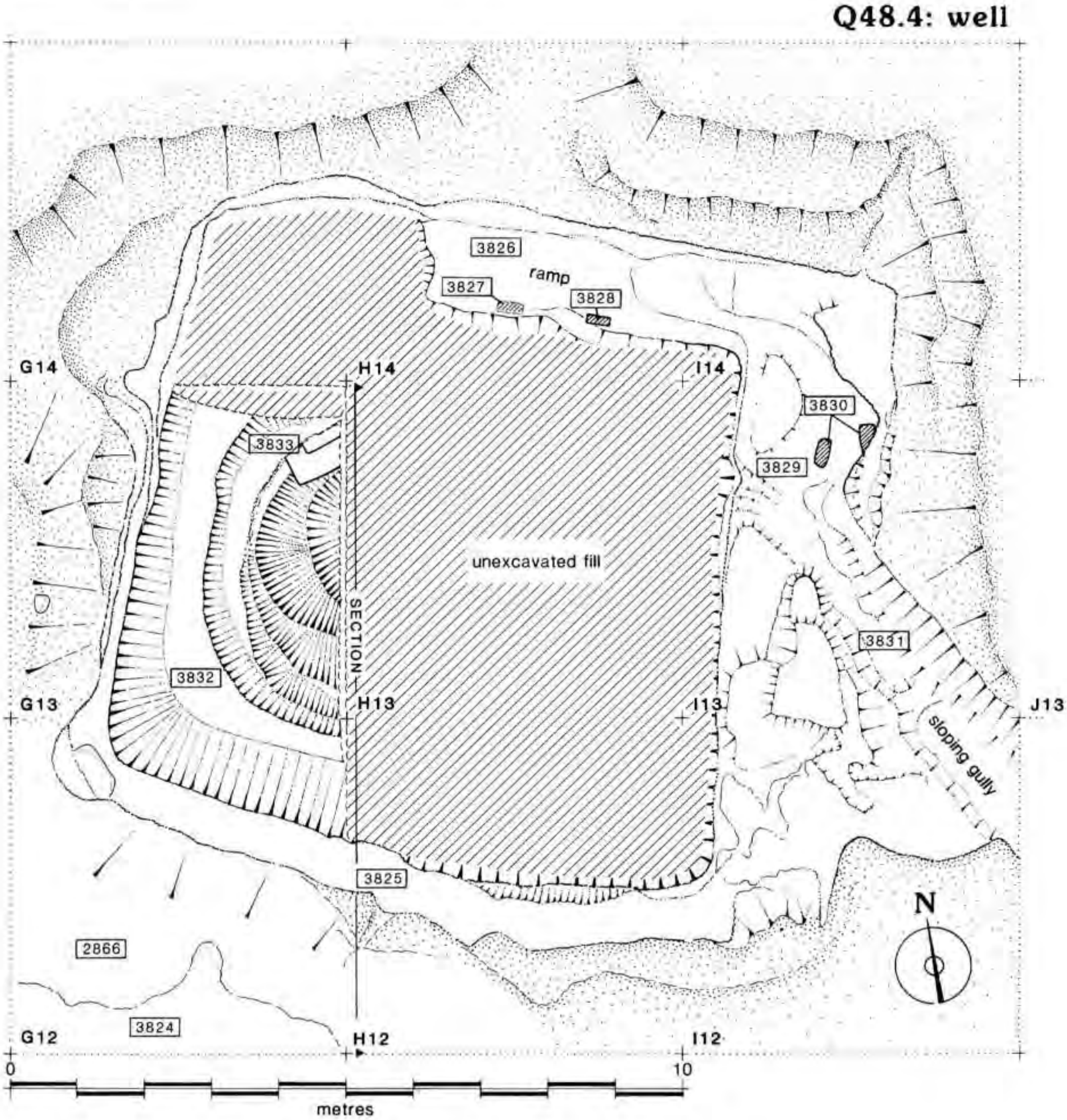

Figure 1.1. Plan of the well, as left at the end of the 1987 season.

held within a layer of grey sand through which it passes freely. Even if we were able to introduce a pump, it would probably prove to be impossible to carry the investigations to a lower level.

With regard to the ancient mound of spoil, a layer of surface material was removed over square J13 on the east side (not shown in Figure 1.1, but see Figure 2.1). This square ran into the surface sherd cover mentioned above, and the purpose of this shallow excavation was to remove an adequate sample of the sherds. It confirmed that the sherd cover has little real depth.

1.2 The construction of the well

Beneath the superficial layer of sand and gravel which makes up the desert lies a hard marl bedrock [2866] interspersed with cemented layers of pebbles and larger stones and with layers and lenses of compacted sand. A distinctive pebble bed occurs towards the top. Weathering, both

Figure 1.2. The well at the end of the 1987 season, looking west. The ladder descends at the south-west corner of the stratigraphic pit. The metre scale runs beside the descending ramp [3826].

pre- and post-Amarna Period, has greatly softened the topmost zone of bedrock and given it an orange hue. In the course of our own excavations this soft material was removed, and this, as well as the processes of erosion, may well have made the rim of the well seem to be much more irregular than was anciently the case. The oddly shaped triangle in the south-east corner, between the sloping gully and the well proper, has probably suffered particularly.

