

## PART II.

## THE CRIMEA.

IN the preceding pages we have thought it advisable to place under one view, irrespective of order of time, the facts in regard to the sanitary condition and subsequent improvement of the British hospitals situated within the Turkish territory, and we shall next describe the sanitary state of the allied occupation before Sebastopol, with the measures laid down in the instructions issued by the Commission for its amelioration.

The first step taken by the Commissioners on their arrival in the Crimea, in the beginning of April 1855, was, of course, to deal with those defects which they found to be most urgent, especially at Balaklava; but they did not neglect other more general subjects of inquiry respecting the topography, climate, water, &c., all of which had to be considered in their relations to the health of the troops.

These inquiries were carried out from time to time as opportunity offered, but it may be well that the results should be given, before entering on the consideration of the more local and removable causes of disease.

## § I. TOPOGRAPHY OF THE ALLIED OCCUPATION.

The allied occupation in the Crimea, at the beginning of April 1855, was limited to the plateau before Sebastopol, and the sea coast mountain range extending from San Georgeo to Marine Heights at Balaklava. Shortly afterwards, the occupation was extended to beyond Kamara on the east, and to the Tchernaiia on the north. Later in the season, the basins of Varnoutka and Baidar, and the mountain ridges to the north of them, were likewise occupied. A sketch of the topography and geology of the entire district is given in the Appendix, and also the special local circumstances connected with the diseases of the country. It is unnecessary, therefore, to do more than state the general results as far as these were likely to influence the sanitary condition of the army.

Considered in relation to the health of the troops, the ground occupied by Her Majesty's forces in the Crimea cannot be said, as a whole, to be peculiarly unhealthy, perhaps with the exception of the site of Balaklava itself and the marshy ground extending from the head of the harbour to Kadikoi. The neighbouring valleys generally are deep and narrow; the natural drainage defective; the subsoil apt to become saturated with water; and the sun's rays are reflected strongly from the bare rocks. The lower part of the basin of Balaklava, extending to the east of Kadikoi, was marshy from its defective drainage, and consequently unhealthy.

Nearly the whole surface of the area occupied by the army consists of loam and clay, underneath which, on the plateau, there is a spongy, calcareous, rocky subsoil, retaining water. From the hard, impervious nature of the rock on the eastern side of the occupation, the rainfall is concentrated on comparatively small surfaces on the bottoms of the valleys, consisting either of porous debris, or of loam or clay. In not a few places, there are impervious beds, underlying water bearing deposits on hill slopes, either retaining the water or turning it out along the edge of the impervious bed, so as to keep large areas of ground towards the valleys almost constantly wet in all states of the weather.

A high average temperature, with an intensely hot sun, is very likely to generate malaria under such circumstances, and to predispose to attacks of periodic fevers, which are the chief diseases of the country. The fevers are not usually malignant in character. They are very much what might have been anticipated from the local climate and topography, and would, in all probability, be eradicated or greatly mitigated by cultivation and drainage, as has been the case in the chalk districts of England. In certain situations, however, especially during autumn, these fevers assume a more dangerous tertian or remittent form, with biliary derangement.

The marshy heads of the sea inlets are all unhealthy, and the malaria from the mouth of the Tchernaiia is, at certain seasons, considered to be dangerous. Their effects are said to have been felt as far as Sebastopol. The influence of these marshes could hardly have been experienced in the British camps; but we were informed that cases of fever of a remit-

tent type, with a tendency to pass into typhoid and continued forms, had been admitted into hospital in April 1855, from the regiments nearest to Inkermann Heights, which overhang the marshy ground. The French camps on Fedoukine Heights, in the valley of the Tchernaiia, suffered from intermittent and remittent fevers.

It has been stated that ophthalmia used to be prevalent in Sebastopol, and there are local causes sufficient to account for it. The streets are unpaved, and the whole ground is covered with a very light, white calcareous dust, which is driven about by every breath of wind. From this state of the surface soil in dry weather, dust storms at times took place over the occupation, and during some of them, the dust has been raised in columns nearly 1,000 feet high during the hot season. The air, moreover, was frequently of an excessive degree of dryness, which, conjoined with the intense sunlight, reflected from white surfaces, and dust, was very likely to produce ophthalmia.

The surface of the plateau had no shelter from the winds or cold of winter, but, on the contrary, it received the full influence of the cold blasts sweeping from the north and north-east from the lofty snow-covered mountain ridges which overtopped it.

The subject of the waters of the district will be discussed more at length in the following pages; but it may be stated generally, that if any injurious influence was exercised on the health of the troops by the water they made use of, it arose from no natural bad quality of the water, but from foreign admixtures, arising from the manner in which it was collected and distributed.

There are no natural topographical conditions within the occupation which by themselves could have occasioned the disease and mortality among the troops during the winter and spring of 1854-55.

## § II. CLIMATE.

Meteorological observations were carried on for too short a time to enable an accurate estimate to be formed of the climate of the allied occupation in the Crimea. So far as these observations go, however, they afford tolerably reliable

results from which to judge of the effect likely to be produced by the climate on the health of the troops.

Observations were kept irregularly by various persons in Balaklava, but there was no regular series except those kept at the Castle Hospital by Drs. Jephson and Matthew. The instruments made use of were an aneroid barometer, a maximum and minimum thermometer, a wet and dry bulb thermometer, by Negretti and Zambra, a sun thermometer, and an air thermometer. The instruments were placed on the north side of one of the huts, about 320 feet above the sea, and overhanging it. From this circumstance, and from partial observations elsewhere, it is probable that the Castle Hospital observations represent a sea climate rather than a land climate; that the mean temperature in the close land-locked harbour of Balaklava, with its overhanging mountain slopes reflecting the sun's rays, was higher than at the Castle Hospital, at least during summer; and that the extremes of heat and cold, as well as of dryness, were greater on the plateau before Sebastopol.

The following table gives the monthly means and ranges, from April 1, 1855, to May 31, 1856, as deduced from the observations kept at the Castle Hospital, Balaklava:—

Month.	Barom. Mean.	Barom. Range.	Mean Temp.	Mean Daily Range	Mean Max.	Mean Min.	Mean Dry.	Mean Wet.	Mean Sun Temp.	Days of Sun- shine.	Rain.
	Inches.	Inches.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.		Inches.
1855.											
April.....	29.463	.962	50.3	21.3	64.1	40.7	57.0	59.0	68.1	22	2.346
May .....	.544	.748	62.9	23.2	74.3	51.3	64.6*	58.5*	81.0	29	5.308
June† .....	.624	.480	71.2	23.9	83.6	59.8	..	..	96.4	29	3.825
July .....	.543‡	.474‡	73.1§	22.9§	84.7§	62.2§	76.8	67.9	99.3§	29	4.003
August.....	.574	.385	73.0	22.5	84.5	61.5	76.6	68.0	107.5	28	2.776
September ....	.634	.535	58.6	19.1	68.0	48.7	61.2	51.9	87.9	23	No data.
October .....	.610	.540	59.1	18.7	70.5	50.0	61.0	55.5	81.4	27	.118
November ....	.651	.870	48.9	13.7	54.9	41.0	49.8	45.7	82.4	16	2.067
December ....	.503	.950	33.3	11.3	39.3	28.9	35.1	33.9	55.2	13	2.400
1856.											
January .....	.469	.760	40.0	9.4	46.0	35.0	40.8	39.9	59.0	15	2.499
February .....	.536	.715	36.2	12.4	42.5	30.0	38.0	35.7	58.8	15	2.438
March .....	.500	.870	32.6	15.7	40.5	25.0	35.9	33.2	65.8	22	2.012
April.....	.481	.465	47.9	18.1	56.4	38.9	50.5	44.27	80.9	26	1.203
May .....	29.408	.605	60.9	20.2	71.0	50.7	62.9	56.6	85.4	25	1.529

\* 12 days.

† 29 days.

‡ 23 days.

§ 29 days.

|| 21 days.



The highest observed sun temperature was on the 14th August, 1855, on which day the sun thermometer indicated  $125^{\circ}\text{F}$ . The highest observed shade temperature was  $99^{\circ}\text{F}$ . on the 23rd July; and the lowest observed temperature was  $2.5^{\circ}\text{F}$ . on the 19th December, 1855.

On comparing the climate of the allied occupation with that of the metropolis for a series of years, we find that in April 1855, the excess of mean temperature at Bala-klava over Greenwich was  $3.8^{\circ}\text{F}$ .; in May,  $9.5^{\circ}\text{F}$ .; in June,  $11.9^{\circ}\text{F}$ .; in July,  $11.3^{\circ}\text{F}$ .; and in August the excess was  $11.9^{\circ}\text{F}$ . In September,  $1.8^{\circ}\text{F}$ .; in October,  $9.4^{\circ}\text{F}$ .; in November,  $4.6^{\circ}\text{F}$ .; in December, the Crimean temperature was  $7.1^{\circ}\text{F}$ . under the London mean of the month. It was  $1.7^{\circ}\text{F}$ . above the London mean in January 1856. In February it was  $2.6^{\circ}\text{F}$ . below the London mean, and  $9.2^{\circ}\text{F}$ . below the same mean in March. In April the Crimean temperature showed an excess of  $1.4^{\circ}\text{F}$ . and in May of  $7.5^{\circ}\text{F}$ . above the London mean.

The daily mean range of the month was in excess of that of Greenwich. In April 1855, the excess was  $+4.4^{\circ}$ ; in May,  $+4.1^{\circ}$ ; in June,  $+4.1^{\circ}$ ; and in July,  $+5.4^{\circ}$ . In August it was  $+4.5^{\circ}$ ; in September,  $+1.8^{\circ}$ ; in October,  $+5.1^{\circ}$ ; in November,  $+3^{\circ}$ ; in December,  $+2.3^{\circ}$ . In January, 1856, it was  $+1.2^{\circ}$ ; in February,  $+1.9^{\circ}$ ; in March,  $+1.5^{\circ}$ ; in April,  $+1.2^{\circ}$ ; and in May,  $+1.1^{\circ}$ .

So far, then, as can be ascertained by the observations, the Crimean climate, during the period of the allied occupation, may be characterized as one of extremes. Intense summer heat and sun radiation, and severe winter cold. The observed difference of air temperature in July and December was  $93.5^{\circ}\text{F}$ .; and the difference between the highest sun temperature and the lowest air temperature was  $122.5^{\circ}\text{F}$ . The daily variations were also at times excessive. During the hot season, the daily maximum shade temperature ranged from  $72^{\circ}$  to  $99^{\circ}\text{F}$ ., while the minimum ranged from  $44^{\circ}$  to  $72^{\circ}\text{F}$ . The sun temperature, to which the troops were exposed day after day during the same season, varied from  $110^{\circ}$  to  $125^{\circ}\text{F}$ . The passage from the sunshine to the shade was attended by a fall of temperature of from  $32^{\circ}$  to  $44^{\circ}\text{F}$ . A sun temperature of  $120^{\circ}\text{F}$ . was followed

by a fall of from  $50^{\circ}$  to  $60^{\circ}\text{F}$ . at the minimum period of the same night.

Occasionally the winds were hot and sultry, and during winter the effect of the severe colds was much increased by high winds. The cold continued late in the spring, partly from the continuity of the Crimea with the great steppes of Southern Russia, and partly from the late continuance of snow on the mountain ridges to the north and north-east of the occupation.

The dryness of the air was sometimes excessive, and its transparency so great that it was difficult to judge of the distance of objects without practice.

Fogs prevailed to a greater or less degree during the colder months, occasioned apparently by the difference of temperature between the Black Sea and the land. During certain times when the fog hung over the sea the water presented an appearance of intense blackness. When the wind blew from the sea to the land the current was suddenly carried upwards by the coast precipices to a height of 1,000 or 1,500 feet, and deposited vapour as it ascended, which rolled over the land as sea fog while the sun was shining brightly on the water below.

The barometric means, so far as could be ascertained by the aneroid barometer, were steady and the range under one inch.

As regards its relation to the health of the troops the Crimean climate was a trying one. The amount of intense solar radiation to which the troops were exposed during the summer heats through the day, not inaptly compared to the sensation of melted lead falling on the skin, alternating with a comparatively low night temperature, and the vicissitudes produced by the direction of the wind, all tended to cause sudden chills of the surface, and to increase the predisposition to those fevers incident to the country. The exhaustion produced by the heat often led to the use of stimulants, or to sleeping in the open air, both of which were no unfrequent causes of zymotic disease. Up to a certain point cholera was observed to increase in severity as the summer temperature rose. During autumn the intense dry day heat

was often followed by a cold north wind at night, or towards morning, succeeded by attacks of diarrhoea among the troops.

The winter differed from that of similar latitudes in other parts of Europe in its want of steadiness. There was no continued frost, followed by a regularly increasing temperature, but a constant oscillation of weather; and cold, moist winds produced by the peculiar climate of the Black Sea.

The cold and variable spring climate was an evident cause of catarrhal and chest affections which prevailed extensively among the troops.

Natives usually guard against inclemencies by wearing warm clothing early in the winter and late in the spring, and light clothing only during the very hot weather.

By attention to such precautions, by proper regimen and shelter, the variations of the climate might of course be provided against; but we apprehend there can be little doubt that without these precautions the Crimean climate is one very likely to affect injuriously the health of foreign troops exposed to it.

From any information we were able to obtain, it appears that the climate of the great undercliff sheltered by the huge sea coast precipices of the south of the Crimea is much milder in winter than any other Crimean climate.

### § III. WATER SUPPLY WITHIN THE BRITISH OCCUPATION.

One of the earliest subjects to which the Commissioners directed their attention was the amount and quality of the water available for use of the army. They examined carefully, and in different states of the weather, the sources of water over the whole of the ground occupied by the troops, and they were about to bring the subject under the notice of the Commander of the Forces, when they received a request from his Excellency on the 15th May, 1855, for assistance and advice in the matter.

The area of the water shed of that portion of the plateau before Sebastopol occupied by the British forces, may be taken at from eighteen to twenty square miles.

Making allowance for loss from surface drainage and evaporation, the rainfall over this area filters into the porous and fissured beds of stratified limestone of the plateau, and appears in the form of springs at any favourable point of issue.

Considered with reference to the water supply, the edge of the plateau overhanging the plains of Balaklava and the Tchernaiia and the line of heights to the north-east of San Georgeo, may be described as the highest level; from which the ground slopes towards the north-west. In doing so it is gradually hollowed into a number of superficial depressions ending in ravines becoming deeper as they approach Sebastopol harbour, and giving outlet to the natural drainage of the plateau.

Within the British occupation there were several of these hollows ending in five ravines considerably depressed below the average level of the plateau.

These hollows were partly filled with a loose porous calcareous debris, capable of absorbing and retaining a large quantity of water. From the porous rock and debris the water escaped in springs at the heads of the ravines; some springs yielding a much larger quantity than others, but none of them sufficient in amount to form the stream running in the ravine lower down. Some of the springs near San Georgeo, after flowing for a few hundred yards on the surface, were again absorbed and lost to sight.

The water at its point of issue was clear and good; but if the springs were not caught at that point they became muddy by running over the debris or loam of the surface when that was trodden under foot, as was generally the case, or after rain. At a number of points the springs did not come to the surface at all, but their position was distinctly marked by greener vegetation, or by a softer condition of the ground; the water in such instances finding its way beneath the surface down to the lower levels, and escaping into the streams in the ravines increased their volume.

The Russian farm-houses in some instances derived their supply from these superficial springs; but in situations where they could not be rendered available it had been the custom



to dig large wells or tanks of moderate depth, and to build the well of rubble stone, set in cement, and lined inside with cement.

The quality of the water was naturally the same as that of all waters filtered through porous tertiary limestone rocks. It was clear and wholesome, though, perhaps about 16° of hardness; but its condition, when taken for consumption, depended of course on the provisions made for collecting, storing, and distributing it for use. With proper care, the water was of as good a quality as was required for the health of the troops, but if suitable precautions were not adopted, it would, of course, become loaded with calcareous and loamy particles derived from the soil, rendering it less wholesome and by no means agreeable to use.

At the time of our examination the quantity issuing from the springs appeared to us to be far from representing the available supply, which we had no doubt could have been considerably extended by opening out the springs, so as to draw on the natural reservoir in the strata, by cleansing, and deepening existing wells or by digging new ones. Several of these springs, combined in a ravine near the Monastery, we gauged on the 15th May, 1855, and found them to yield 35,000 gallons per day of 24 hours, and this yield could have been much increased by very simple engineering appliances.

At that date, several capacious open tanks were being cleared out in two of the ravines. These tanks, however, had been formed on loamy or clayey ground, and as a necessary consequence the water was apt to become muddy unless it were kept perfectly undisturbed.

The supply for the troops was not drawn from the inlet pipe, the water from which was generally comparatively pure, but from the tank itself, by dipping with canteens and buckets, and the water carried to the camps was muddy and less wholesome than it might have been.

The best way for obtaining an abundant supply of pure water under the circumstances in which the army before Sebastopol was placed was:—

1. To have opened the spring heads as already mentioned.

2. To have received the water from the spring into a covered chamber, from whence it could have been drawn by a pipe or pipes for use.