On the south and west sides true ancient faces are first encountered in the form of a narrow horizontal shelf [3825] running along the top of the precipitous sides of the well shaft. That on the south is about 60–70 cms wide, just adequate to form a pathway; on the west it narrows to almost nothing. In the south-west corner a prominent natural boulder projects across it. The east and north sides provided the means of access, principally a ramp cut into bedrock, which really begins more than half way along the east side. It is here more or less horizontal and 3 m wide and so looks more like a platform [3829], but, as it turns to run westwards along the north face of the shaft, it begins a gentle descent [3826] (Figure 1.2). Where it disappears beneath the unexcavated deposits a step seems to be present, and, indeed, in order to make the descent into the lower parts of the well a staircase must have developed here which was very steep. The outer edge of the ramp had been protected by a brick wall, now represented by a single brick [3828] and a bed of mortar [3827], both *in situ*. Two more bricks [3830] lie on the floor of the platform, but their derivation is uncertain. Access to the platform from outside was by means of a narrow sloping gully [3831] that enters at an angle from the south-east. Its upper part is outside the excavation limits, but its course may to some extent be marked by the sand-filled erosion channel which appears on the general site map, Figure 2.1, although, if it ran far in this direction, it would have had to change direction slightly, more towards the east. The floor of the gully is narrow and concave. It was partly filled with a thick layer of gravel washed in after abandonment. It is thus possible that the water action involved also scoured the gully making its floor narrower than when in original use.

How the well developed at lower levels is visible only in the deep trench in squares G12 and G13. To begin with, the rock wall descends as a flat even face, inclining inwards as it does so. If this is maintained around all four sides, the dimensions at rim level would be about 8.50 m east to west, and 8.00 m north to south (measuring to the edge of the ramp, not beyond it). At a distance of about 5.5 m below the rim, the more-or-less straight rock walls ended at a flat and narrow ledge [3832] (Figure 1.5). Its inner edge is irregular, but in general it seems to be following a circular plan. Beneath this ledge the side of the well becomes both more irregular and more difficult to follow. The reason lies partly in a change in the nature of the bedrock and partly in its damp and soft condition which sometimes made it very difficult to distinguish from the sedimentary fill. Beneath the shelf the marl bedrock gave way to a stratum of coarse sand, gravel, and large pebbles. Below this came a calcareous marl, grey in colour and waterlogged, and finally a distinctive stratum of what appeared superficially to be soft sand containing occasional nodules of marl, which, when first exposed in a damp state, was a pale grey in colour. A sample (no. 8), when examined separately and after a slight delay, was found to be a soft, pale-brown (10YR6/3), slightly gritty, sandy-clay loam, slightly calcareous. Its junction with the marl above was sharp and clear, marked by a brown, iron-stained bedding plane; no lower junction could be reached because this was the stratum which transmitted the ground water.

The unexpected discovery that beneath bedrock was sand had a marked effect on the excavation. Within a short time of exposure and drying, cracks appeared in the sand and large lumps detached themselves and fell. Fortunately, the sand was exposed only in a limited patch on the south side. Around the remainder of the limited exposure it was protected by a near-vertical layer of particularly consolidated fill, a complex unstratified mix of coarse sands, marl, and white sand, as well as sherds [3730]. In the drawn section (Figure 1.3a) this layer appears vertical towards the top but lower down thickens as if its outer surface were sloping towards the well centre. There is an element of illusion here because the section line evidently does not cross the well in the middle; hence any slope towards the well centre is exaggerated. Nevertheless, it does seem to slope progressively, as if heading towards a bowl-like hollow, the true base of the well.

The rapid collapse of the grey sand once it is exposed would have been as certain in the Amarna Period as it is now. Yet the well shows no sign of solid lining. The conclusion has to be that the hard-packed earthy layer [3730] is itself a crude lining put in place to safeguard the sides of the well. It was not wholly satisfactory. As the water level in the well rose and fell in response to the annual inundation cycle of the Nile so parts of this lining must have slumped, later to be replaced during a cleaning process in which potsherds were scooped up and patted into place. Perhaps one reason for constructing the well in two stages was to leave room for a degree of collapse of the lower wall without undermining the rock wall above.

On the north side, in both the plan and the section, limestone blocks are visible (Figure 1.4). The two largest [3833] are still partly within the section wall. The upper stone is a reused door jamb, to judge from its profile. It is tempting to regard them as crude steps, continuing the now stepped access ramp which had followed the north face of the well down presumably to the level of the shelf which separates the two stages of the shaft. In the restricted space available they would represent a a stepped turning towards the well centre, built into the side of the bowl-like lower part of the well composed of the earthy packing layer. If this were so, it would imply that the original bottom of the well is not far below the level reached by this year's excavation. This touches on the difficult question of how far the level of the ancient water table differed from the modern one. The water level must reflect two factors: back pressure from the Nile, causing in ancient times a rise and fall as the Nile rose and fell, and a slow inflow from the desert wadisystems to the east fed by occasional rains over the Red Sea hills. Furthermore, it must also be affected by local variations in sub-surface geology. It is possible to imagine, for example, that the grey-sand layer itself has an irregular shape which affects the rate at which water passes through it. It is to be expected that close to the Nile the ancient median level would have been lower than it is now, simply on account of the rise in the level of the river bed and floodplain since ancient times. Away from the Nile, however, this has to apply less. At the same time, our knowledge of changes in regional desert water table is insufficient to shed any light on the subject from this direction. It is important to keep an open mind and to realise that the evidence provided by the wells at Amarna is itself a prime source for hydraulic history.

1.3 The nature of the fill

The sediments which filled the well varied markedly from level to level and preserve a history of changing conditions which is still not fully understood. As the excavation proceeded the deposits were removed as numbered units, marked on the section (Figure 1.3a), and also used to identify pottery and other objects recovered from within them. When, after the end of the excavation and the drawing of the section, the whole sequence was reviewed as a series of geological and climatic events, it became apparent that the whole could be reduced to a simpler series of layers. The original field records were also examined by Mr. Neil Munro, professional soil scientist,[1] who was able to cast them into a far more scientific form, and who suggested the tenfold subdivision of layers that appears in Figure 1.3b, where the ten new divisions are marked, numbered from bottom to top. These form the basis of the ensuing description and take in more detailed notes made on a small series of samples of the soil which were subjected to a closer and more rigorous inspection.

Layer 1. A poorly exposed part of the fill which continues beneath the water line. It shows a complex stratified sequence of pale-brown coarse sands, white sands, and marl bedrock fragments [3729], and contains sherds and large blocks of limestone from well steps. It passed downwards into a more homogeneous mixture of these same materials [3730], still containing many sherds with a high proportion of domestic wares. As the section shows, this was banked against the wall of the well, here formed of the grey sand.

Interpretation: as already noted, we interpret the lowest member [3730] as part of an original lining packed against the side to prevent undermining. This was, in part, locally derived, as the presence of the grey sand shows, and was probably packed into place over the whole period of use, particularly whenever the well was cleaned out. Unit [3729], on the other hand, appears to represent a colluvial fill of debris washed into the well and some of the side wall-facing or bedrock slumping to the base once use and maintenance of the well had ceased.

Layer 2. A finely stratified deposit [3727] of sands and gravels, with silt lenses. Angular fragments of local marl and bedrock occur scattered throughout. The transition to the overlying Layer 3 is sharp. Interpretation: a complex filling of the lower part of the well by a heterogenous mixture of bedrock and other materials. Coarse sediment was probably being washed into the well, and would have contained material typical of the surrounding settlement as well as the valleys to the east. Some of the largest and heaviest pieces of debris have accumulated in the lowest part towards the north. These deposits are typical of flood events bringing coarse material into the well. It represents the first of a series of floods, discussed below for Layer 3.

Layer 3. A fining-upwards member [3725], with sand and gravel passing upwards into a coarse sand. A sample (no. 1) taken near the base shows a poorly sorted and heterogenous gravel with a pale-brown (10YR 6/3) matrix of very coarse sand·medium sand. The gravels are up to 3 cm in diameter, subrounded, and of limestone. The sediment has a strongly calcareous reaction (to hydrochloric acid), and also contains numerous sherds. This coarse part of the unit is continuous at the margins of the well, but in the centre it passes upwards into a weakly stratified bed of coarse sand which also contains scattered sherds and few pebbles. There is a sharp transition to the overlying unit. Interpretation: this is considered to show the second part of a series of seasonal or annual, or perhaps longer-spaced flood events that brought down a great volume of

[1] With Hunting Technical Services.

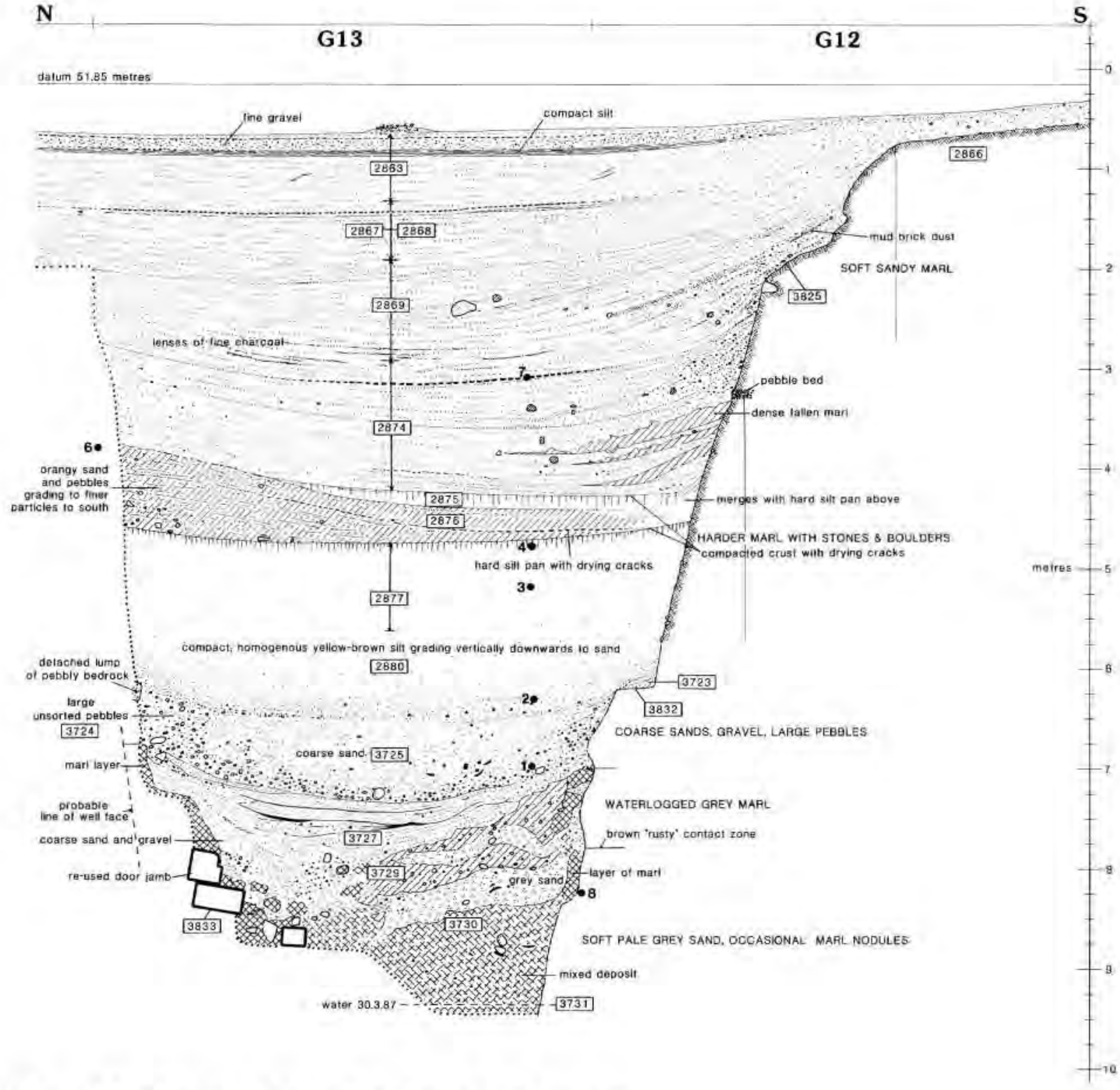

Figure 1.3a. Section of the well and its fill, looking east.