3. To have received the overflow into covered tanks or reservoirs to be drawn from thence only by pipes with taps.

4. All wells should have been cleared out, puddled round the top, and protected by a low wall.

5. All the sources of supply should have been carefully guarded.

The horse troughs were generally supplied by the overflow from the tanks, and the men washed their clothes in the streams in the ravines. The ground around the water tanks and troughs was generally very sloppy from being unpaved. Where water was drawn from wells much was spilt on the surface from carelessness, and flowed back to contaminate the well.

So far as concerned the adequacy of the supply on the plateau, we arrived at the conclusion that unless the quantity of water were increased by proper engineering works, such as those mentioned, and unless additional means of storage were provided to pound the augmented supply, there would be considerable danger of a deficiency before the end of the dry season.

Descending towards Balaklava the upper part of that valley, towards the Col, had a stream of water running down it, derived from springs flowing from the lofty hill-sides south of the Col. This water, if properly economized, would have supplied a large number of troops. Near its source, however, it was fouled both by the Turks and French; and, for want of care, became so polluted in a very short time as to be unfit for consumption.

Below this point, a number of dead animals had been thrown into the bed of the stream, and by the time the stream arrived at Kadikoi it was useless.

In the adjoining valley of Karani, there are a number of springs near the village, flowing from the ridge which closes the valley at the top. The rills from these springs become enlarged in volume by the drainage from the hill-sides, and finally form a small stream from which the Cavalry camps in

the valley derived their supply. It appeared to us, that by suitable arrangements, the quantity of water from these springs might have been increased to a considerable extent.

There was a pure and abundant spring belonging to the Sardinian Head-quarters at Kadikoi, which was drawn from a pipe laid down for the purpose.

The town of Balaklava has abundant sources of water; the most remarkable of which is the ancient well at the head of the harbour, which derives its source from the limestone hill on the east of the harbour.

This water was pure and good, but from the want of a little improvement in the well, the water flowed over the road, keeping it constantly wet and muddy, and the amount so wasted, was very much greater than was used.

Another similar spring, but much less in quantity, flowed from under the hill on the west side of the harbour.

An important source of water is derived from Marine Heights, under which, and about 570 feet above the level of the sea, is an upland valley intervening between the conglomerate and limestone resting upon it. This valley is filled with porous debris, overlying impervious beds, and the water arising from the rainfall crops out all round the margin of these beds, and appears in the form of springs running down the hill-sides, on the one hand towards the plain of Balaklava, and on the other, towards the ravine separating the castle rock from the hills to the east of the town.

These latter springs form a considerable stream supplying the Castle Hospital, and flowing down the ravine into the harbour. Part of the water appears, in former times, to have been conducted along the ridge at the Castle Hospital to tanks and covered reservoirs, which remain partly entire, or in ruins within the walls of the Castle. This large water stream was never rendered available for use, because no precautions were adopted to prevent its being polluted by washing from the ships, &c., and even by worse nuisances, in its short and rapid descent from its source. A recommendation was made by the Commissioners on the 11th April,

1855, for covering over this stream to render it useful as an additional source of water supply. At a subsequent date, on the 17th July, a recommendation was made to have the stream guarded and protected from pollution.

So great was the amount of water at Balaklava from all these sources, that after making allowance for a reduction of three-fourths of the amount during the hot season, it was found that even then there would have been water enough in the immediate vicinity of the town to have supplied the whole British army, provided it could have been carried to the camps.

In all parts of the camp, the manner of supplying water to the horses appeared to the Commissioners to require improvement. It was usually accomplished by receiving the stream, or overflow, into a long trough, the overflow from which went into another trough, and so on, for a number in succession. By this arrangement, the water became more and more polluted in each successive trough, until it not unfrequently happened that the horses would not drink it. The evil admitted of easy remedy, by supplying the water to each trough separately, and in this way the whole line of troughs could have been in use. The total length of trough was too small for the number of horses to be watered, and there was not a little loss of time and some quarrelling in consequence.

Another prominent defect at Balaklava, was the want of watering-troughs for cattle landed from the transports. These animals were generally kept several days without water during the voyage from the ports of the Black Sea, where they were shipped, and were landed in this state and driven to the depôts without water, even in the hottest weather. A few yards of piping, of which there was plenty in Balaklava, laid from the stream in the Castle ravine to a few troughs on the cattle-wharf, would have permanently supplied the want. We represented this defect at the time, and it was finally remedied by the Commissariat Works Corps early in the present year, 1856.

These various points connected with the water supply were brought under the notice of the late Field-Marshal



Lord Raglan, in communications on the subject addressed to his Lordship on the 16th and 26th May, 1855.

We therein pointed out, that the water-supply from the springs in different parts of the camp before Sebastopol, might be increased in quantity in the manner already pointed out.

That the water should be conducted from the sources by pipes only.

That tanks and reservoirs should be covered. That piping should be laid to facilitate the distribution of the water.

That filter beds could easily be made if found to be requisite.

That additional lengths of watering-troughs should be laid down, and each trough supplied independently.

That all watering-places should be drained and paved, so as to preserve the surface hard and clean.

In making these recommendations, the Commissioners were aware of the want of certain materials required for carrying them out; but they stated at the same time that every requisite article, as well as skilled labour, could be got at Constantinople, where the whole practice of distributing water is perfectly well understood; and they also expressed their opinion, that were the improvements carried out, the camps before Sebastopol and at Balaklava, would have a sufficient supply of water during the ensuing summer. Mr. Rawlinson also offered his services in planning the necessary works.

The Commander of the Forces was most desirous of giving effect to any improvements the Commission might suggest, and he directed Captain Ewart, R.E., to consult with Mr. Rawlinson on the subject; but, unfortunately, before an appointment could be kept, Mr. Rawlinson was obliged to return to England.

In the course of the summer and autumn of 1855, during a long drought, there was some deficiency of water in the camps; but as various improvements had been carried out for increasing and distributing the supply, the deficiency was not so great as it might have been.

The previous removal of a large number of French troops to positions within reach of the canal of the Tchernaiia, relieved the other water sources, and opened up the exhaustless stores of the Tchernaiia itself.

Before concluding this part of our Report, it may be useful to mention a few practices which were adopted for obtaining water.

The usual way of conducting water all over the East, is to lay down earthenware pipes from the spring to the point of delivery; a plan well adapted for fixed camps in certain positions. One of the best illustrations of this mode of supply existed on the plateau, where some wet ground was opened, two springs discovered, and joined into one by separate pipes laid in the ground and covered over. The water flowed from the end of the delivery-pipe clear and wholesome.

One of the Sardinian establishments in the valley of Balaklava derived its water supply from a small source on Marine Heights, a considerable distance off. The water flowed down the hill-side in a carefully-cut drain, and arrived comparatively pure.

Some distance further to the east, a large spring was discovered, at the foot of a hill, which might have been delivered in excellent condition by a short wooden spout; but, instead of this simple expedient, considerable labour had been spent in digging a hole, into which the spring flowed; and as the water was drawn by dipping, it need hardly be stated that it was muddy, and scarcely fit for consumption. The remedy was pointed out on the spot.

A ready way of obtaining clear water was to knock the ends out of a couple of casks, to dig a well in any position where water was likely to be found near the surface, and to put in the casks one over the other, so as to form a sort of wooden well and filter.

The water for the Russian Inkermann batteries was obtained from a porous bed of debris near the top of one of the ravines, 500 feet above the sea, by digging, and inserting large gabions, to keep up the sides of the well thus formed.

The camps on Marine Heights were supplied by sources near the surface of the ground in the upland valley. With reference to these springs, it may be stated that when the Turkish troops were camped higher up the hill than the site of the sources, one of the first things they did was to dig latrines close to the spring heads. We represented this to head-quarters at the time. Such things are in constant danger of happening in camps, and the circumstance is mentioned here to show the necessity of carefully watching and protecting the whole neighbourhood of water-sources from similar dangerous nuisances.

The camps of the Highland Division at Kamara, which were formed there at the end of the year 1855, were abundantly supplied with pure water; the lofty hill slopes above the encampments are covered with beds of porous debris, the springs from which had been conducted by the native population through pipes, so as to form fountains. These were repaired in a tasteful manner by the men, and so left at the period of the evacuation. The water of one of these fountains was received and stored in a succession of barrels, from which it could be drawn pure and good.

Other instances of storage in barrels occurred, and it appeared a simple and efficient method, for it admitted of drawing by dipping, and yet the water did not become muddy.

In conclusion, we are of opinion that the water supply within the British occupation was naturally wholesome in quality, and admitted of being made sufficient in quantity; and that where the water was deficient either in purity or amount, such defect admitted of easy remedy.

#### § IV.—SANITARY CONDITION OF THE BRITISH ARMY IN THE CRIMEA.

We shall next give a detail of the steps taken by the Commissioners for improving the sanitary condition of the town and harbour of Balaklava and the camp before Sebastopol; but, before doing so, it is requisite to give

such a general account of the health of the troops, at the period of our arrival in the Crimea, as may be necessary to show the diseases from which they chiefly suffered, and to prove the necessity for the measures which we recommended for adoption.

The approximate sanitary statistics in the following pages were deduced week by week from abstracts prepared by the Secretary to the Commission, of the regimental and divisional medical states, placed at our disposal by Sir John Hall, K.C.B., to whom we were indebted for much information respecting the health of the army, and for facilities in examining the camps and hospitals.

In the beginning of April 1855, the health of the army, when compared with that of males of the same ages elsewhere, was by no means good. It was, nevertheless, hardly below what has hitherto been the usual standard of armies in the field, and its health was better than that often experienced by armies similarly circumstanced.

On the week ending April 7, the sick and wounded amounted to 124 in every 1,000, or nearly to an eighth part of the army. The wounded were only 5 per cent. of this proportion. The force amounted to 31,610 men.

During the five weeks ending May 5, when cholera began to appear, the average sick and wounded may be stated at 109 men per 1,000, and of this number 100 were from sickness alone. The sick from disease was 10 per cent. of the army, and the sick from wounds was less than a hundredth part of the army. No less than 61½ per cent. of the total disease belonged to the class usually called zymotic diseases, namely, fevers, diarrhœa, dysentery, and cholera. Half of the whole sickness prevalent in the army during those five weeks was due to fevers alone.

Asiatic cholera, which had showed itself slightly in the camp, advanced during the week ending May 12, and forty cases were admitted into hospital twenty of which proved fatal. The total admissions into hospital during the week were equal to 37 per 1,000 of the force. One half the admissions was due to the zymotic class of diseases, and about a seventh part to wounds.

The deaths during the week were at the rate of 10 per



cent. of the force per annum, and no less than 78 per cent. of the mortality arose from zymotic diseases.

On the week ending May 19, there were 1,621 admissions, including 92 from wounds, and of this number 1,066, or 65 per cent., were due to zymotic diseases. There were 194 cases and 109 deaths from cholera. The total mortality was at the rate of 23.7 per cent. of the force per annum, and 80 per cent. of the mortality arose from zymotic deaths, chiefly from cholera.

During the succeeding week, ending May 26, the admissions equalled 40 men per 1,000, and 59 per cent. of these admissions arose from the zymotic class, which also occasioned 88 per cent. of the mortality. There were 101 cases and 68 deaths from cholera during the week.

The mortality for the week was at the rate of 15.6 per cent. of the force per annum.

Above 10 per cent. of the admissions, and less than a tenth part of the deaths, arose from wounds.

On the week ending June 2, there were 113 cases and 58 deaths from cholera. A twelfth part of the army was on the sick list, and the weekly deaths averaged  $12\frac{1}{2}$  per cent. of the army per annum. 5.3 per cent. of the admissions and 5.6 per cent. of the deaths arose from wounds, while 64 per cent. of the admissions and nine-tenths of the mortality arose from zymotic disease.

On the following week, ending June 9, 274 cases and 145 deaths occurred from cholera. The total sick amounted to 104 men per 1,000; the admissions equalled 66 per 1,000, and the deaths were at the rate of 32 per cent. per annum. 57 per cent. of the admissions and 80 per cent. of the deaths were again due to zymotic disease, chiefly fever and cholera.

The week ending the 16th June gave 199 cases, and 121 deaths from cholera. The total mortality was at the rate of 26 per cent. per annum;  $17\frac{1}{2}$  per cent. of the total admissions and 16 per cent. of the total deaths arose from wounds. The zymotic class of diseases furnished  $63\frac{1}{2}$  per cent. of the admissions into hospital, and 77 per cent. of the deaths during the week. 95 men per 1,000 were on the sick list.

The week ending June 23 shows a large increase of sick and wounded, from the advance of the cholera and the attack on the Redan. The proportion of sick rose to 130 men per 1,000; the admissions for the week equalled 100 men per 1,000. 1,659 wounded men were admitted, being 40 per cent. of the total admissions, and there were 85 deaths from wounds, or 30.8 per cent. of the total deaths, which, during the week, amounted to 276, or at the rate of 35 per cent. per annum.

The zymotic class of diseases still vindicated its deadly superiority over one of the bloodiest struggles of the whole war. No fewer than 1,912 zymotic cases, or  $46\frac{1}{2}$  per cent. of the total admissions, went into hospital; and there were 178 deaths from the same class of diseases, equal to 64.4 per cent. of the total mortality, in hospital, during the week.

The following week, ending June 30, showed 138 men per 1,000 of the army sick.

The increase was due to zymotic disease. The admissions during the week equalled 70 men per 1,000, and the deaths were at the rate of 33.8 per cent. per annum. There were 351 admissions and 177 deaths from cholera, and there were 1,197 admissions and 9 deaths from diarrhoea. The total zymotic cases admitted were 2,179, or 75.6 per cent. of the total admissions, and the same class of diseases furnished a mortality of 207, or 77 per cent. of the total deaths.

During the week ending July 7, the cholera materially diminished. The admissions from this disease had fallen to 95, and the deaths to 66. The zymotic class, nevertheless, supplied 72 per cent. of the total admissions, and 64.3 per cent. of the total deaths. 8 per cent. of the total admissions and 31.4 per cent. of the deaths were due to wounds. The total admissions during the week were 60 men per 1,000 of the force, and the total mortality was at the rate of 17.6 per cent. of the force per annum.

On the week ending July 14, cholera subsided still further, and yielded 65 cases and 51 deaths. Fever, diarrhoea, and dysentery still retained their ascendancy. The zymotic class yielded 73 per cent. of the new cases, and 71 per cent. of the deaths during the week. The admissions from wounds

were 8.8 per cent of the admissions, and they yielded 26 per cent. of the total deaths, which were at the rate of 13.5 per cent. per annum.

The experience of these ten weeks, intervening between the 5th May and the 14th July, are sufficient for the purpose of illustrating the sanitary state of the troops. The period selected includes the interval between the first advance of spring temperature and the setting in of the fierce summer heat. It includes the commencement and first decline of the cholera. It comprehends a period of harassing and dangerous duty in the trenches, and one terrible assault.

The average strength of the army during the ten weeks was 38,507 men. The total admissions into hospital were 22,541, or 58 per cent. of the force, and the deaths, exclusive of those at Scutari, were 1,643, or 4.2 per cent. of the force.

The admissions from wounds were 3,858 or 10 per cent. of the force, and the deaths from wounds were 334 = 0.87 per cent. of the force.

The admissions from all diseases, excluding wounds, were 18,683 = 48.7 per cent. of the force, and the deaths from disease alone were 1,309 = 3.4 per cent. of the force, or 17.6 per cent. per annum.

The admissions from the zymotic class of diseases were 14,142, and the deaths 1,264, equal to 37 per cent. and 3.2 per cent. of the force respectively.

The admissions from all other diseases, not zymotic, were 4,541, and the deaths 45.

It thus appears that only 17 per cent. of the total admissions, and 20 per cent. of the total deaths were due to wounds, exclusive of deaths in the field, the remainder being due to diseases of various classes; that 74½ per cent. of the total diseases admitted into hospital were of the zymotic class; and that 96 per cent. of the total mortality from disease alone were zymotic deaths.

Of the 14,142 admissions from zymotic diseases, diarrhoea supplied 6,736 cases, 70 of which, or a little more than 1 per cent., proved fatal.

There were 1,709 cases and 955 deaths from cholera—a mortality of 55.8 per cent.

Dysentery afforded 824 cases and 13 deaths, or about 1½ per cent. of the cases.

The various classes of fevers supplied 4,873 admissions and 226 deaths, or 4.6 per cent. of the fever cases.

The diseases classed under the general denomination of "fevers" yielded a low proportional mortality. They consisted to some extent of the usual fevers incident to the country and climate; and many of the slighter cases arose from drinking, lying out, or from exposure to the sun's rays. Such cases seldom lasted above a few days, and the soldier was soon discharged to duty. A considerable proportion of the cases were of the ordinary continued type, and some were of a typhoid character, marking in either case the operation of causes other than those specially connected with the country or climate.