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material. Initially this flood would have swept through the site carrying off a proportion of the coarser stones and sherds; it would then have passed over the well site, and part would have been washed down into the well. The absence of any turbation in the well sediments suggests that the well was full of water prior to the flood's arriving. This could be the result of rainfall augmenting the natural water-table level.

Layer 4. The basal part [2880] is similar to Layer 3, with a basal sandy-gravel layer merging upwards into a coarse sand. Fining upwards continues into a massive loamy layer [2877], 2.5 m thick, that is capped by a well-structured silt lens. The upwards fining (grading of particle size from coarse to fine) was less evident from visual observation than from tactile inspection, through running one's forefinger slowly and carefully up the deposit in the section face. Sample no. 2 represents the basal component: it is a yellowish-brown (10YR 5/7) gravelly, fine to medium sand, with common small flat limestone fragments. Sherds also occur, and the material is strongly calcareous.

The transition upwards, into non-gravelly sand and the massive loam layer, is progressive and clearly seen to be part of one fining-upwards sequence. A sample (no. 3), taken 1.25 m from the

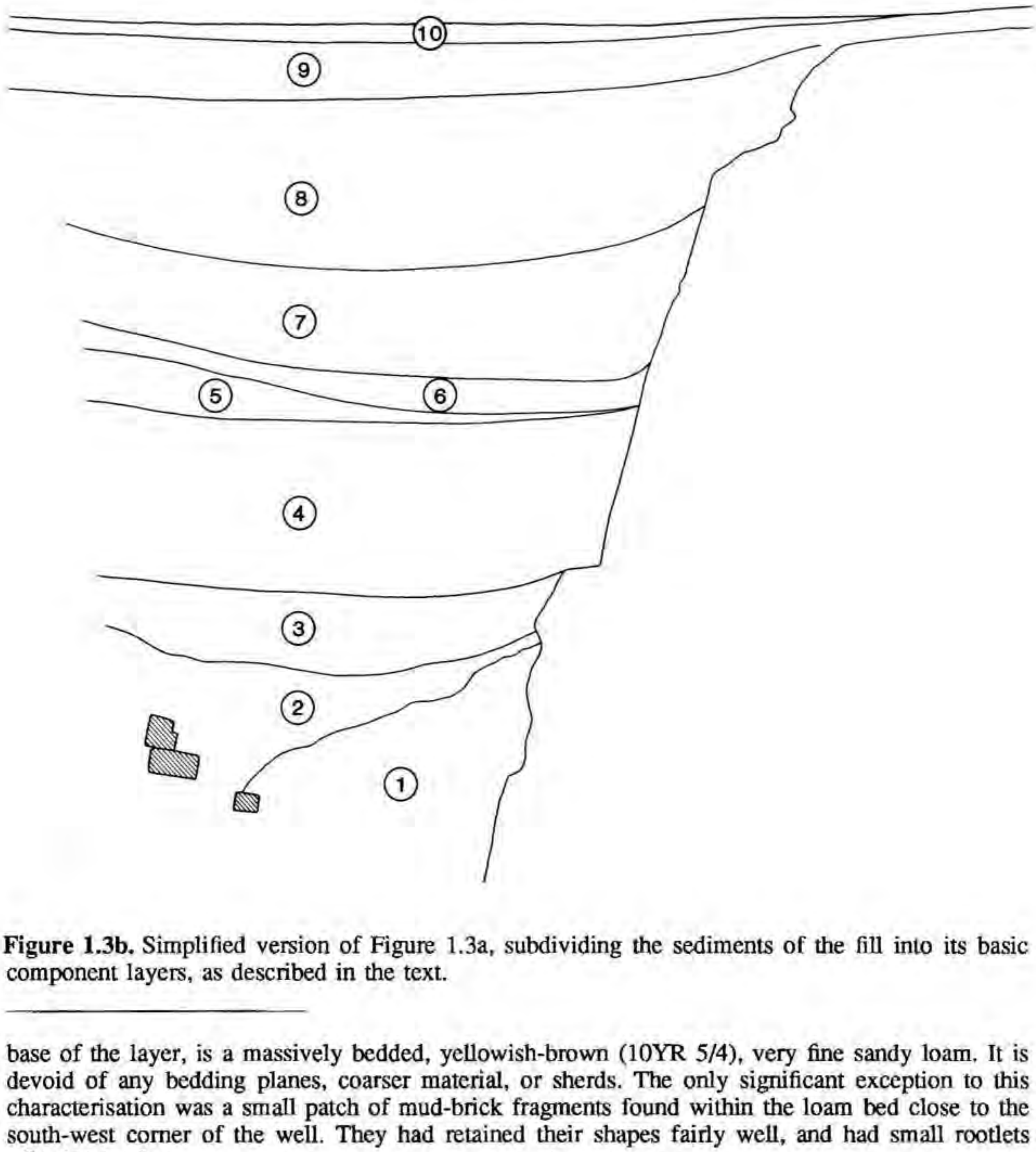

Figure 1.3b. Simplified version of Figure 1.3a, subdividing the sediments of the fill into its basic component layers, as described in the text.

base of the layer, is a massively bedded, yellowish-brown (10YR 5/4), very fine sandy loam. It is devoid of any bedding planes, coarser material, or sherds. The only significant exception to this characterisation was a small patch of mud-brick fragments found within the loam bed close to the south-west corner of the well. They had retained their shapes fairly well, and had small rootlets adhering to them.