While inquiring into the sanitary state of the troops, we were struck with the comparatively small amount of sickness in the Naval Brigade serving in the camp before Sebastopol, and we applied to Dr. Smart, R.N., surgeon to the brigade hospital, for information on the subject, requesting him to state the reasons why, in his estimation, the brigade had suffered less than the army. His report, which contains points of interest to the service, we have appended. It appears from it that the average strength of the brigade, from October 2, 1854, to April 30, 1855, was 1,200 men; that the cases treated in hospital equalled 5 per cent. of the force per month; that there had been 40 deaths during the period, being at the rate of 57 deaths per 1,000 of the force per annum; that 84 per cent. of the cases, 423 in number, and all the deaths except one had occurred from cholera, diarrhoea, dysentery, and fever. All the cases of sickness, except 59, took place during the months of October, November, and December, 1854, and at the period of our inquiry the brigade was healthy. 1.200

The great prevalence of zymotic diseases, their predominating influence on the physical efficiency of the army, and the known fact that means had been successfully applied, even in crowded cities at home, for mitigating their ravages, arrested the attention of the Commission at the commencement of the inquiry, and we saw that it would be with the local



favouring causes of these maladies we would chiefly have to deal.

There can, we apprehend, be little doubt that the unfavourable conditions in regard to diet, clothing, fatigue, and shelter to which the army had been exposed during the preceding winter still, to some degree, exerted their influence on the constitutions of the men who had passed through them, and that a certain amount of the existing predisposition to zymotic disease might be fairly attributed to these circumstances. Some of them, it is true, had by this time ceased, and the diet of the army underwent a most beneficial improvement shortly after our arrival, from the supply of fresh meat, vegetables, and bread. Notwithstanding these improved conditions, zymotic maladies were increasing in frequency, and the men who suffered most from the severer forms were the new arrivals—a clear indication of the existence of local predisposing conditions. There was, at this period, a prevailing epidemic constitution over the whole of the allied occupation, and in fact over the whole East, specially indicated by the outbreak of cholera in the army, and this epidemic state appeared to have rendered all persons exposed to it liable to attacks of zymotic diseases of other types besides cholera. The advance of spring, and the rise of temperature, had likewise called into operation local causes of sickness, which had been accumulating since the commencement of the occupation, but had lain comparatively dormant during the cold weather. These causes did not differ in kind from those which are observed elsewhere to determine the specific action of epidemics on the human organism.

In this respect the allied occupation afforded no exception to the general law, that, given an epidemic influence, the effects of that influence will be most marked where there is damp, and filth, and foul air; where there is defective drainage, want of cleansing, nuisances, overcrowding, defective ventilation, and impure water.

Certain positions exhibited these defects, or some of them, in so marked a manner, that the only remedy, in the absence of other means, was change of position. In other instances, from the more intense heat of the climate, local conditions, which otherwise might have appeared com-

paratively harmless, became of great importance to the public health.

While making this general statement, we would, at the same time, not overlook the predisposing effects of personal conditions. In the Crimea, drinking, fatigue, exposure to harassing and exhausting duties, exercised the influence they do elsewhere; but neither would these things by themselves, nor the climate, nor the existing epidemic constitution, account for the extent of zymotic disease, from which the army suffered at this time.

Whatever the amount of such influences, the Commissioners had no power to interfere with them. Their duty was to recommend, and to see to the removal or abatement of all sources of local malaria, or other local causes of disease, so far as the means at their disposal enabled them to do so.

In carrying out their instructions, the Commissioners directed their attention, in the first place, to the town of Balaklava, as that point of the occupation where improvement was most urgently needed, and as soon as the sanitary works required there were commenced, they proceeded to examine the camps.

#### § V. SANITARY CONDITION OF BALAKLAVA.

The topographical peculiarities of Balaklava have been elsewhere briefly described. Considered in relation to the health of the inhabitants and of the shipping, they require some further detail. Balaklava is a small town, capable, at the time of our inquiry, of containing from 500 to 600 people, built on a bank of debris, resting on a steep hill-side, and receiving all the surface water from the ground above its level. The water of the harbour came close up to some of the houses. The harbour is about 850 yards long, measured from the Castle Rock to the head, and about 260 yards wide. Like other seaports in tideless seas, the water preserved nearly the same level, except when acted upon by winds and sea currents, through the agency of which alone could its mass be renewed. Along the east and west sides, the harbour is bounded by ranges of steep, rocky, limestone hills, from 600

to 800 feet high. On the south, it is divided from the sea by the Castle Rock, rising to the height of 469 feet, and round the base of which the entrance to the harbour winds. On the north end the hills open, leaving between them a narrow, marshy plain, through which the drainage of the valley of Balaklava flows into the head of the harbour. At a comparatively recent period, the harbour extended further inland than it does at present. It appears to have shoaled gradually by the amount of detritus brought down by the stream, and by rain storms, and the portion so filled up had become a noisome marsh, in which salt and fresh water intermingled. The area of this marsh was about ten acres, but it went on increasing in area, for the upper end of the harbour continued to shoal during the whole period of the occupation, and when the troops left the Crimea, there was marshy land where the sea had flowed not many months before.

North of the head of the harbour, the ground was marshy as far as Kadikoi, about three-quarters of a mile distant, and it there joined the lower and wetter part of the plain of Balaklava.

The town has no communication with the sea, except by the water entrance to the harbour, on account of the precipitous rocks by which the harbour is inclosed.

The water supply for the town and shipping was derived from the sources already described, and also from shallow wells dug in the debris on which the town is built. The water so obtained was not so pure as that derived from the natural sources.

The local position of Balaklava cannot be considered as naturally healthy, and under the most favourable circumstances would probably give rise to periodic fevers at certain seasons.

The native houses are built of the rubble stone of the district, or of stone scabbled into rough courses. The walls are set with mud and a little lime, timber for bond being freely used. The rooms are small and low, the walls thick, the windows small, the roof overhanging, and covered with common red earthenware tiles. In many cases there were external galleries and staircases, protected by overhanging

eaves. Some of the windows were double glazed. The fire-places were low, and the flues small. In many situations the foundations of the house had been dug out of the hill side, so that the earth came up several feet against the back walls, rendering the lower flats damp and unwholesome. The subsoil moisture in these houses rose by capillary attraction above the level of the ground, and showed its presence very decidedly on the lime-washed walls, a sure sign of an unwholesome house. Much sickness, chiefly fevers, originated in these houses after the occupation. Five or six cases were taken out of the basement of one of them. More mischief from this cause would have been produced during the summer and autumn of 1855, had many of the houses not been pulled down by Lieutenant-Colonel Harding the Commandant, and huts erected in their stead.

Besides these local sanitary defects, incident to the town before its occupation, other causes of disease came into existence as soon as it was taken possession of by our troops.

The harbour became filled with shipping. Every available accommodation within the town was crowded with inhabitants. There were stables and other places for a large number of horses and cattle. A considerable number of Turkish and Croat labourers were located in the town and in its immediate vicinity. Many thousands of men and a large number of animals came into and left the town every day on the service of the army. And for all this increase of population and traffic there were no adequate cleansing or other sanitary measures provided. The consequence was, that putrescent organic matter accumulated in the very places where it was most likely to do harm. Had there been any road past the cliffs leading out to the sea, it would have been comparatively easy to have removed the whole town refuse, and to have turned it into the water at a distance; but, unfortunately, there was no such road. It might have been removed in large boats or barges, as it subsequently was, but there were none until a later date, when one or two large Russian barges were obtained. There were neither suitable roads nor means of transport to have removed the manure to a distance inland, and, instead of leaving it among the houses



of the town, it was judged better, apparently, to throw it into the harbour. This appeared to have been the special place of deposit for every kind of filth and refuse; and the Commissioners found on their arrival, that nearly the whole of the eastern margin of the harbour—that part nearest the town, and directly under the sterns of the shipping, where men were at work unloading stores for the army, was composed of a mass of organic matter, consisting of filth, stable manure, bellies and offal of slaughtered animals thrown overboard, amongst which had been imbedded numerous carcasses of dead animals. The railway was, we believe, carried along the upper margin of the harbour, partly on stable manure which had been laid down there.

The great mortality which took place in the winter of 1854-55, led to the use of the marsh at the head of the harbour as a place of interment, into which a large number of dead were put close to the line of the public road. The bodies appear to have been laid almost in water, and so sparingly covered with earth, that portions of the clothing, and even of the remains, protruded through the surface at the time we first examined it. Close to this graveyard a number of animals had also been buried.

There had been during the preceding months an excessive mortality among the Mohammedan part of the population, and the dead had been imperfectly buried in a graveyard of their own at the head of the harbour, but on its west side.

There were a few old buildings at the lower end of the town, under the Castle Rock, where cattle had been slaughtered. The ground behind these buildings was saturated with blood and offal, the smell from which was overpowering.

The number of latrines was insufficient either for the stationary or movable population; and this circumstance, conjoined with the habits of the native population, had led to the existence of nuisances both on the hill-sides and within the town.

The state of the harbour was also very unsatisfactory. It was full of shipping, the filth and refuse of which, as well as the blood and offal of the animals slaughtered on board, were thrown into the water, and left to float about till they

were either carried out to sea by winds or currents, or deposited on the margins of the harbour to increase the putrefying mass already there. Dead cattle, goats, sheep, and fowls were often thrown into the harbour, and were seen floating about.

The practice of throwing refuse organic matters upon the margins of seaports is common all over the East, and is a very obvious cause of the liability of these towns to plague, fevers, and other pestilential diseases. All such matters as are not consumed by the troops of dogs in every town, are left to decay, and infect the atmosphere perennially, until the neighbouring population become ripe subjects for pestilence. Even this equivocal protection did not exist at Balaklava, for all the dogs had been summarily destroyed.

Besides the exhalations immediately proceeding from the putrid matters themselves, organized structures from decomposing the sulphates in sea water, cause the evolution of large quantities of sulphuretted hydrogen gas, which of itself is a powerful aerial poison. The horrible smells arising from it were a constant source of complaint at Balaklava, and especially on board ship. On warm still nights the stench used to be so overpowering as to prevent sleep. In similar weather the effluvia from the putrid marsh and graveyard at the head of the harbour used to be sickening. There was hardly any escape from the malaria, except high winds happened to prevail. The air moving up the harbour was tainted by the state of the margin, and that moving from the north passed over the putrid marsh before reaching the town and shipping.

It is hardly necessary to state that the public health in Balaklava and the camps in its immediate vicinity was endangered by this condition of the town and neighbourhood, and that it was not safe for men to pass even a few hours in the town while on duty. Fevers were very prevalent even early in spring, and not unfrequently passed into typhus. Fever was prevalent in the camp of the Guards above the head of the harbour, and especially so in the Land Transport camp, close to the marsh. The hospital attached to this latter camp frequently contained hardly any other than severe fever cases.

The huts first occupied by the Sanitary Commission were in the same locality, and all the inmates of these huts suffered from fever within ten days or a fortnight of their occupation.

It was matter of general remark that a large proportion of the men engaged on fatigue duty in the town suffered from illness of a similar character. When cholera prevailed, men coming from more healthy districts, and remaining for a short time in the town, were exposed to the well-known danger of being more readily attacked than residents.

These, then, were the chief points regarding the sanitary condition of Balaklava with which the Commissioners had to deal.

It has been already stated that Dr. Gavin had, in consequence of a resolution of the Commission, left Constantinople for Balaklava on the 21st March; Mr. James Newlands and two Inspectors having preceded him the week before, and that Mr. Newlands had been directed to prepare a statement as to the measures more immediately required for cleansing the town.

The first meeting of the entire Commission at Balaklava was held on the 6th April, 1855, and Dr. Gavin laid before the Commission a statement of the sanitary defects requiring remedy. On the 9th, Mr. Newlands sent in his suggestions; and after the Commissioners had made a minute personal inspection of the whole town and its vicinity, they adopted Mr. Newland's memorandum as the basis for cleansing operations.

They found that Lieutenant-Colonel Harding the Commandant, and Rear-Admiral Boxer had been using their best endeavours to improve the sanitary condition of the place, but the great obstacle that had been experienced by both—that which had left so much that was essentially necessary undone—was want of labour and means of transport. This difficulty, which had been anticipated by the Commissioners before they left England, met them at the outset of their work, and although the Commander of the Forces and the heads of departments were ready to consider, and, as far as they had the means, to give effect to the instructions of the Commissioners, the difficulty was

never overcome until the Army Works Corps was sent to the Crimea. The army itself was fully occupied with the severe and harassing duties involved by the siege works, and by guarding the lines; there was no native labour procurable within the occupation. The labourers brought from Eupatoria, Constantinople, and elsewhere, were by no means efficient. They were unskilled and most expensive, and there was difficulty experienced in adding to their numbers.

It was perfectly evident that the Commissioners would have to restrict their requirements to measures of the barest possible necessity, and to trust more to efficient direction and organization of a small staff of men than to numbers.

The following were the precautionary measures more immediately required for the town:—

1. The covering over of the burial-grounds at the head of the harbour with lime or charcoal, and then with earth.
2. The covering of all ordure, and all collections of animal and vegetable organic matter with lime, or charcoal and earth; and the burning of all such refuse as could be safely destroyed by fire; also the use of charcoal and lime to collections already covered, from which nuisance might be found to proceed.

To prevent the recurrence of similar evils, it was requisite:—

3. To erect a sufficient number of latrines in convenient situations, and to provide for their management and regulation.
4. To provide a staff of men with carts and hand-barrows, to collect and remove refuse.
5. To provide a slaughtering-place for animals at present slaughtered on board ship.
6. To provide barges for collecting and conveying out to sea the refuse of ships now thrown into the harbour; also the refuse of the slaughtering-place and of the town.
7. Lime-washing, outside and in, of all filthy houses, and cleansing and levelling of all uneven surfaces where water and filth collect.

Besides these precautions, which were of immediate necessity, the Commissioners were further of opinion that, in the event of any lengthened occupation of the town, it



would be very desirable to fill up the shoal at the upper end of the harbour; to construct temporary quays along the east side of the harbour; to form covered channels for offensive water; to cover the stream of water running down under the Castle Rock, to prevent fouling of the water; and to name the streets and number the houses, for the greater facility of ascertaining the locality of nuisances.

These points were embodied in a report addressed to the Commander of the Forces on April 11, 1855, in which the Commissioners at the same time expressed their conviction, that such was the extent of the local evils to be remedied, that there would be danger of an outbreak of disease on the setting-in of the hot weather. The Commissioners further stated in their report that officers fully acquainted with superintending the practical details of sanitary operations had been sent out by Her Majesty's Government, and that they were ready to give every assistance in their power in aiding in the execution of the requisite measures if they were enabled to do so.

Before this report was sent to head-quarters, a number of men had been placed at the disposal of the Commission for executing work of immediate necessity, but they had been withdrawn for what appeared to be more urgent work. There were thirty-three men on an average so employed for seven days. They were removed on the 9th April, and there were none returned till the 17th, when twenty-three labourers were put to work.

On the 15th a letter was received from Lieutenant-General Simpson, requesting the Commission to send an estimate for the number of men and the amount of materials that might be required for carrying out the works recommended in their report of the 11th, in order that Field-Marshal Lord Raglan might at once endeavour to procure them; but stating at the same time that the demands of the service were so urgent, that his Lordship could not spare any men from the force under his command.

The Commissioners found that, taking into account the quality of the labour, the current cleansing work for Balaklava and its neighbourhood, considering its resident population, and a daily influx of from 20,000 to 25,000 men, and large

numbers of animals, would require seventy-six men to do it thoroughly. For the other works, of a more permanent nature, such as the covering up of the graveyards marsh, &c., the number of men required would of course depend on the time within which the work must be done. In the prospect of the near approach of warm weather, it appeared that at least 293 men would be necessary, with suitable tools and means of transport.

There was at the time abundance of peat charcoal and lime at Balaklava, and there was a large bank of debris, suitable for covering the malarial surface of the marsh and graveyard within a few feet of its margin.

As soon as the work was completed, the intention of the Commissioners was to have recommended the Commander of the Forces to direct the men to be employed on other sanitary works connected with the army.

The estimate was sent to head-quarters on the 18th April, and on the morning of the 21st, Dr. Sutherland and Mr. Rawlinson had to deplore the loss of their zealous colleague, Dr. Gavin, who was accidentally wounded on the preceding evening, under very painful circumstances, and died in about eight hours afterwards.

Between the 17th April and the 2nd of May the total number of labourers that could be spared for sanitary works averaged only twenty-five men a-day, a number wholly inadequate for the current work at Balaklava. The larger number of men required by the estimate, for covering the marsh and graveyards, was never obtained.

At this period the supply of men and materials was irregular, as well as the direction of the work, because every officer was occupied with duties connected with the siege, and the Commission, in consequence, deemed it to be advisable, in order to realize the intentions of their instructions, to offer to aid in directing the works, provided the Commander of the Forces saw no objection thereto. They had an interview with Lord Raglan on the 26th April, and, at his Lordship's request, addressed a letter to him on the 27th, proposing several plans to answer the object. The one selected by his Lordship was to place the works directly under the Commission.