At the top of this unit is a thin bed of silt, with a very prominent vertical cracking pattern. A sample from this layer (no. 4) is an angular, blocky-structured, yellowish-brown (10YR 5/4), silty clay loam. It is strongly calcareous, has a dry and hard consistency, and contains a few old root pores and also a few fine dead roots. There are also traces of very faint rusty mottling on structural faces. The silt layer is slightly redder in colour than the underlying sandy loam.

Interpretation: this major fining-upwards sequence represents a single flood event of dramatic proportions. As before, the stratification shows that the well filled with water, on this occasion to a depth of at least 2.5 m, and a great volume of fine gravel and then sand was washed down. This suggests that the surrounding terrain was largely denuded of coarser material by now. As the flood ceased the sediment fractionated out, the heavier material sinking to the bottom and a layer of silt gently accumulating at the top. When the pieces of mud brick fell in, the evaporation of the pool had probably reached a point where the sediments had the consistency of a quicksand, so that the fragments sank some way, but not within sufficiently moist surroundings to cause them to dissolve. Subsequently the well dried out, allowing the silt to crack and plants to grow on the new floor. There is a notable absence at this stage of further material falling into the well. There is also no evidence that wind-blown sand was filling the well. The sediments, however, could be derived from a variety of older materials. Wind-blown dust is considered later as a source material.

Layer 5. This layer (part of unit [2876]) shows rapid alternation of sand and fine gravels of an orange colour but is wedged-out to the southern edge of the section. The drawn section is not fully representative of its shape, however, for the wedging out also occurred from west to east (Figure 1.4). Thus the maximum thickness lay against the west wall of the well. Interpretation: the sequence is similar to Layer 4, but, because of the cracking and plant growth of the surface of Layer 4 on which it stands, it is considered that Layer 5 was deposited at least one wet season later. A considerable amount of coarse material occurs, which is thicker to the north and to the west. The directions of slope show clearly how the deposit (and Layer 6 above) had entered the well, i.e. as a cascade of water and debris from a gully in the north-west corner of the well, and the composition of the deposit suggests a fresh supply of coarse material.

Layer 6. A further fining-upwards sequence of orangy sand (part of unit [2876]) with few gravels, passing up into a vertically cracked silt clay loam bed [2875]. This bed is wedged-out to the northern part of the well section. Interpretation: a fining-upwards deposit, and the result of one seasonal or annual flood. Despite the thin nature of this layer, the silt is, in proportion, rather thick. This suggests that a considerable amount of finer material was being eroded in the catchment area, although what the source material was we cannot tell from this preliminary investigation. This silt could be the result of a large dust fall into the flooded well, and thus be of aeolian origin.

Layer 7. The upper part of the fill of the well is primarily composed of three similar stratified fining-upwards beds, of which this is the first. The main component is a finely layered sand to loamy sand (the main element of [2874]), with scattered blocks of marl from the wall of the well, and on the southern side of the section several lenses of marl bedrock that has slumped from higher up the well side. At the top of this layer is a thin bed of vertically cracked and platy-structured, brown (7.5YR 5/4), silty-clay loam (sample no. 7). Interpretation: a seasonal/annual flood being washed into a flooded well, and settling out over an unknown length of time. The boulders/stones that appear in the layers did not show any "bomb sag" structures that might be expected if they had fallen into the well after the main flood. The presence of large blocks of slumped material suggests that the bedrock was saturated by the water table and collapsed, perhaps owing to ground disturbance accompanying the arrival of the flood.

Layer 8. Although similar to layer 6, it is distinguished by lenses of fine charcoal near the base. They were encountered across the square to the east in the later phases of the excavation, i.e. across square H13, and must have been brought in by the wind blowing charcoal from somewhere outside, but whether from a nearby point, e.g. from a digging within the adjacent site to the south, or from a conflagration further afield, we cannot tell. There are fewer fallen blocks or lenses of bedrock marl, but pebble layers are prominent on the southern edge of the section, where thin layers of mud-brick dust also occur. The whole layer (primarily [2869], and part of [2874] and [2867=2868]) is capped by a thin stratum of vertically cracking silty-clay loam. Interpretation: as for layer 7 generally. The supply of coarse sand in these upper strata is probably linked to erosion of terrains to the east, giving a steady supply of sand-sized particles. Such material is typical of the present. The presence of mud-brick dust may indicate erosion of houses around the well site.

Layer 9. Comprising the lower part of unit [2863], it is composed of weakly layered sands which extend beyond the limit of the well along its southern edge. There are few coarser particles, and it is capped by a thin layer of platy, compact silt that occupies the gently concave central part only of the section. Interpretation: as for Layer 8, although the absence of stones and the fine layering suggests a filling of the well by an unusually textured deposit. It is conceivable that this layer represents the air-fall of a wind-blown aeolian material.

Figure 1.4. View of the stratification pit in the well fill, looking north.

Layer 10. The final element of the fill (upper part of [2863]) is a thin, sandy gravel layer (part of [2863]) that occupies the central part of the well section. It is coarser than the underlying silt and is wedged-out along the margins of the well. Interpretation: another fluvial deposit, suggesting a return to more violent flooding. It represents the final infilling of the well.

On one aspect of the filling up of the well we can shed no light, namely: how rapid it was. No datable material was found which was not of the Amarna Period, nor was there sufficient organic material to justify collection of samples for possible radiocarbon dating in the future.[2] One comparative piece of evidence does bear citing, however. In the 1988 excavation season, at Kom el-Nana, a second large well was examined. It was impossible to pursue the digging to a significant depth because of the weakness of the surrounding ground, but it was possible to establish that the well had filled up by late Roman times (c. 5th–6th centuries AD).

2 Neil Munro reports: "It could be possible to use thermo-luminescence dating to provide relative ages for the layers, to determine if the layers were laid down over several years or a much longer period. The value of this method for sediments is in doubt, however. I would think that, in fact, this infilling was fairly rapid, and as frequent as the rate of return of flood events in the region."

Figure 1.5. View of the stratification pit, looking south. The wooden ladder stands on the shelf, unit [3832].

If the filling of the well at Q48.4 had been a uniform process of sediment accumulation, the rate of filling would be of minor interest, but the fact that major episodes of flooding were the dominant factor within the earlier part of the filling has potential value for climatic history. In two places in particular the ancient city has suffered massive damage from flooding from the desert, in which an entire strip of the site has been washed away, leaving a broad wadi.[3] One cuts across the North Suburb, the other the Main City. The latter runs close to site Q48.4 and the well under consideration, and it is at least possible that the same great flood which swept through the

[3] Wadi activity on this scale is reported, e.g. in Hume 1925: 84–85, a reference to the Nubian journey of Linant, when the explorer's boat was prevented from passing upstream beyond the mouth of the Wadi Allaki, on account of a torrent rushing down the wadi from a rainstorm in the eastern desert. In the 1960s part of the modern village of el-Till was destroyed from a wadi torrent emerging from the valley which leads to the Royal Wadi.

city also poured into the well. Although we can not provide a date for this, the well sequence gives the impression that it took place long ago, probably in antiquity, something supported by the record at the Kom el-Nana well just mentioned.

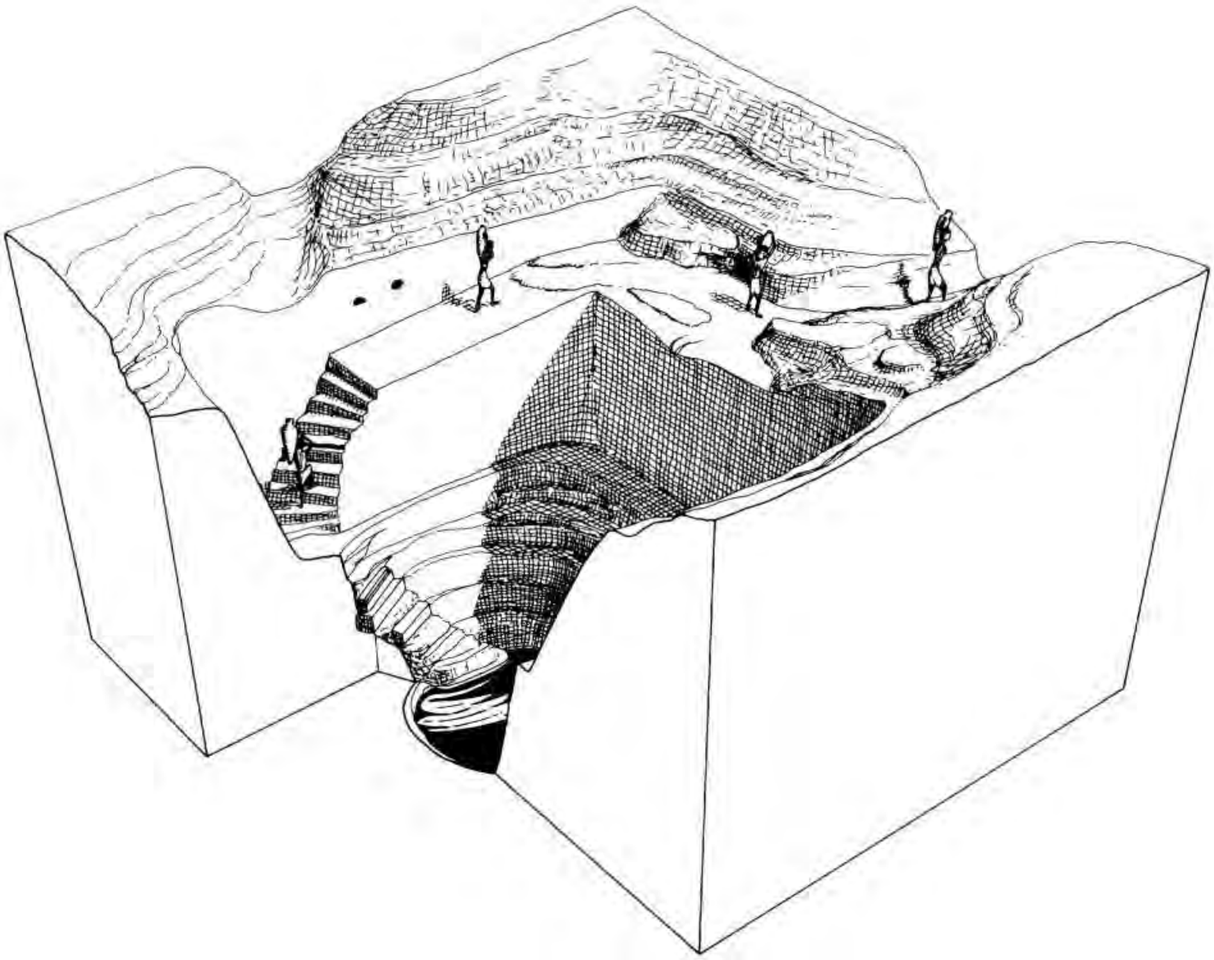

Figure 1.6. Perspective view of the well as excavated in 1987, with reconstruction of the unexcavated portion.