A letter was received by the Commissioners on the 1st of May, conveying his Lordship's decision, and requesting that Mr. Newlands should apply to General Simpson in writing whenever additional labour or materials were required. By this date, however, valuable time had been lost, and further delays would necessarily take place before the labour could be procured. The warm weather was rapidly approaching, and the Commissioners had the most serious apprehensions lest a severe outbreak of cholera should take place on board the transports, and the efficiency of this essential branch of the service be compromised. Whatever was now to be done required the utmost dispatch, and 500 labourers would scarcely have sufficed to do all that was necessary in the time. This number was asked from General Simpson on the 2nd May, with a request that as many labourers should be supplied at once as could be spared, and the remainder as soon as practicable. The day afterwards the average staff of men was raised to eighty, and no more were sent till the 30th, when the number was increased to 155, but by that date the time for which Mr. Newlands' services were placed at the disposal of the Commission had expired, and as he was urgently required at Liverpool, he was obliged to resign his appointment, and left the Crimea on the 7th June. The direction of the sanitary works, therefore, reverted to the military authorities, and the two inspectors who came with Mr. Newlands remained to superintend the men.

The extreme difficulty experienced by the military authorities in obtaining labour was the cause of the delay. There was no indisposition on their part to assist the Commissioners, and to give effect to their instructions.

Although the works had not been carried out with that decision which was requisite for protecting the public health in such an emergency, a good deal had been slowly accomplished by a careful direction and economizing of the labour in hand. The town had been cleansed and kept clean, and as soon as the more urgent cleansing operations had been completed, and peat charcoal used for deodorizing offensive matters, the inspectors were directed, on the 24th April, to detach as many as they could of the small staff of men at

their disposal, to cover over the worst of the graveyards.\* A layer of peat charcoal was laid upon the graves, and eight to twelve inches of sandy ballast were placed above the charcoal. The work proceeded slowly, and after the surface had been gone over once it was found that the deodorizing substances used, but especially the sand, had acted so effectually in destroying the odour that it was unnecessary for the time to add to the depth of the covering. By this means an abominable and dangerous nuisance was in the end got rid of.

At the same period, Lieutenant-Colonel Harding began the construction of a temporary wooden quay across the top of the harbour, preparatory to filling up the shoal water there. While the graveyard was being covered, the men employed on it co-operated with those employed on the quay in filling up the end of the marsh nearest to Balaklava, and the nuisance from it was abated. The large exhaling surface of the marsh was never covered, for want of labour, neither was the Turkish burial-ground on the west side of the harbour, and both continued to generate malaria during the whole summer.

Additional latrines were erected, old unwholesome dwelling-houses were cleared away, and lime-washing was extensively used by order of the Commandant.

The inspectors, and the labourers under them, likewise applied peat charcoal and lime extensively to the margin of the harbour, to diminish, as far as practicable, the nuisance from the filth and animal matter that had been deposited there.

Two barges had, in the meantime, been provided, for removing filth and offal out to sea, and the deposit of manure along the margin of the port had been put a stop to. One of the barges was moored at the head of the harbour, and a notice was sent round by the Commandant, directing the people to deposit their refuse in it. These barges were towed out to sea, sometimes by boats and sometimes by a

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\* The following extract from Mr. Newlands' diary shows the dangerous state of the graveyards at this time:—"The stench from the uncovered graves frightful. No one can stand over them to work for an hour without becoming sick, and being attacked with diarrhoea. The inspectors have to procure wine and stimulants for the poor labourers hourly."



steam-tug; but partly from the state of the weather, partly from the boats being otherwise employed, it was not always possible to ensure regularity in the removal of refuse. To obviate this defect, as far as practicable, the inspectors were directed to cart away as much of the manure as they could, to a place at the head of the harbour, on the west side, and to burn it there.

The condition of the harbour itself underwent a gradual improvement, as the harbour police, organized by Rear-Admiral Boxer before the Commissioners went to the Crimea, became more practised in its work. It is true that the Commissioners had several times to make complaints of offal and dead animals having been thrown into the harbour, but these complaints met with immediate attention, and the nuisance was diminished for a time. The only effectual remedy for the evil was the construction of a slaughtering-place, and the prohibition of slaughtering on board ship, as had been recommended. There was no available ground for the purpose, and Admiral Boxer gave directions for the formation of a slaughtering wharf under the Castle Rock, by blasting, and laying down a temporary quay. Considerable progress was made in the work at the date when the Admiral fell a victim to the epidemic which then prevailed.

For reasons already stated, the sanitary precautions progressed slowly and irregularly, and the Commissioners had constantly to dread an outbreak of disease. A vigilant watch was kept up over the state of health of the population, especially on board ship. In the close, warm nights of early summer, the odours arising from the mass of decomposing organic substances, in contact with the salt water, along the shores of the harbour and at its head, were perceptible over the whole area of the town and harbour, and it was impossible not to feel alarm at the prospect of cholera, or some other epidemic appearing.

Early in May the temperature rose considerably, with a warm south-east wind. On the 10th, 11th, and 12th, there was heavy rain. On the 13th there was sunshine, with a hot, close, and damp state of the atmosphere, and cholera began to show itself in the camp before Sebastopol. There had

been a few cases before that date among new arrivals, and among men engaged in the trenches. About the same time, the disease first indicated its presence on board ship, in the harbour of Balaklava.

The earliest intimation of it which reached the Commissioners was in the form of complaints of danger to health from the old accumulations of filth along the water side. Inquiry was at once instituted, and it was found that diarrhœa, and one or two cases approaching in character to cholera, had appeared. The Commissioners immediately saw Admiral Boxer, and asked his aid in placing both ships and crews under medical inspection, with the view of adopting sanitary precautions on board, and bringing the diarrhœa under early treatment.

Admiral Boxer at once issued instructions for a more rigid exercise of the powers of the harbour police: he provided additional means of removing the refuse of the town and port out to sea; he issued orders to Her Majesty's ships that medical assistance should be rendered to any persons labouring under cholera or diarrhœa, and he ordered a general inspection to be made of all ships in port.

At our request, Mr. Walling, of Her Majesty's ship "Wasp," was directed to communicate with us, for the purpose of organizing the requisite inspection. At this period, Dr. Costello was employed, under Captain Heath, as medical officer of transports, but it was obvious that one medical officer was insufficient for the execution of the contemplated preventive measures. It was therefore arranged that the harbour should be divided into three districts, and that Mr. Walling, Dr. Nolloth, of Her Majesty's ship "Leander," and Dr. Costello, should undertake the duties, aided by two assistants. These gentlemen were instructed:—

To give medical aid to all applicants;

To examine the sanitary condition of all transports;

To enforce any measures of cleansing, disinfecting, or ventilation that might be requisite;

To inspect the crews, and to treat, on the spot, any persons affected with diarrhœa, cholera, or other zymotic disease;

To deposit medicines on board where requisite, and to warn all captains, officers, and crews, of the necessity of immediate attention to diarrhoea.

They were further requested to report to the Commissioners at regular intervals, and to point out any nuisances along shore, or in the harbour, that might occasion mischief on board ship.

The ship inspection was begun on the 19th May, and had to be continued for four months from that date. It was most efficiently done, and was of great importance to the public service.

By its means, numerous nuisances in the harbour arising from the offal of slaughtered animals and refuse surreptitiously thrown overboard, were discovered and removed. The state of the beach was represented to the authorities from time to time. Foul ships were cleansed, lime-washed, ventilated, and fumigated, and the harbour was thinned of ships as soon as there was an appearance of overcrowding.

Numerous cases of zymotic disease were discovered, and promptly put under medical treatment. The sanitary measures, beyond doubt, diminished the number of attacks, and the immediate treatment of diarrhoea cases arrested the development of cholera. The following table shows the cases brought under treatment, but it does not contain the whole number of premonitory cases :—

Cholera.	Choleraic Diarrhoea.	Diarrhoea.	Dysentery.	Fevers.
90	172	530	81	229

From inquiries made respecting the probable average numbers of seamen among whom these cases occurred, it appears likely that they exceeded 2,000 men.

Many of the fever cases were preceded by diarrhoea. Hardly any diarrhoea cases passed into cholera. The results of the cholera cases are not given in the returns, because whenever it was practicable to do so, these cases were sent

to hospital, and went from under the care of the visiting surgeon.

The following brief extracts, taken here and there from the journals of the surgeons, will show the conditions under which the disease prevailed :—

"Epidemic disease was found to prevail more or less extensively, according to the greater or less apparently insalubrious position of the ship or ships."

"Particular ships appeared to suffer in proportion to the greater or less neglect of their cleanliness or ventilation."

"Disease became more general where the men were dirty and more than usually closely packed together."

"Sickness was greatest towards the top of the harbour, and this diminished as soon as such ships were removed either to the entrance or just outside the harbour."

"The 'Paramatta,' where cholera and choleraic diarrhoea continued for several weeks, had a large quantity of soiled blankets on board."

"The cattle-ships have proved to be always the most sickly."

"Seamen, during the prevalence of an epidemic, should be dispersed as much as convenient throughout the ship,"

An affected ship is described as being :—

"Moored close to the beach on the eastern side of the harbour, and opposite to her are two pools of decomposing vegetable matter, bread, onions, and cucumbers, the stench from which is most powerful."

"The heavy rains and great traffic have converted the eastern beach and road into a filthy puddle, and it is amongst the ships close to this beach that three-fourths of the cases of cholera have occurred in my division. Fever and dysentery are always prevalent in that quarter."

"About a fortnight ago this ship was hauled further off the beach, and though only some fifteen yards, it is most astonishing the decrease in the number of sick."

"Stench from the beach unbearable; the master of one of the vessels told me this morning that he looked upon it as the cause of his having lost four of his men from cholera."

"The steamers employed in carrying cattle are the most unhealthy vessels in my district. The prevailing diseases on board them are intermittent, remittent, and continued fevers, diarrhoea and dysentery."

"On board the 'Paramatta,' lying at the upper part of the harbour, found five cases of choleraic diarrhoea."

"Sickness has been much more rife on the south-east than on the north-west side of the harbour, which latter is quite free from the many sources of vitiated air found on the opposite side."

"Inspected the 'Black Sea,' having just landed mules. Her between decks contains a large quantity of animal excretions, and is generally insanitary. Found four cases of choleraic diarrhoea."

"Examined 'Kangaroo,' found her in a very insanitary condition, having brought up 250 cattle. She had on board a large number of dead cattle in



different stages of decomposition, an immense quantity of dung, animal excretions, &c. Recommended to Captain Heath that she should land her live oxen as quickly as possible, and proceed out to sea to dispose of the dead bullocks immediately, and clean ship, using chloride of zinc, charcoal, white-washing, &c."

These extracts will give a general idea of the localizing conditions of the epidemic disease in the harbour. Many affected ships were found in a bad sanitary state, especially the small Levant traders. The cargoes of vegetables, fruit, hay, &c., brought by them were often decayed or partially rotten. The holds foul and the bilge water often offensive. The forecastles were not unfrequently crowded, filthy, and unwholesome.

In numbers of cases affected ships were found in good condition, except that they were moored close to the nuisances on shore. Sending such ships outside the harbour was a certain means of arresting disease. Lime-washing, cleansing, ventilation, &c., were also used with advantage. Referring to the precautionary measures adopted, Mr. Walling, of Her Majesty's ship "Wasp," who had the worst division of the harbour under his charge, says in his report:—

"During the winter and spring I have often looked with feelings of alarm to the approach of summer, and the effects of its scorching sun especially when examining the filthy beaches and the insanitary condition of the cattle-folds, slaughtering-places, and graveyards. The favourable way in which the summer has passed appears to me to be entirely due to the immediate institution by the Sanitary Commission on the first appearance of the epidemic of most active measures for its suppression."

The sanitary condition of ships engaged in the transport of animals deserves more attention than it has received. It never appeared to us to be recognized that animal health and life depend on the same conditions as human health and life. From neglect of this obvious principle a large number of valuable animals were continually being sacrificed during the siege of Sebastopol, and many of those landed alive at Balaklava were often in so diseased a state, even after a voyage of two or three days, that some of them died immediately on being landed; a large number sometimes died shortly after, and the flesh was often of a very inferior quality in those that were slaughtered for use. Excessive filth, want of fresh air, and deficiency of water and sometimes

of food, along with the careless manner in which the animals were hoisted on board, frequently by a rope passed round the horns, were the main causes of the loss. It is beyond a doubt, as proved by many of the horse-transport steamers, that the transport of animals can be effected without the accompaniment of these elements of suffering and destruction, and it is within the bounds of probability that the want of care not unfrequently evinced in these matters might have led to serious consequences to the public service.

Such was not unfrequently the condition of these cattle-ships that during the prevalence of the epidemic the Commissioners considered their presence in the harbour as hazardous to the public health. It was at first the custom to throw the dung overboard into the harbour, but when this practice was put a stop to, the ships were ordered to be cleansed on their outward voyage. During the epidemic this regulation was deemed to be insufficient, and the Commissioners therefore issued an instruction on June 14th that the fires on board should be banked up on all cattle-ships coming into harbour, the live stock discharged, and that immediately thereafter the vessel should proceed outside the harbour, to throw the dung overboard, cleanse decks, and wait for orders. This instruction was put in force at once.

The reports of the visiting surgeons show that, as the Commissioners had anticipated, the emanations from the margin of the harbour were the most powerful localizing causes of the pestilence. Most of the cholera cases, and nearly all of the fatal cases, occurred in ships moored close to it. The foul matter from which the emanations proceeded could not be removed, for it was imbedded below the surface, and any disturbance of it would have been dangerous. All that could be done was to use peat charcoal, or lime, to deodorize the mass, and to cover it with earth as far as the labour would admit of its being done. Although the smell was remedied to a certain extent by these means, the peculiar organic effluvia which appear to determine the action of the cholera poison on the human constitution, still exhaled into the air.

A somewhat remarkable illustration of this fact was afforded by the case of the steam-ship "Chester." This ship

had been in harbour several weeks, and was moored stern on to the shore. She was loaded with charcoal for the use of the army, which was being discharged by the crew. A lofty wall of bags of charcoal had been piled up within a short distance of her stern, and a good deal of charcoal dust had fallen all over the quay, so as effectually to deodorize the surface of the putrid matter of which the quay was at this point composed. The men were dusted over with charcoal from their work. There was no smell in the ship, and none from the quay close to it. If charcoal, as has been asserted, really had the power of absorbing or neutralizing the effluvia which predispose to epidemic disease, here was a case in which of all others the crew ought to have enjoyed immunity from cholera.

Nevertheless, on the 21st May a case of cholera occurred on board. On the 23rd and 24th there were five new cases. Of these six cases, five proved fatal with extreme rapidity. On the afternoon of the 24th the ship was removed from the influence of the local atmosphere of the harbour, by being sent a short distance outside into the open sea, after which a few cases of diarrhoea, all readily yielding to treatment, occurred among the crew, but there was no more cholera.

With regard to the removal of ships out of harbour, it may be stated that, practically, a change of place no more than sufficient to withdraw the vessel from the immediate atmosphere of the harbour, made all the difference between safety and danger, a very conclusive proof of the merely local conditions on which the outbreak of cholera depended. It was, in fact, simply a question as to whether the ship lay on the north or south side of the Castle Rock. If in the former position, and within the harbour atmosphere, her crew were in danger; if in the latter, and in the open sea air, they were comparatively safe.

Another ship, called the "Peace," also laden with charcoal, was moored within the harbour. She was a sickly ship, and had, moreover, two cases of cholera on board, both of which proved fatal.

The practical results of the measures enforced during this epidemic, in preventing the extension of cholera, confirmed the experience of former epidemics, and also justified the

opinions promulgated by the first General Board of Health, in their Reports on Quarantine, as to the neglect of sanitary precautions on board ship being attended by a liability to epidemic diseases, and as to the effect of a bad sanitary condition of seaports in localizing pestilences, both in seaport towns, and on board ship in harbour.

At the beginning of June the inspectors were directed to push forward the sanitary works specially connected with the margin of the harbour.\* In compliance with the

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\* A few occasional extracts from the diaries of Mr. Newlands and the inspectors will show clearly the sanitary evils they had to deal with up to this period, and the progress made in carrying out the works:—

"1855. April 3, Tuesday.—We were enabled to commence operations in the village of Balaklava, having had forty-three labourers (including four umbashies or chiefs) placed at our disposal by the Town Adjutant, Mr. Deacon, and we received from the Storekeeper of the Royal Engineers ten wheelbarrows, twelve shovels, and twenty picks. We immediately set nine of the men to work in removing a quantity of timber that had been indiscriminately strewn over a piece of vacant land in Quay-lane, and situated at the back of the Commissary rum store, and which had been, and still is, the resort, as a privy, not only of the workmen employed in the various stores and shipping discharging on the quay, and also of the Turks, Greeks, and Maltese living in the immediate vicinity, but of thousands of people who daily come to the village to transact business. As might be expected in such a place, the surface is entirely covered with human ordure, in many places to the depth of several inches.

"We caused the wood to be piled at the entrance to the ground, and had a portion of it levelled. The other men were employed in levelling the ground, and in removing large quantities of filth and offensive matter, also in burying refuse and other garbage, which had been deposited in several places on the surface, at the back of the Naval Brigade magazine. This place had also been a stand for Commissary horses, and several tons (say forty) of manure and other filth had been permitted to accumulate on the margin of the stream flowing down the ravine from the Sanatorium. As some of the filth was dry, the inspectors set fire to it, and in some measure the smell emanating from it was remedied.

"April 4.—Thirty labourers were placed at our disposal by the Town Adjutant this morning, six of whom were employed at the ground in Quay-lane in finishing, levelling, and otherwise improving the place. Four loads of quicklime and ten bags of charcoal were freely distributed over the surface, and in deodorizing the filth, and the place was in a great measure improved. There are some Maltese living in a small room in this yard, and three were lying (on this day) ill of fever. The remainder of the labourers employed on the same place as yesterday with a very beneficial result, as the whole of the filth from where the houses stood had not only been entirely



instructions, large quantities of peat charcoal and lime were used for covering afresh the worst parts of the margin, and the construction of temporary quays was commenced with such materials as could be obtained on the spot.

removed, but the surface of the ground was in a measure levelled, so that no water or filth could remain on it to stagnate or become offensive."

"April 5.—Thirty labourers again at work in digging large holes for burying filth and organic matter. Others employed in covering over collections of filth on the hill-sides and on tent sites."

"April 6.—Thirty labourers were again given by the Town Adjutant, all of whom were employed during the forenoon in cleansing the margin of the harbour, near the Ordnance wharf, and in dragging the garbage and other filth that had accumulated there on to the shore (the smells emanating from which were most offensive and sickening). Six large holes were dug, and the filth buried, but, previous to covering over with soil and ashes, quicklime was freely used, and the locality, when the work was completed, presented a very different appearance and a purer atmosphere. During the afternoon, the labourers were employed in covering with lime and earth a large heap of manure near the ravine."

From the 10th to the afternoon of the 17th no labour was supplied for sanitary work, when twenty-three labourers were sent to the inspectors, who "were employed for the remainder of the afternoon at the margin of the harbour, between the cattle and ordnance wharfs, in cleansing and liming. We had the carcasses of two calves, and several bellies and other garbage buried, and used plenty of lime thereat. Afterwards we strewed a quantity of lime on heaps of filth and offensive matter in the yard of the Chaplain's house, and between it and the Quartermaster-General's office. We then had three barrows of lime and a quantity of charcoal thrown into the public latrine in Mount-street. Previous to so doing, it was very offensive, but after the process was completed, the stench was entirely removed. A latrine belonging to the General Hospital was similarly dealt with, and a dead mule was buried."

"April 23.—Twenty-five men employed on similar work to that of yesterday. In the afternoon some of them were employed in deodorizing the latrines at the General Hospital, at the back of the Guard-house, in Mount-street, and behind the Turk's Stores. Also the one at the Castle Hospital. This was attended with most beneficial results. We had also a quantity of lime carried to the head of the harbour, for the purpose of mixing with gravel, to cover some dead horses that had been buried a few inches below the surface of the ground."

"April 28.—Twenty-nine labourers employed to-day; twenty-three of them at the top of the harbour, and six finishing the pits of the latrines at the Turkish Hospital. The weather being now very hot in the middle of the day, very offensive smells arise from the graveyard at the top of the harbour, and many loud complaints are being made about it. In some instances the bodies have been laid on the surface, and then covered with earth, and as decomposition set in, it made its appearance on the surface of

Rubble stones and squared stones were collected from old walls and houses, and a line of quay was carried outside the decomposing filth, and between it and the water. A solid surface was thus gradually formed over the most dangerous places. The inspectors were also directed to put down

the ground, which is marshy. We have had to change the labourers from off the ground almost hourly every day, until a coat of gravel, about twelve inches deep, has been spread over the surface. This will form a portion of our work for many days to come. The gravel has to be carried on the labourers' shoulders, in baskets holding about a stone, in consequence of our not being able to get a sufficient number of carts or wheelbarrows.

"May 3.—Seventy-five men were employed this day, sixty-three at the top of the harbour and graveyard, and the remaining twelve, in filling up holes in the main road, where some stagnant water and filth had accumulated, near the wharf where the sick and wounded soldiers are taken on board the transports, and which smelt offensively.

For some days after this one hundred men were employed on the same work.

"May 12.—The excessive rain having somewhat abated, we employed seventy-five men in various parts of the village in cleansing the streets and overground drains, and removing the filth that had accumulated in holes in various places.

"May 15.—Seventy-five men and ten carts employed in covering the graveyard at the head of the harbour, and in removing large quantities of stable manure from the yards in the town to burn it at the Turkish burial-ground for neutralizing the smells proceeding from it. The drivers refused to work in removing the filth, their health is visibly affected by the horrible exhalations from the graveyard.

"May 21.—Seventy-four labourers and ten carts employed at the graveyard at the head of the harbour, with the exception of six, who were employed in filling the dirt-boat.

"May 31.—150 men and seven carts employed at the graveyard at the top of the harbour.

"June 7.—150 men and seven carts engaged at the head of the harbour and graveyard, and in cleansing the margin of the harbour, and macadamizing the road near the water's edge on the east side.

"June 27.—100 labourers and three carts. Eighty were employed at the top of the harbour and graveyard, and twenty at the quay, until noon, when they were sent to Quay-street, to remove a number of old and filthy houses.

"June 30.—100 men and three carts at work at the same time and places as yesterday. On Thursday the Sappers and Miners having commenced to drive piles to form a quay, and to do away with the offensive smell of the sides, we rendered assistance by filling in with stone and gravel, and in a few days an excellent quay was formed, and the smells which had injured the health of the workmen were removed.

mooring-posts for the shipping, to prevent the quays being pulled down, and the filth turned up and exposed by the customary manner of anchoring to the beach.

The number of native labourers told off for sanitary works by the beginning of June had been raised to 150, with seven carts, and the requisite tools. Towards the end of the month the number was reduced to 100, and, during the month of July, the usual number was ninety-eight.

During June and July the workmen were superintended by the inspectors of the Commission, but the works were under the direction of the military authorities. The Commissioners kept a constant oversight on the proceedings, and communicated with the military authorities, or with the inspectors when it appeared necessary to do so.

The number of men employed affords no correct indication of the work done, for it was found in practice that six native labourers were required to do the same amount of work that one English labourer could have accomplished in the same time. As a general rule, it may be stated that, even in using a wheelbarrow, a native labourer hardly ever was able to wheel above a third or fourth part of a barrow load. There was, besides, a constant tendency to idling and waste of time, which it required the utmost vigilance on the part of the inspectors to prevent. On these accounts the work progressed slowly, notwithstanding the apparently effective force of men employed.

The deposit of stable manure and offal along the east side of the harbour was at length put a stop to by obviating the necessity for doing so. As much as could be taken out to sea was removed by the dirt barges, and the remainder of the stable manure was burned at the top of the harbour. The formation of temporary quays for covering the filth previously deposited, progressed as quickly as the labour and supply of materials would allow, and the sanitary state of the town continued to improve.

#### § VI. SANITARY CONDITION OF THE CAMPS NEAR BALAKLAVA.

Immediately after the preliminary examinations at Balaklava were completed, and the necessary instructions

issued for the sanitary improvements, the Commissioners proceeded to examine in detail the various camps of the British army around Balaklava and before Sebastopol.

The camps were situated in two districts of country, the topographical and sanitary conditions of which differed. Those around Balaklava occupied the ridges, slopes, and valleys of the jurassic limestone and conglomerate. Those before Sebastopol were scattered over the eminences and flats of the tertiary limestone of the plateau.

The camps in the neighbourhood of Balaklava were those which first came under the notice of the Commissioners, because they presented the most obvious sanitary defects, at least with two or three exceptions. For topographical purposes these camps may be divided into three groups, namely, the camps on Marine Heights to the east of Balaklava; the camps on the slopes to the north-west of Balaklava harbour, and the Cavalry camps in the valley of Karani:—

1. The group of hills known as "Marine Heights," consists of highly inclined beds of conglomerate, dipping from east to west, and terminating abruptly on the east in a long narrow ridge running from south to north, and falling rapidly towards the north into the valley of Balaklava.

The highest point of the ridge is its south end, which overhangs the sea at an elevation of 1,227 feet above its level. On the east side of the ridge the ground is very steep and commands a road leading from the valleys east of the occupation to Balaklava. On the west side of the ridge the slope is more gentle, following that of the conglomerate beds, although the descent is still a steep one. About 600 feet below the crest of the ridge, on the west side, and resting on the conglomerate, is a hill of compact jurassic limestone, at the foot of which the town of Balaklava is situated.

Between the two formations there is an upland valley; the highest point of which at its southern extremity is about 580 feet above the sea level, from whence the valley falls gradually to the north, and opens into the valley or plain of Balaklava.

A line of entrenchments, beginning at the summit of Marine Heights, was carried down the ridge to the north,



following its curves, and passing in its course through a variety of ground from hard rock to soft clay soil. Within the entrenchments, and on the western side of the crest of the heights, there were two camps, that of the Rifles, on the very summit, and the camp of the Royal Marines, following the slope of the ridge towards the north.

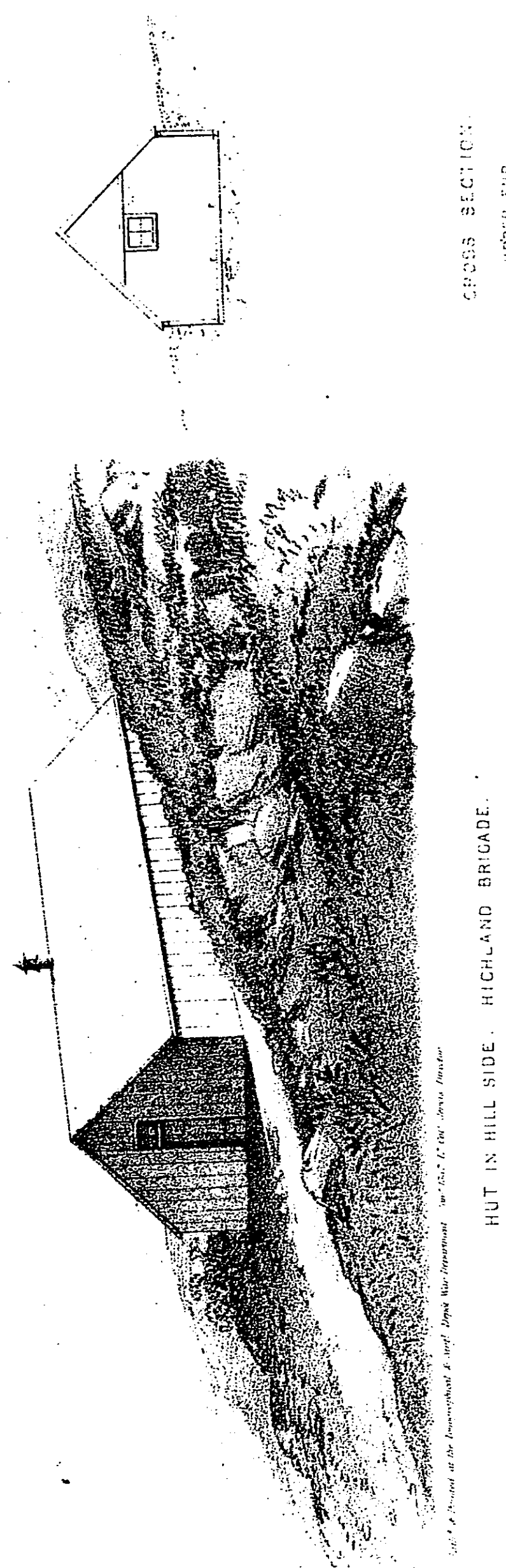
The bed of the upland valley already mentioned is formed of retentive beds, on which in some places rests a superficial stratum of porous sandy loam and debris full of water. The opening of the valley on the north, was cut across by the line of intrenchments with *trous de loup* outside. At all times a considerable quantity of water escaped from the line of the works, and ran down the hill-side to the valley of Balaklava. Even after dry weather many of the *trous de loup* were three-parts filled with water, showing to what an extent the soil was charged with it. Close to the line of the intrenchments at this point were the camps of the 79th and 42nd Highlanders.

Following the slope of the limestone hill towards the head of Balaklava harbour, the 71st were encamped along a road on the hill-side. The site of the camp was on a bed of debris. At the foot of the slope, under the 72nd, were the huts and stables of the Royal Horse Artillery.

As regards the medical topography of this group of camps, the ground occupied by the Marines and Rifles was hard, dry, and naturally well drained, exposed to no special cause of malaria, but being on the boundary of sea and land, and having a considerable elevation, the camps were subject to rapid changes of temperature, high winds, and sea fogs. During the spring of 1855 the average range of the thermometer on the heights was about 20° Fahrenheit in twenty-four hours.

The camps were formed of tents, wooden huts, and stone huts. In most instances we found the ground had been well prepared before erecting them. Drains had been made for turning surface water from the sites of tents and huts; soft parts of the ground had been paved with rubble-stone, and the camps were clean. They were in a comparatively good sanitary condition, except that the huts were not sufficiently well-ventilated for the numbers they had to

Fig. 1.



accommodate. At the time of our inquiry we were informed by the medical officers, that the chief diseases, under which the men suffered in this lofty exposed situation were pulmonary complaints.

The next camp following the descent from Marine Heights was that of the 79th Highlanders.

Part of this regiment occupied a range of wooden huts and tents on the slope, immediately under the steep descent from Marine Heights, at an elevation of about 550 feet above the level of the sea. The ground was a porous sandy loam, with a considerable water shed above it. In preparing the ground, sites for huts had been dug out of the slope, and the earth was heaped up against their sides. The surface was not sufficiently drained, and the huts were not properly ventilated.

The remaining part of the 79th were, for special military reasons, encamped 100 feet lower down, where the ground was soft and wet. The ground sloped rapidly towards this part of the camp, and from the configuration of the surface, the drainage from Marine Heights above was concentrated in a hollow, within which a number of huts had been erected for the men more immediately engaged in the defence of the works, which passed close to the doors. A few of these lower huts were erected above the hollow, and with a good natural drainage.

The whole of the ground was wet, and traversed by superficial drains, and it had, moreover, been extensively turned up in constructing the works. In erecting the huts, the space cut out of the slope was just sufficient to hold the hut, and the earth was left in contact with the boarded sides for two or three feet in height. (*Fig. 1* shows this defect.)

The attention of the Commissioners was first specially directed to this part of the camp, by a representation from Sir Colin Campbell, that fever had been very prevalent among the troops occupying it. On the 13th April, 1855, the Commissioners met Sir Colin Campbell by appointment, and proceeded to make a careful examination into the circumstances.

It appeared, that shortly after the ground was occupied in the end of October 1854, zymotic diseases, chiefly diarrhoea, with a few cases of fever and cholera, occurred among



the men. From the week ending 31st October, until the date of our inquiry, 80 per cent. of the sickness in the regiment had been occasioned by zymotic diseases. Diarrhœa cases were most numerous until the week ending January 16, 1855, and there were comparatively few fever cases before that date. From the 16th January till the 18th April, the time when the measures recommended by the Sanitary Commission were taken, above 74 per cent. of the total sickness had been caused by fever. During the week ending April 11, out of 64 cases 60 were from fever. The type of fever was remittent, passing into the typhoid form, clearly marking the causation. At the time fever prevailed, the other forms of zymotic disease had nearly disappeared.