1.4 Discussion: water supply in ancient Egypt

As noted at the beginning, only a single large "administrative" well has been excavated before at Amarna. This was by Pendlebury in 1933–34, within the stable block of the Military and Police Quarters, R42.10 (*COA* III: 133, Pls. XXI, LII.2–4). The report states merely that the parade ground within the building "had originally a well in the centre to which a flight of mud-brick steps descended". The plan seems to show a well cut in two stages, similar to our own: an upper rectangular pit (c. 19 x 25 m) with inwards sloping sides, and a lower circular shaft positioned off-centre with a diameter of about 3 m, provided with a mud-brick curb around the top. The mud brick flight of steps evidently provided access from the surface down to the floor of the rectangular shaft. Unfortunately, insufficient evidence is provided to enable the depths of the two sections to be assessed. But the main operating principle must have been the same as with our well: for much of the vertical distance involved water was raised in pottery vessels carried by porters up a stairway or ramp. The lifting of water in a vessel suspended on a rope was restricted to the lower stage, the circular shaft. In our well the local geology had caused the shaft to collapse and become a broader circular hollow with sloping sides, but it is quite possible that initially the lower stage was smaller and more shaft-like.

The few small private wells that have been excavated at Amarna reflect the same acceptance that carrying was as appropriate as lifting by rope, in that a spiral staircase descends for a part of the distance involved.[4] A few wells have been identified at Amarna where, it is claimed, only a small circular shaft reaching all the way up to ground level was involved: one at the King's House (*COA* III: 86, Pl. XVI), one in the grounds of the North Suburb house T35.6 (*COA* II: 42, Pl. VII), and a third one at the Desert Altars (*COA* II: 101–102, Pl. XXVI),[5] with diameters of nearly 3 m, of 1.15 m, and 2 m respectively. In neither the first nor last case do they seem to have been cleared to any significant depth, so that it must remain open to question whether they are really wells as distinct from shallower cisterns. But with the example in house T35.6 the excavator is more specific, referring to "a deep well, with a square bricked well-head." One can also cite an example from Medinet Habu (Hölscher 1941: 67, Fig. 41, 68), and a possible one at the Nubian site of Amara West.[6] Nevertheless, the abundant surface evidence from Amarna, in the form of shallow circular depressions (cf. Kemp 1981: 92–93, Suppl. 4–6) which, whenever they have been excavated, have revealed two-stage wells, tells us that this type was the norm. Even at Medinet Habu the two-stage well seems to have been preferred. Although three relatively narrow shafts were made, two of them lined with stone, two were also provided with carefully constructed roofed staircases (Hölscher 1941: 66–70) to provide direct access to the water level. The temple may even have possessed, towards the front, a large open Amarna-type well (Hölscher 1951: 20), as did the adjacent mortuary temple of Amenhotep son of Hapu (ibid.: 20, note 58).

In a recent article R. Ventura (1987) has sought to identify a deep shaft outside the village of Deir el-Medina (Bruyère's 'Grand Puit', Bruyère 1953) with a deep well, the digging of which was undertaken during the Twentieth Dynasty according to textual sources. Whether or not this identification is correct, it draws fresh attention to this major feature of the Deir el-Medina landscape, which does actually provide a spectacular example of a well designed for carrying rather than lifting, such that one can say that it conforms closely with our expectations of New Kingdom well-digging practice, here attempting a depth much greater than can be found at Amarna. Bruyère's shaft was rectangular for the whole of its 37.75-metre depth, narrowing in three stages from about 27 to 8 m. A staircase carefully cut in the rock followed the sides the whole way. The bottom consists of a series of low flat steps cut in the rock (which was here marl), as if the work had been left unfinished, and this is Bruyère's and Ventura's conclusion, too. One of Bruyère's published photographs of the bottom, however, leaves open the possibility that over a more restricted area, beside the foot of the steps, there was still further to dig, into a narrow round shaft or pit corresponding to the final stage of other wells of this type (ibid., Pl. VIII.2, cf. p. 24). Our own experience at Amarna has several times shown that when a layer of fallen pieces and particles of marl is exposed to weathering or becomes damp it can set almost as hard as the parent bedrock, and thus it becomes difficult during excavation to distinguish between parent rock and fill. This, however, is only speculation and does not affect the identification of the shaft as having been a Ramesside well.

This design of well, so careless in its use of labour to raise water, was not confined to Egypt. Several striking examples have been excavated on Mycenaean and Levantine town sites (Broneer 1939; Miller 1980, 1988). These utilised the same concept for the upper part — the winding stair for the human carriage of water — but where strategic necessity dictated substituted for the lower-stage shaft a sloping or horizontal passage leading to a water source situated laterally from the site of the shaft.

4 The list of small domestic wells excavated so far appears to be: Borchardt and Ricke 1980: 97, Plan 27 [P47.2]; 111–112, Plan 28 [P47.10]; 131, Plan 23 [P47.21]; 173–174, Plan 52, Taf. 17B [N49.1]; 203, Plan 60 [O48.8]; 206–207, Plan 57, Taf. 20 [O48.10]; 237, Plan 73 [N49.9]; 258, Plan 84, Taf. 17A [O49.20]; also Borchardt 1912: 12–16; *COA* I: 11–12, 48, Pl. VII [N49.18].

5 The plan shows two wells, one with a spiral ramp and the other a plain circle enclosed by a square chamber. Neither is mentioned in the text. It is the latter that we are referring to here.

6 The possibility is suggested by the plan in Shinnie 1951: Fig. 2, but there is no mention in the published text to confirm or contradict it.

Our knowledge of water supply in earlier periods of ancient Egypt is surprisingly slight. Several desert-edge settlements from the Old and Middle Kingdoms, and from the Eighteenth Dynasty prior to the Amarna Period, have been excavated, but at none (including Kahun) has a trace been found of a well leading directly downwards to an underground water supply.[7] At the Middle Kingdom fortresses in Nubia, including those built on the flat banks of the Nile, the water supply in time of siege was still the Nile, to be reached by a stone-lined passage to provide protection from observation and assault, whereas a well within the walls, not technically difficult at the lower-lying forts, would presumably have served better.