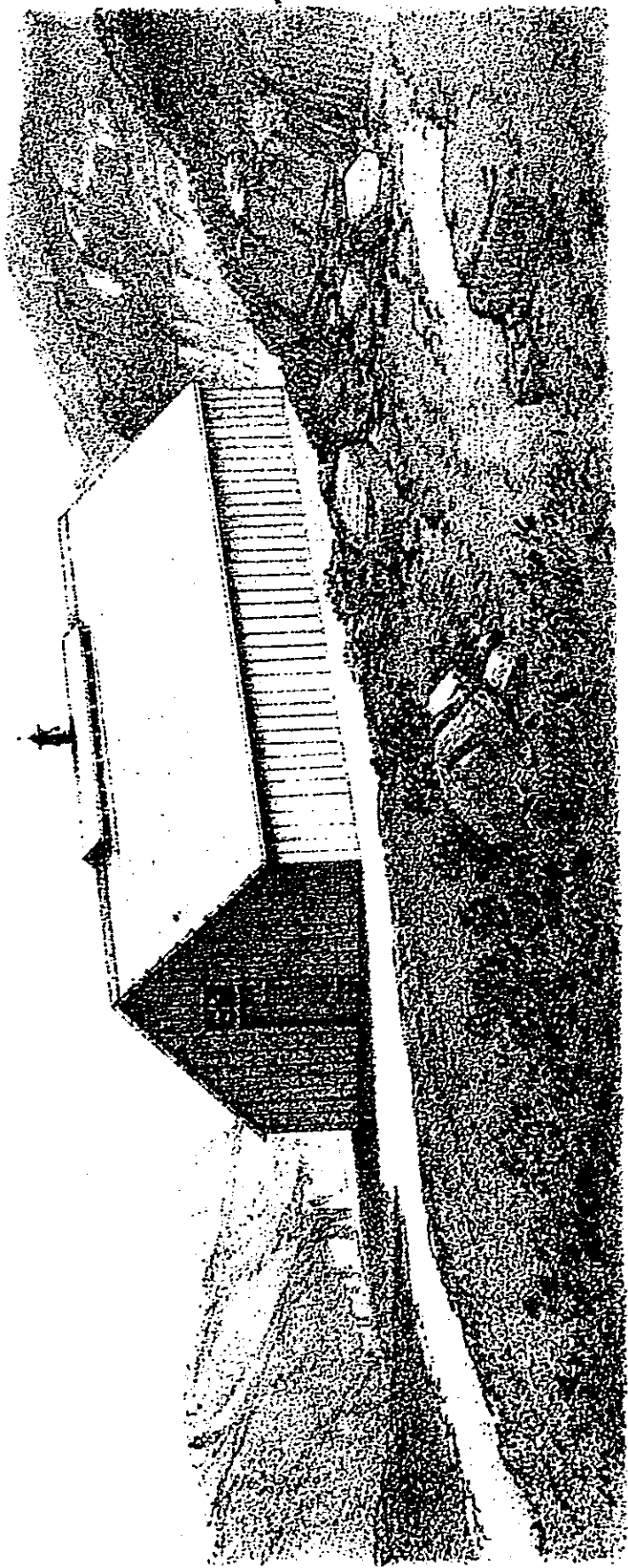
There had been some fever in the range of huts under Marine Heights; but the majority of the cases were confined to the huts on the wet ground, close to the works. There was little or no fever in tents in the vicinity.

In addition to the topographical defects already mentioned, we found the floors of the infected huts very damp; and on removing the boarding, the surface of the ground beneath was found covered with threads of fungi, and the atmosphere in the huts had the peculiar odour and dampness usually experienced on going into an underground cellar.

So wet was the subsoil, that water was found under one of the angles of a hut. The men slept on the boarding, hardly raised above the ground, and breathed the damp malarial atmosphere arising from it. The cubic contents of the huts were 3,645 feet, and allowing twenty-five men to a hut, the cubic space per man would be about 146 feet. The ventilation was insufficient; and under all the circumstances, the huts were overcrowded. (*Fig. 3* shows the usual internal arrangements of unventilated barrack huts.)

The Commissioners were of opinion, that nothing short of the removal of the men from the lower huts would put an effectual stop to the fever; but that the huts under Marine Heights admitted of being improved. There was nothing in the case essentially differing from the experience obtained elsewhere as to the effect of damp, unwholesome dwellings on health; like causes everywhere produce similar effects, and the Commissioners had no hesitation in expressing their

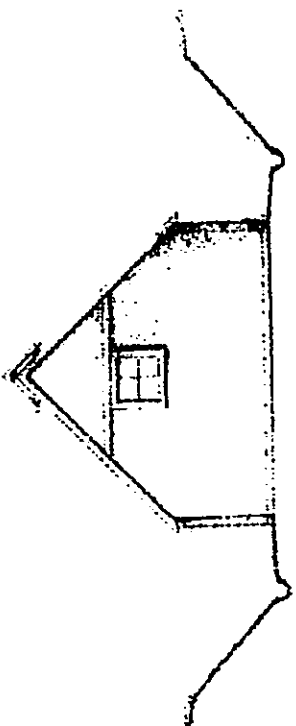
Fig. 2.



100 ft. of passage at the lower end of a shaft. From the Department of the Interior, U.S. Geological Survey.

HUT CLEARED AND VENTILATED AT RIDGE.

CROSS SECTION.





opinion that if the entire brigade, consisting, as it did, of robust men in the prime of life, were made to occupy the lower huts in succession, a considerable proportion would be disabled from service in a very short time.

On the 14th April, the Commissioners recommended the Commander of the Forces either to remove the troops to better ground, or should the exigencies of the service render this proceeding impossible, that the ground occupied should be drained, the huts isolated by digging the earth away from the sides, and the site of each hut separately drained by a trench cut round the cleared space, and about a foot below the level of the floor; that the huts should be thoroughly ventilated by ridge and floor ventilation, and the number of men reduced in each. By comparing *Fig. 2* and the ground plan *Fig. 3* with *Fig. 1*, this manner of improving the drainage and ventilation will be readily understood.

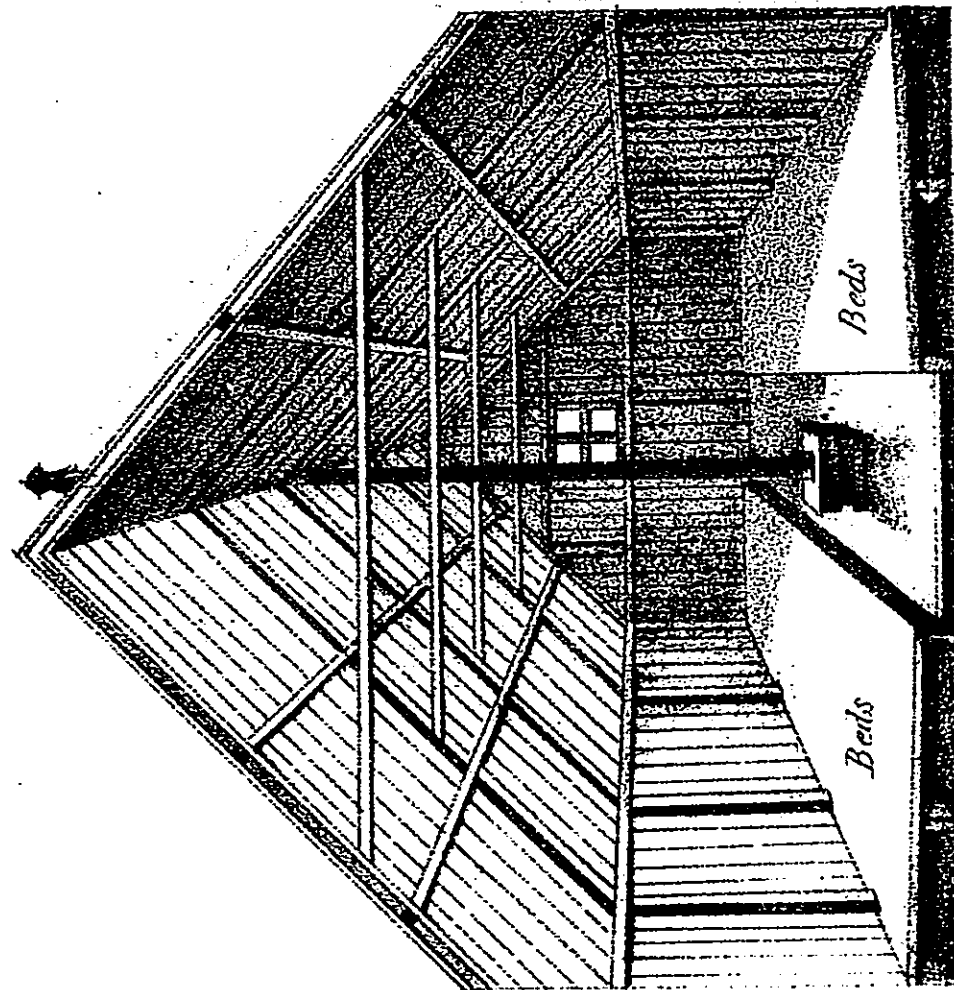
These recommendations were immediately acceded to by Lord Raglan. All the huts on the better ground were improved in the manner pointed out, and those on the wet ground were vacated. A few tents were erected to receive the sick on the higher and drier ground.

The result of these measures was an immediate abatement of fever, hardly any new cases having appeared after the removal of the men. The improvement in the sick was equally striking.

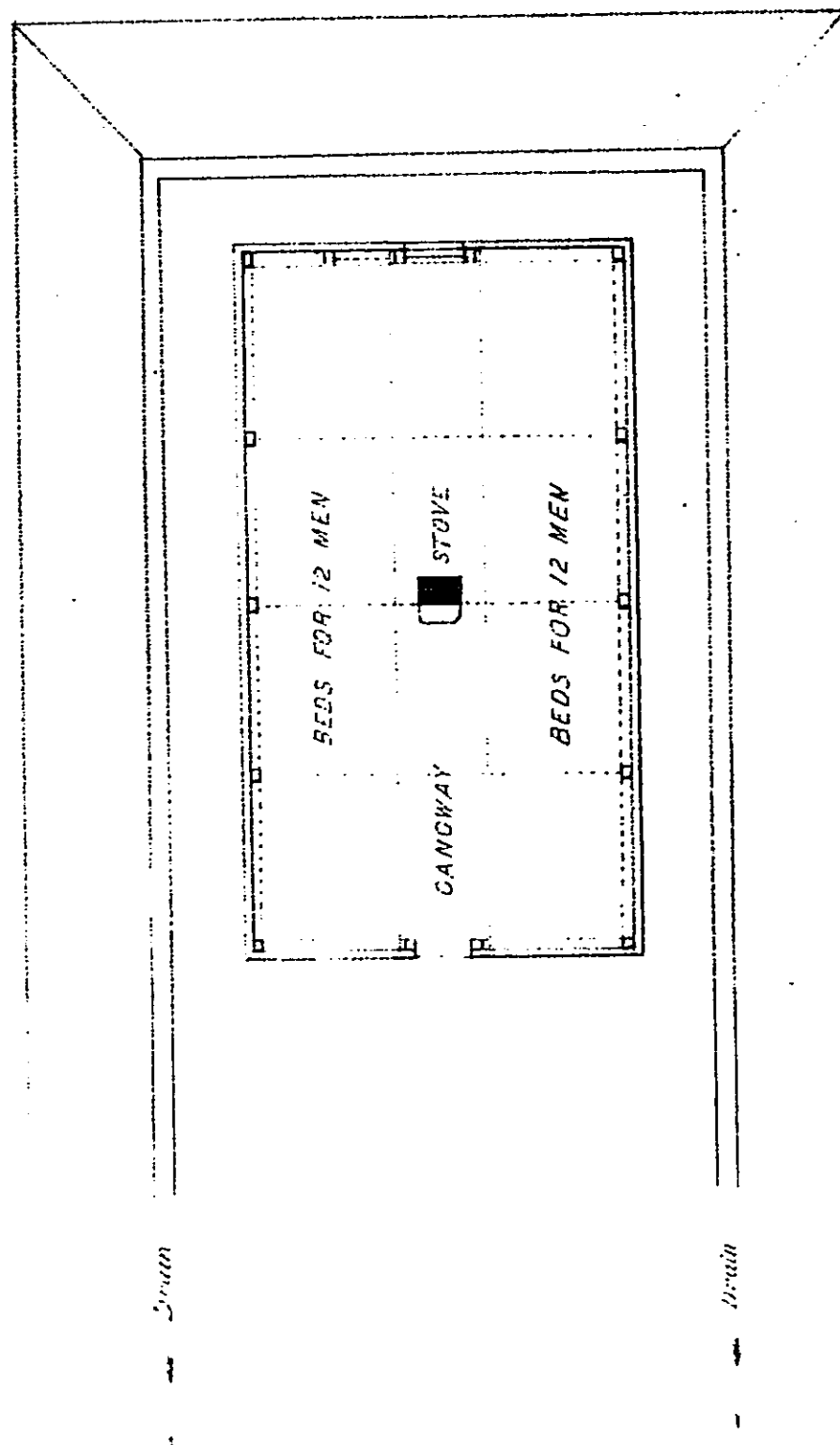
It may be useful to mention here what remains of the history of these same huts, because it strongly illustrates the importance of selecting healthy sites for the physical efficiency of an army.

In consequence of the removal from them of the men of the 79th, the huts were only partially improved, but never sufficiently so to make any material difference in their sanitary condition. They were rather considered as unfit for occupation on account of their position. After the 79th left this ground, the 31st Regiment arrived at Balaklava, and took possession of the huts on the 25th May, 1855. Their strength on landing was 873. On the 1st June, a case of cholera occurred in the regiment. Its occupation of the huts was only for a temporary purpose, and on the 16th the regiment was removed to the front. Between the 1st and the 16th June, there were thirty-four

Fig. 3.



INTERIOR SHEWING BED ARRANGEMENT.



79TH HUT CLEARED.

deaths from cholera, and a great number of diarrhoea cases. The company most severely affected occupied the bad huts. This company was removed higher up, and the disease abated. The regiment carried it with them to the front, and there were seventeen deaths there after their arrival.

The huts were again left in their original condition, and were occupied early in September by the Royal Artillery, four companies of which, in all about 500 men, disembarked at Balaklava on the 8th of the month and were marched up to Marine Heights.

Three of the companies were placed in the old huts of the 79th Regiment, and the fourth was encamped on dry, open ground, outside the lines. On the 7th October, cholera appeared among the men occupying the huts on the wet ground, and one death occurred. This was followed by six other deaths from cholera in the same huts, and diarrhoea was very prevalent among the men. Finding that the disease showed no disposition to leave the huts, the medical officer ordered all the affected huts, twelve in number, (the entire number in the hollow,) to be pulled down and re-erected at a higher level under Marine Heights. They were again reoccupied in their new position by the same men, after which one death from cholera occurred and the disease entirely disappeared.

The fourth company, which was encamped outside the lines, at a short distance from the affected huts, escaped the disease altogether.

On examining the ground after the huts were removed, it was found exuding water at every pore.

To return: the huts situated at a short distance from those in the wet ground, but having a sufficient natural drainage, were comparatively healthy, except from the effects of deficient ventilation. They were occupied at the time partly by the 79th, and partly by the 42nd. The camp of the 42nd was about 400 feet above the level of the sea, and had excellent means of drainage. Much of the water from the higher levels was indeed cut off from this site, and had its outlet through the ground occupied by the affected huts of the 79th. The lower end of the camp was thoroughly drained by a deep, natural water-course, which

passed through the camp. The part of the camp west of the water-course was situated on a bed of porous debris resting on the steep slope of the limestone hill.

Speaking generally, the sites for most of the huts had been prepared, the ground levelled, the earth cut away from the hill-side at the back of the hut, and thrown forwards so as to complete the platform on which the hut was erected, and thereby affording additional facilities for the natural drainage of the subsoil. Some of the huts required trenching and draining, and all of them required ventilation. The tent sites were tolerably good.

The huts of the 71st were erected in foundations dug out of debris. The steepness of the slope afforded them good means of natural drainage, but they had the serious defect that the earth rested against their sides, and they were not ventilated.

The camp of the Royal Artillery in the valley, under the 71st, was not well situated for health. Much of the drainage of the higher levels found its way into this valley. The huts had the usual defects, and there were large manure heaps belonging to the stables on the plain immediately below them, on a spot of ground where a number of dead animals had been buried. There was nuisance from these causes complained of as far up as the camp of the 71st.

These lower camps were exposed to malaria arising from the marshy ground at the head of the harbour, and from the lower part of the plain of Balaklava.

2. The second group of camps occupied a site on the north-west side of Balaklava Harbour. The steep rocky limestone hills which bound the harbour on the west side, terminate a little above the head of the harbour, and a wide gap, or rather a very steep ravine, divides the north end of this ridge, and separates it from a spur of conglomerate which juts out from the sea-coast mountain chain to form the south-eastern boundary of the valley of Karani. The ravine between the two formations is almost filled up by a huge highly-inclined bed of calcareous loamy debris, with underlying shaley beds. This debris, under the action of the weather and rains, has been deeply furrowed by a number of narrow secondary ravines, but where it rests on the con-



glomerate it presents a tolerably even but highly-inclined surface, rising rapidly towards the south-west. This ground forms a long, narrow, highly-inclined belt, the higher extremity of which is about 600 feet above the level of the sea. The Guards' camp was situated on this belt, and occupied about 300 feet in perpendicular height of it. The highest part of the camp was about 600 feet, and the lowest about 300 feet above the sea level. Somewhat lower down was the camp of the 3rd Buffs, and at the foot of the ravine, and between it and the head of the harbour, was the Land Transport camp.

All the inclinations from the Guards' camp were very steep, and the means of drainage ample. There was, moreover, no great extent of water-shed above the site. The soil, like that of the remainder of the district, became, under the influence of rain, a wet, tenacious, plastic clay, retaining the surface water in every hollow, and becoming in some parts almost impassable. The highest end of the ground was the best; it was stony, and partly covered with brushwood, amongst which the tents were pitched. There were tents and huts on the lower part of the ground, and most of them overhung the heads or edges of the ravines. It is very questionable if these damp shaley ravines are ever wholesome. There were similar ravines in other parts of the occupation. On going through them in different states of the weather, the air had always a peculiar faint unwholesome odour, very likely to affect the purity of the neighbouring atmosphere. The ravines leading down from the Guards' camp had this further disadvantage, that they opened at their lower end on the foul marsh extending from the head of Balaklava Harbour towards Kadikoi. Though the site upon the whole was not a very good one, considerable attention had been paid to the preparation and improvement of the camping-ground. In most instances the sites of huts had been insulated from the surrounding ground; in some instances the foundations of huts had been raised above the level. Trenches had been cut to carry off the surface water from many of the tents and huts, and the surface of the ground was clean. There were a number of instances, however, where the earth had been heaped up against the sides of the

huts and generally the huts had no proper means of ridge ventilation.

It will be seen that there were causes in this camp likely to have produced disease. Besides these, the Guards were at this time mostly employed on duty at Balaklava, and were exposed to its malaria, from which they probably suffered more than from any sanitary defects there may have been in their camp.

About the middle of June 1855, the Guards moved from this camp to the front, and were one of the most healthy brigades of the army.

The Land Transport camp was, in April 1855, situated at the lower end of the ravines descending from the Guards' camp close to the head of the harbour. Its topographical position was one of the worst in the whole occupation. There was a large number of animals picketted among the huts and tents; the ground was filthy; the whole neighbourhood was covered with filth by the Tartars employed in the camp, and in many places offal of slaughtered animals infected the air. At that period the men connected with the Land Transport Corps chiefly lived in tents, the huts being used as hospitals, and they were, as might have been expected, crowded with fever cases. This camp was, fortunately, removed from the site, as the organization of the corps went on.

3. The third group of camps near Balaklava were those of the Cavalry Division in the valley of Karani.

This valley is about two miles and a-half in length from its head to Kadikoi. It runs nearly from west to east, descending rapidly from its western or highest end, about 600 feet above the sea level, to 70 or 80 feet above the sea level at Kadikoi. The sides of the valley are formed by ridges of compact limestone, which are widest apart at its lower end, and they leave between them a tolerably flat bottom, inclined to the north. This space is about three-fourths of a mile long and one-fourth of a mile wide, and its height above the sea level may be taken at from 90 to 150 feet. On this area, and on the lower slopes of the south side of the valley, most of the Cavalry regiments were encamped. The camps were placed at the upper end of the ground. The

17th Lancers were encamped on a slope of the hill on the north side of the valley, immediately above Kadikoi, and the Royal Artillery were encamped below them, just in the opening of the valley. Higher up the valley, and at a point where it becomes very narrow, the 4th Dragoon Guards and the Royal Horse Artillery were camped. The 12th Lancers and 10th Hussars occupied a plateau of ground about 200 feet above the other Cavalry camps.

The valley was well calculated for winter protection, but the ground over most of the area was so bad, that it became almost an impassable clay swamp after heavy rain. The rainfall from all the heights to the west and south flows directly down into the bottom, which was then occupied by the cavalry, and its natural outlet is into a water-course running close under the hill on the north side of the valley; the water from all the south slopes of the valley, that was not carried off by evaporation, had thus to find its way across the ground occupied by the camps to reach the outlet stream.

Although the ground was not marshy, it still retained sufficient water to emit malaria in hot weather after rains. The sun's rays acted intensely on the narrow space occupied by the troops, and there was no free sweep of wind over it.

The topographical defects of the site would not of themselves account for the extent of sickness, especially of zymotic disease, then prevailing. As usual, the newly-arrived regiments suffered, especially from diarrhoea and cholera; but we are disposed to attribute a large part of the sickness to the sanitary defects of the camps, especially in the lower part of the valley, where numbers of men and animals were congregated on too confined a space for safety. This kind of surface overcrowding always gives rise to sickness, for it leads to the saturation of the ground with excretions of men and animals, so that after a time the area so occupied gives off emanations which predispose all who breathe them to zymotic diseases.

The necessities of the service, also, rendered it indispensable that the men should be near their horses, and hence the picketting grounds were distributed among the camps,

and they were thus placed too close to the quarters of the men. Such was certainly the case in most of the Cavalry camps in the valley of Karani.

There is no remedy for this but the most scrupulous attention to cleanliness; sweeping of the surface; frequent removal of the manure away from the camps; change of ground as frequently as possible, and scattering some deodorizing or disinfecting substance, such as quicklime or charcoal dust, over the vacated ground before it is re-occupied. The true purifying agents are those which nature furnishes—air, sun, rain, and the absorbing power of the soil. It is by making use of such remedies that the unwholesome emanations from saturated picketting grounds can be best got rid of.

The accumulation of stable manure was another obvious cause of atmospheric impurity, at the time we first examined these camps. The usual way of disposing of it was to collect the manure in long heaps within the circuit of the camp, and fire it, but this was generally done without due regard to the rapidity and perfection of the burning. The fired heaps therefore smouldered away, and not unfrequently the humid, foetid smoke from them occasioned much nuisance and atmospheric impurity. During dry weather, and with proper care, the burning can be readily effected by opening up the heaps with a stable fork, so as to admit the air. By taking advantage of the weather, and using this simple precaution, many heaps in the camp were burned rapidly and with a large bright flame. This plan was adopted before the evacuation of the camp before Sebastopol. By the common method of burning, the most that can be expected is the covering of the unconsumed litter with a layer of charcoal, derived from the surface combustion, which to some extent deodorizes the mass below. The more perfect combustion by admitting air in the way described, or by throwing the manure on a bed of large stones to admit the air below it, is, however, far preferable.

The best method for disposing of the organic refuse of a fixed camp, including stable manure, is that used in the cantonments in India. A furnace, like a lime-kiln, is constructed, and thoroughly heated. The whole organic products



of the camp are collected by people set apart for this purpose, carried to the furnace regularly, and thrown in. In this way stable manure, bones, offal, &c., are consumed, and the saturation of the ground prevented. At first, the Commissioners were of opinion that it might be advantageous to construct similar furnaces in the Crimea, but they were deterred from recommending them, on account of the great difficulty of obtaining labour and materials for more urgent sanitary works. They found, besides, that the bulk of the manure from stables and picketting grounds could be sufficiently well burned, if due care were bestowed on it. During the spring of the present year, two furnaces were constructed at Scutari by Mr. Unsworth, surveyor to the Commission there, on the recommendation of Dr. Milroy, for burning the manure of the cavalry camp at Haidar Pascha, which had accumulated during the winter so as to occasion nuisance.

As a general principle, it appeared that at the period of our arrival in the Crimea, camps where there were animals yielded a greater amount of sickness than others. This was especially the case with the mule camps, which the native drivers kept in a very filthy state, and there was much fever in consequence.

During the early part of the warm season, from the beginning of May till the middle of July 1855, there was an excess of sickness among the Cavalry and Artillery over that in the Infantry, and the admissions from zymotic diseases to force in the Cavalry and Artillery exceeded somewhat those in the Infantry. The proportion of zymotic cases to the total diseases admitted during the same period in the Cavalry and Artillery also exceeded the proportion in the Infantry regiments.

A similar difference continued up to the period of the evacuation of the Crimea, and appeared to be mainly due to unwholesome conditions arising from the presence of animals.

During the cold season of 1854-55, there was a considerable number of carcasses of dead horses buried close to the Cavalry camps, which still gave rise to nuisance at the period of our inquiry.

The huts which had been erected for the men presented the usual sanitary defects. The foundations had not been

prepared or drained, and earth was raised against the walls. We had the floors taken up in several instances, and found the earth beneath, very damp and covered with fungus. The ventilation was also defective. Numerous cases of fever had occurred in these huts. It may be further stated, as indicating the causes of the fever, that one Cavalry regiment, most of which was under canvas, had little or no fever, and that in the huts of the Royal Horse Artillery, which had their sides properly isolated from the surrounding ground there were three cases of intermittent under treatment, out of a force of 230 men—a very small proportion at that date (May 5, 1855).

At the mouth of Karani valley, on the rising ground close to Kadikoi church, part of the Highland Brigade was at this time encamped. The ground itself was tolerably good, but the lower part of the valley of Balaklava in its vicinity was marshy.

#### § VII. SANITARY CONDITION OF THE CAMP BEFORE SEBASTOPOL.

The general topography of the plateau before Sebastopol has been already described, and we shall now add a few details respecting the positions of the different camps.

The camp of the Guards, after its removal to the front, occupied an excellent site on one of the undulations of the ground, about 1,300 yards to the north-west of the edge of the plateau, and about 600 feet above the sea. The surface soil was the usual loam of the district, but it was mostly thin and underlaid by a calcareous sandy subsoil, which, in some places, came to the surface. The natural drainage was good, and the position a healthy one.

The 3rd and 4th Divisions, and part of the 1st Division, were camped on an elevated part of the plateau, to the north-west of the Guards. It was nearly surrounded by depressions and deep ravines affording ample facilities for surface drainage. The elevation of the ground varied from 500 to 650 feet above the sea level, the highest point being the summit of Cathcart's Hill. The whole area was exposed to the free sweep of the winds. The porous limestone strata come to the surface round the edges of the ravines, but most of the area is covered with a thin tenacious loam. In some

places occupied by hospitals and camps, the surface was more deeply covered with wet, retentive clay. These camps were not so healthy as others on the plateau, and when cholera first appeared in May 1855, it attacked them by preference. With the exceptions named, the positions of the camps were good.

The 2nd Division occupied part of the eastern slope of Cathcart's Hill, about 50 or 60 feet below its summit, and also a slope on the opposite side of the ravine intervening between Cathcart's Hill and the Woronzoff road. Much of the ground under Cathcart's Hill was not very good, especially the lowest portion of it, where the clay was deepest. The part towards the Woronzoff road was, generally speaking, better.

The Light Division was encamped on the north-east side of the Woronzoff road, and occupied two crests of rising ground, with the intervening slopes. Its natural means of drainage were good. The ground was partly rocky and stony, or covered to a greater or less depth with loam. The position was a healthy one, if we except the lowest points.

The camp of the Naval Brigade was situated on sloping ground facing the south, under the camp of the 3rd Division. It was well protected from cold winds during the winter and spring by the high ground immediately above it. The site was a tolerably good one for a winter camp, but below it there was a wet valley, which joined one of the ravines leading to marshy ground, at the head of the inner harbour of Sebastopol. We deemed it necessary to recommend the removal of this camp to higher ground.

The positions occupied by the different regiments, chiefly during the autumn and winter of 1855-56, are given on the map.

The site of the camp before Sebastopol, consisting, as it did, of summits and sides of ridges or heights, with intervening depressions ending in ravines, without any marshy ground in its immediate neighbourhood, and with ample means of natural drainage by the ravines, was, with limited exceptions, arising from the nature of the surface soil, as healthy a district as could have been found within the whole occupation, but it was, of course, exposed to those local and climatic conditions common to the country, which are known to give rise to periodic fevers at certain seasons.

Before communicating with his Excellency the Commander of the Forces, the Commissioners made several examinations of the camp, in different states of the weather, with special reference to the condition of the surface. Considering the pressing nature of the siege duties at that time, they found the camp remarkably clean, and the external sanitary arrangements, on the whole, well attended to. There was considerable difference in the condition of camps, which appeared to depend very much on the pains taken by the commanding officers and surgeons. Some were much better than others, and there were some regimental camps in regard to which it would have been difficult to have suggested improvements.

On closer examination, however, there were sanitary defects, likely to affect the health of the troops, observable in various parts of the camp. They were not general, but whenever and wherever they did occur, it was our duty to notice them. We next proceed to state what the defects were.

1. *Huts.* The huts most in use at the time of our arrival were known as "Portsmouth huts." These huts were 27 feet by 15 feet inside measure, and 6 feet high to the eaves, with a ridged roof rising to the height of 12 feet from the ground. Their cubic contents were 3,645 cubic feet, giving about 146 cubic feet per man for their usual occupants, 25 men. The boarding was single throughout. Some huts had boarded floors, but the majority of the barrack huts had a partial raised floor running along each side, on which the men slept, the space between the two strips of flooring being either paved with rough stones or made of earth. The roof was covered with felt, impervious to air. In some huts there was a swing window at each end under the ridge, and one door: in others, the window over the door would not open, although the window at the opposite end opened by sliding.

These huts had no independent means of ventilation, and when they were used for hospitals the thin boarding was not sufficient protection either from the cold or from the intense sun heat.

It was not unfrequently the custom, as already mentioned, respecting the huts of the 79th Regiment, to erect the huts without sufficient preparation of the ground. The



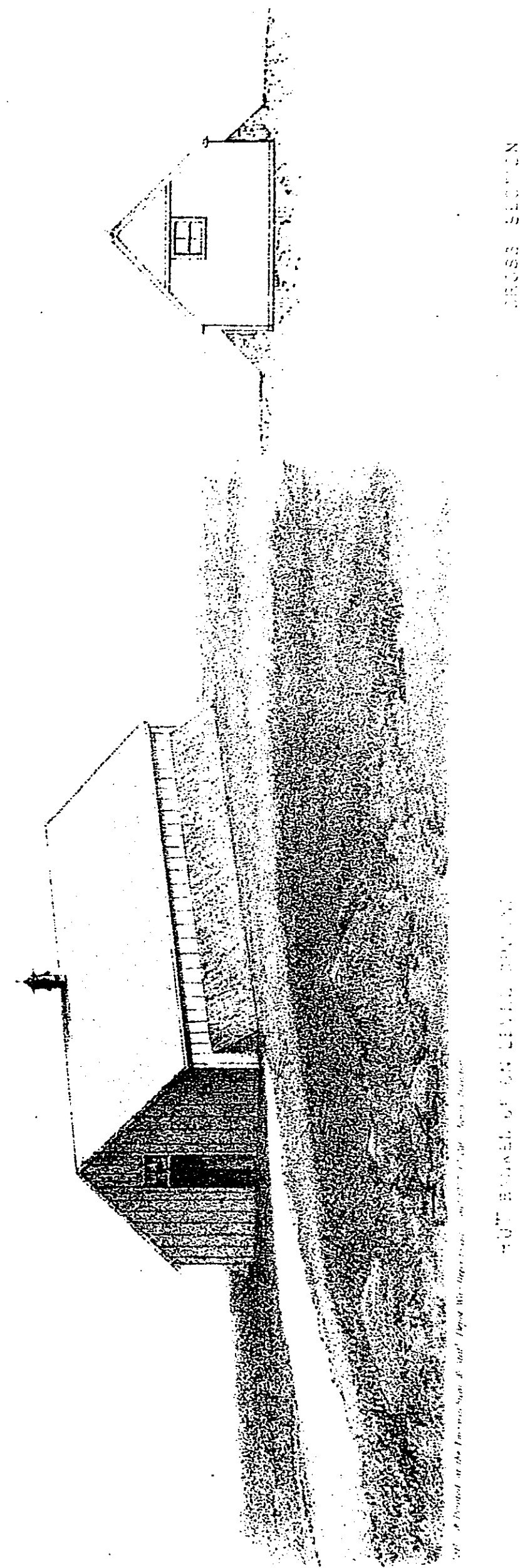
site was either undrained, or defectively drained; the floor of the hut was below the level of the surrounding surface, or the earth was piled a foot or eighteen inches against the sides, as shown in *Fig. 4*. The surface drainage in the vicinity of huts and tents was sometimes so defective that the camp was wet and muddy for days after rain. The ground under the huts and tents became damp from this cause, and endangered the health of the men from zymotic diseases, as already mentioned.

This damp condition of the subsoil is one of the most common local causes of disease for the removal of which engineering works are carried out in towns. It is an evil fraught with danger to health wherever it exists, and in fixed camps it is perhaps of more importance than in towns, because in towns a considerable part of the rainfall runs directly off the surface by the pavement, a means of drainage which does not exist in camps. Hence the necessity for isolating, preparing, and trenching the sites of huts and tents to facilitate the flow of surface water.

2. *Tents.* The space between tents was generally sufficient. In some cases it was more than in others, and there were instances of tents being too close together. In such cases the regiments were not among the most healthy in the camp.

The most obvious sanitary defect in the tents was their want of ventilation. An ordinary bell tent has about 512 cubic feet of capacity. It is usual on march for twelve to fifteen men to sleep under a bell tent, but in camp one-third of the number are on duty. The cubic space for each soldier would thus be from fifty-one to sixty-four cubic feet. The necessity of economizing transport, renders a considerable degree of overcrowding in tents inevitable; but the evils arising from this circumstance would be greatly mitigated by ventilation. The indispensable necessity of renewing the air is, indeed, recognized, for there are a few small openings for this purpose near the apex of the tent, but they are of too small a size to be of use.

We had occasion to examine the ventilation during the outbreak of cholera in May 1855, and were struck on entering the tents by the foulness of the atmosphere. This led to inquiry, and we found the men were perfectly aware



of the defect, and complained of it themselves, especially in the morning. It may be laid down as an axiom, that an atmosphere in this condition cannot be breathed during sleep, night after night, without risk to health. At the same date we found instances of sick being treated under bell tents, and in going into one of these, we saw pans of peat charcoal on the floor, and were told by the surgeon that were it not for the use of charcoal for absorbing the emanations from the sick, the air of the tent would have been unbearable — a very sufficient proof of the necessity for a better ventilation.