Amarna stands in stark contrast to this background picture. The density of its wells makes it unique amongst Egyptian settlement sites, and together the wells must have provided a supply of water independent of the Nile even for people living or working not far from it. Well depressions can be observed as close as 400 m to the present river bank.

One further aspect remains to be considered. In a well-known scene in the tomb of the high priest Meryrē at Amarna occur the earliest Egyptian representations of a *shaduf* (*RT* I: 41–42, Pl. XXXII). The setting is a garden, and traces of one *shaduf* are visible beneath one of the trees, at ground level. Near-contemporary scenes in other tombs (Davies 1933: 70–73, Pls. XLVI, XLVII) make this a familiar setting, but in them the water source is a water-hole or the river, from which water can be lifted within the vertical scope of a single *shaduf*. In Meryrē's scene the water source is different. It is a square basin with a flat floor in the centre of which is a smaller square depression. The artist has emphasised the considerable depth of the basin partly through the depth of his own cutting into the wall surface and partly by the flight of steps carved in one corner.

We are evidently looking at a rendering, and a reasonably faithful one, of a large two-stage well of common Amarna type. Only part of the second *shaduf* survives at the edge of a patch of damage to the wall scene, but it is very clear that it stood on the floor of the first-stage basin. If we visualise Meryrē's well in terms of excavated Amarna wells the purpose of this second *shaduf* must have been to lift water from the second-stage water-hole to the floor of the basin, where it would be poured into jars for carriage to ground level by means of porters ascending the stairs. The vertical lift of a *shaduf* is not much more than the height of a man. A whole series of them would be needed to raise water from source to ground level, and such an arrangement would require intermediate platforms and cisterns in the sides of the basin, for which there is as yet no direct evidence. Once at the top of the stairs the jars could be carried to their final destination, or emptied into a limestone tank or conduit for distribution to the elements of a garden, or perhaps to an establishment with a substantial demand for water. This last remark is made in the light of the two limestone conduit blocks found loose on the pottery factory site Q48.4, described in the next chapter. It is here that a second *shaduf* as depicted in Meryrē's tomb would be used, to compensate for a contrary slope of the ground that the line of a conduit might have, for we should remember that the natural desert surface at Amarna is not as flat as is easily supposed. It is thus possible that a *shaduf* was fitted in to the irregular side of the lower part of our well in Q48.4, but to have worked at all it would have had to be within, say, 2 m of the water table.

It is here that we have to take account of the fact that the level of water in a Nile Valley well will respond to changes of river level, so that the annual cycle of inundation and low water would have caused the level of water in a well to rise and fall by several metres. It is tempting to argue that the floor of the upper stage was intended to approximate to the maximum expected height of the column of water, but this is difficult to sustain in the face of the considerable variation in the depths of the upper stages of the private wells excavated by Borchardt (see below). A *shaduf* erected beside the mouth of the lower shaft could be expected to work for part of the year when the water was within reach of its limited lift but not for the time when the water level had dropped to its lowest.

The system just pictured applies to the large "administrative" wells, such as that excavated this year. In some small private wells the relative depths of the two stages were different, that for the basin ranging from about 5 m (O48.10) to as little as 1.69 m (P47.21) and 1.80 m (N49.18). Borchardt had the opinion that a *shaduf* was used for raising the water up the shaft, and that the

7 A possible exception is at Malkata, Site JX1, where the 1973 excavations revealed a shaft well with surface emplacements for a lifting device. However, the dating is by no means clear and could be much later. This is due to be published in the near future.

shortness of its lift explained the two-stage construction of the common Amarna well. However, as already noted, the shortness of the *shaduf* lift would have limited it, at best, to the time of high water, and with some wells its use is probably excluded altogether. In the one instance where the level of the water was reached and recorded (P47.10: Borchardt and Ricke 1980: 111–112, Plan 28) it was 5 m below the platform which separated the two stages, and one wonders if a *shaduf* operating within the limited confines of the upper stage of the well would ever have been of much use, if, indeed, there was sufficient room for its pivoting beam to swing (*COA* I: 48 voices this view). The means of lifting water in these cases is more likely to have been simply a vessel let down the lower shaft by means of a rope, and the filled vessel then carried up the stairs to ground level.

The state of the evidence at Amarna is still far from satisfactory, not least the uncertainty as to the range of the ancient water levels. Further excavation, taking due note of the character of the sediments filling each well, is justified. But for the moment an hypothesis can be formulated on the general history of water supply in ancient Egypt that can be tested further. Until the mid-New Kingdom, urban water supply was primarily achieved by the carriage of water from the nearest open surface source, either the river, a canal or even a basin, or from a water-hole on the floodplain which was sufficiently shallow to require neither stairs nor a means of lifting more complicated than a vessel on the end of a length of rope. The terms used in early periods for water sources and which are commonly translated as "well" (*ẖnmt*, *šdt*) would in fact refer to basins and water-holes. What we see at Amarna is a relatively new phenomenon: a full urban water-supply independent of the Nile, drawing on a water table significantly below levels previously utilised and able to deliver substantial capacity. The two-stage Amarna well represents a conceptualization of water-supply moulded by long experience: namely, that the upper stage with its winding stairway was a means of access to a water-hole which just happened to be located significantly below ground level, a way of thinking which seems to have been present in Levantine examples. The remarkable ubiquity of such wells at Amarna, something as yet without parallel in ancient Egypt (even at the Amarna Period site of Sesebi in Nubia), points perhaps to a royal decree to this effect and to another of Akhenaten's experiments which failed to win popular acceptance.

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