Fresh earth also absorbs animal effluvia, and it is highly probable that the surface covered by a tent absorbs a certain amount from the foul air inside for a time; and this may account for the fact that tents become unhealthy, unless the ground is changed, probably on account of the saturation of the earth. It also accounts for the faint, sickly, unwholesome odour observed after the removal of camps, when the ground is exposed to the action of the sun and air, but which is not experienced to the same extent while the tents are standing. This peculiar odour was especially observed to last for days on camping ground vacated by the Allies after the conclusion of peace, and the smell was at times so strong as to resemble that proceeding from imperfectly buried carcases of animals.

To remove as far as practicable the evils of overcrowding, it appears indispensably necessary to improve the ventilation of tents.

In so far as regards the saturation of the earth, the great and obvious remedy in stationary camps, like that before Sebastopol, is to strike the tents and remove them to a fresh surface, even at a short distance off. On one occasion, early in May 1855, while recommending this verbally, we were informed that the supply of tents was deficient, and that it was impossible to strike the tents we pointed out, as they were too much decayed to admit of removal.

In pitching tents it was a common practice to dig a circular pit, eighteen inches or two or more feet deep, and to pitch the tent over it. Very often no adequate provision was made to turn aside the surface water, and we have



seen tent pits filled with water to the level of the ground in consequence. It has been stated to us that charcoal fuel has been used to warm these excavated tents, and with fatal results, from the carbonic acid having filled the pit to the surface, just as if it had been water, and causing asphyxia in persons sleeping with their heads below the level of the ground.

3. *Latrines.* All the British camps were supplied with excavated latrines, except those of the natives. The latrines were too wide, and not deep enough. They exposed too extensive an exhaling surface, were kept too long open, and were not regularly deodorized.

4. *Burial of Carcasses of Animals.* At the time of our first examination of the camp, there were very few unburied animals to be seen within the British portion, but in a number of localities we found carcasses imperfectly buried, and giving off emanations which infected the air to some distance. It appeared to have been the usual practice to dig a shallow pit, not sufficiently deep to contain the carcase, to drag the carcase into it, and to throw earth over it. Sometimes the carcase was left on the surface, and merely covered with earth, in either case producing nuisance.

5. *Slaughtering-places.* The slaughtering-places belonging to the divisions were generally kept in good condition, and the offal buried in a satisfactory manner. During numerous examinations we seldom detected any smell from them, except immediately on the area, and after moist hot weather. There was a large depository of offal belonging to the French Commissariat between the British head-quarters and the 3rd Division, which we had to report to the Commander of the Forces, on account of nuisance proceeding from it.

6. *British Burial-grounds.* The dead of the British army and navy during the siege of Sebastopol were interred in 66 burial-grounds, scattered over the occupation, from the advanced trenches before the Redan on the west, to beyond Kamara on the east, and from the heights of Inkermann to Cossack Bay. The larger burial-grounds on the plateau were generally situated in advance of the army, on the slopes of ravines leading down towards Sebastopol, but there were many smaller grounds containing a few graves,

scattered over the space occupied by the different divisions of the army. When first used, most of these grounds were at a sufficient distance from the camp, but as the positions were advanced, some of the grounds were included within its circuit, and others were formed on any vacant space of ground at a sufficient distance from the tents and huts of the regiments.

Except at Inkermann and the Redan, those who died in hospital, or were killed in the trenches, were buried in single graves, with four or five feet of earth over the corpse, according to the Army Regulations. We had frequent opportunities of observing the manner of burial, and on every such occasion the interments were conducted with care and decency. The good taste and feeling displayed by the soldiers in the laying out and decoration of the different regimental cemeteries can never be forgotten by those who witnessed it.

On one occasion complaint was made to the Commission of graves being too shallow in the burial-ground near Kadikoi, and on another, a ground too close to some huts was complained of as emitting offensive smells; but with these exceptions there was every reason to be satisfied with the practice of burial in the camp. The case of the burial-grounds at the head of Balaklava harbour, which was an exceptional one, has been already referred to.

7. *Manure Heaps.* There were stables and picketting grounds in various parts of the camp before Sebastopol, which were at the date of our examination kept in tolerably good condition. The manure was swept up, and on the whole well burned.

The most influential sanitary defects at this period were those connected with the huts and tents. The former were the more important, and were remediable, but the exigencies of the service at that time rendered it impossible to remove the tents to fresh ground, except in special cases.

In pointing out the remedies, we considered it to be most advisable to recommend improvements we found already in operation in some part or other of the camp, on the very obvious principle that what had been done successfully in one regiment might be readily done in another. This course

was always taken, and where we found that something further required to be done, we endeavoured as far as possible to limit such requirements to what was barely necessary. We usually pointed out the defects and suggested improvements on the spot, sometimes accompanying the recommendations with rough sketches for the guidance of the workmen. By the middle of May the whole camp had been examined, and on the 17th of the month a brief statement was drawn up and sent to Lord Raglan, containing all the points more immediately requiring notice, which we had observed, some here, some there, over the entire area of the camp, with the necessary remedies.

The following were the sanitary improvements recommended for huts during the warm season, whether used as barracks or hospitals:—

1. The site of each hut to be cleared for a space of not less than four feet around and beyond the lines of outer boarding.

*Fig. 5* shows the hut, *Fig. 4*, cleared of earth and ventilated as recommended.

2. The whole space actually occupied by the hut to be isolated by drainage at least twelve inches from the shallowest part of such drain, which drain must in all cases be formed round the extreme limits of the site cleared.

3. Over the whole inner space of each hut charcoal should be laid, to the extent of half an inch in thickness, before the boards are nailed down.

4. The surface drainage of the side-long ground should be intercepted, and carried off by proper channels.

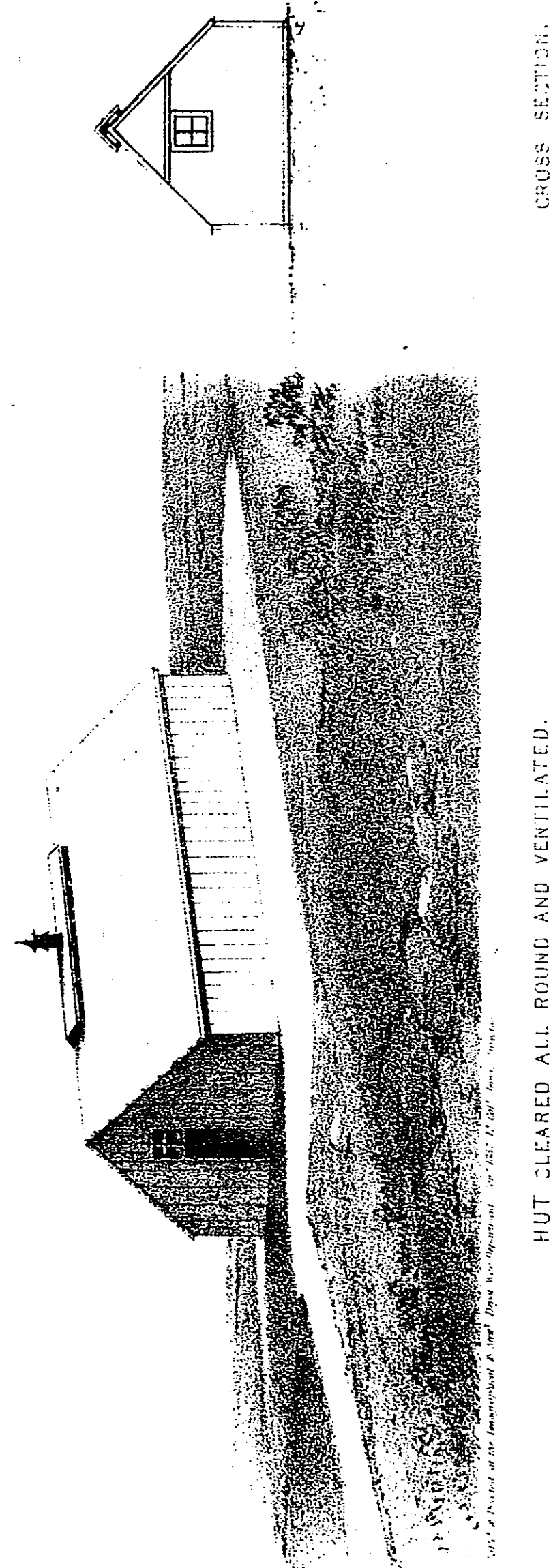
5. In all huts to be hereafter built, the foundation timbers to be laid upon dry material, rubble walls, gravel, or concrete. If practicable, the external space cleared round the hut should be formed with gravel, or paved.

6. Perflation beneath the floor should be provided for.

7. To secure each hut to the site in exposed situations, holding down bolts or timbers should be inserted in the rock or earth, as the case may be. The angle uprights of the huts should be spiked or bolted to these.

8. Ridge, end and side ventilation to be provided. The ridge ventilation to be obtained by clearing a space on either side of the ridge-piece, and covering the opening by

Fig. 5.





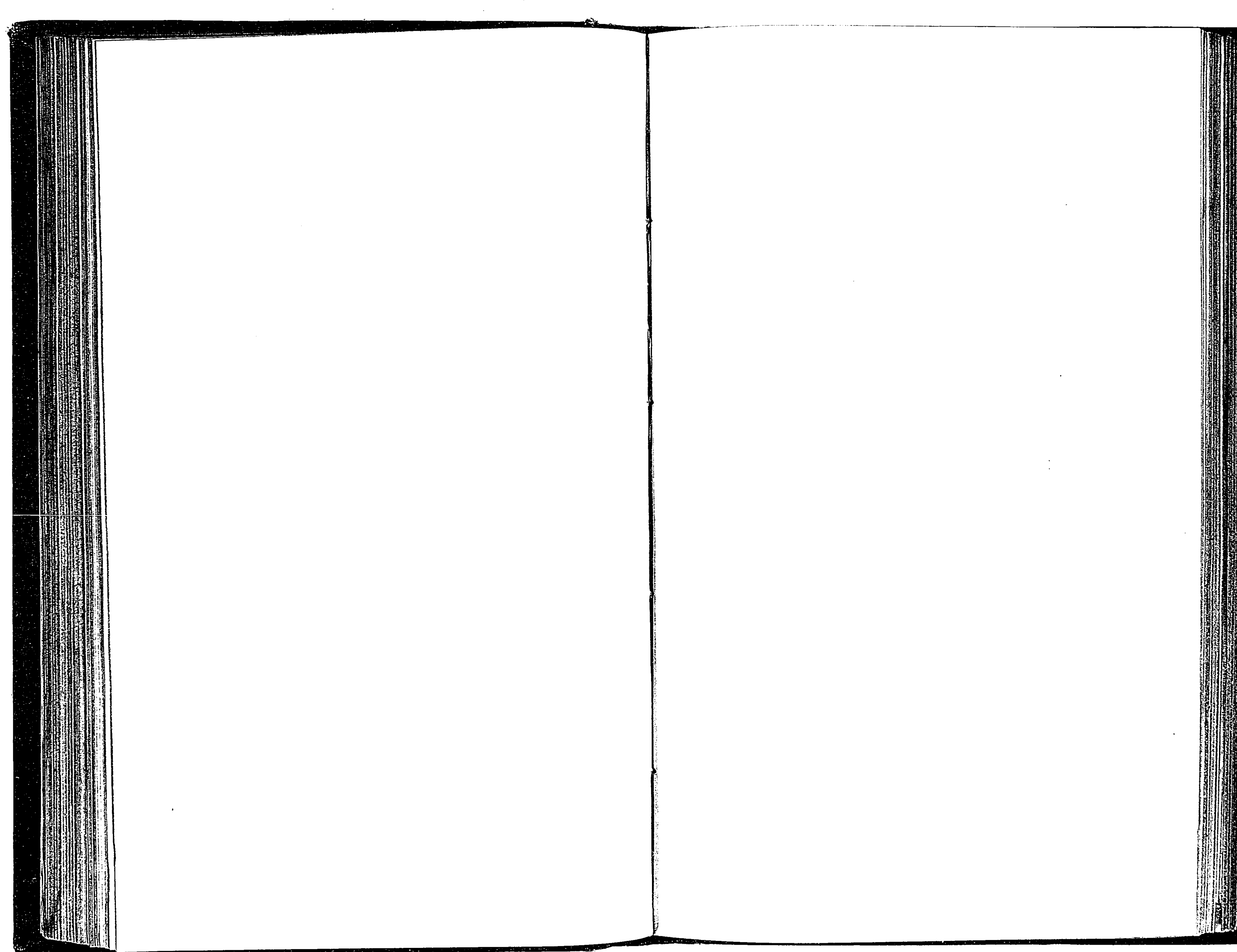
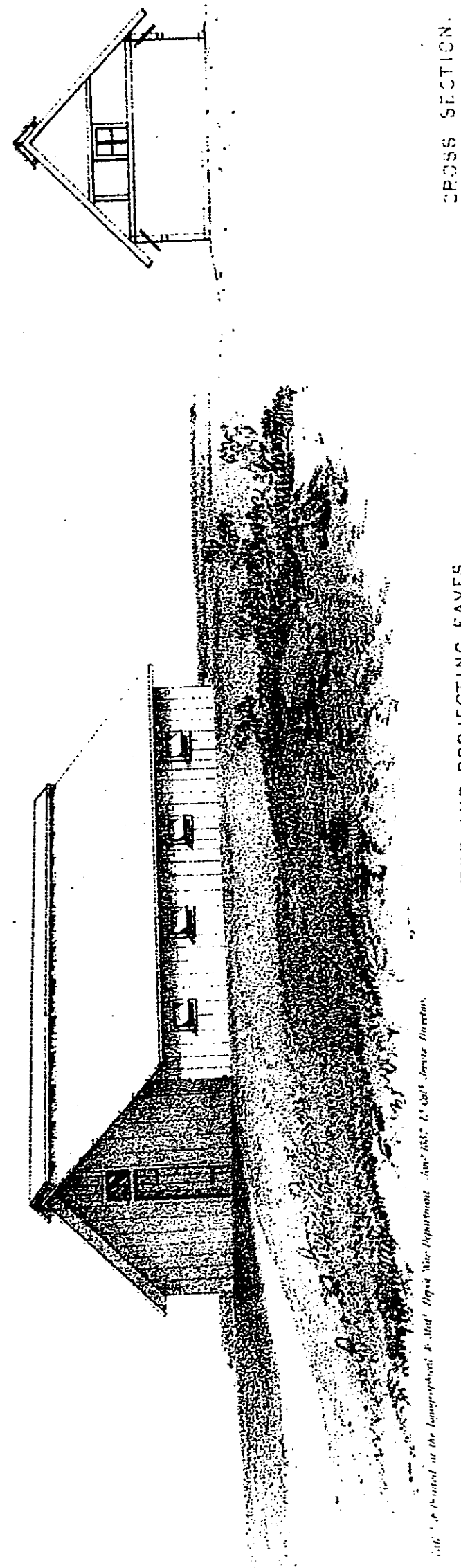


Fig. 6.



a second board, as had been done at the Castle Hospital. Side spaces to be opened in the walls of the huts, and protected by hinged or sliding shutters, of which there were examples in the Second Division.

9. To obviate the necessity usually alleged for banking up huts with earth outside, a practice most injurious to health, the huts to be lined inside about three feet in height from the floor, to prevent the wind blowing on the heads of the men. In hospital huts external seats to be provided for convalescents.

10. All huts to be lime-washed externally.

11. Should fever or cholera occur, the numbers in each hut to be reduced, and if the surrounding subsoil be wet, the site should, if possible, be changed.

12. Projecting eaves-boards would reduce the temperature within the huts during hot sunshine.

Fig. 6 shows the full ridge ventilation, and projecting eaves recommended for huts, as they should be.

The hospital huts which were at the time being erected for the Naval Brigade above Cossack Bay, according to the recommendations of the Commission, presented all the necessary improvements, and were recommended as examples.

Existing huts in various parts of the camp were also being improved, the labour for which had been found by commanding officers of regiments.

On the same date on which the suggestions for improving the huts were drawn up, other general recommendations, to be put in force wherever and whenever it might be necessary to do so, were also transmitted to Lord Raglan. They were all required in some part or other of the camp, but such cases were exceptional. The cases, however did exist, and to that extent the health of the army was liable to suffer, and it was part of our duty to deal with them.

We recommended:—

1. That all those parts of the camp where dead animals or offal have been buried, be examined from time to time, and wherever any offensive odour is perceptible, or wherever any animal remains are exposed, a quantity of charcoal be strewed over the whole surface, and an additional foot or more of earth be placed over such remains.



2. That all dead animals or offal be buried immediately to such depth that three feet of earth, at the least, intervene between the upper surface of the decomposing matter and the level of the ground. In every case, before the earth is filled in, a quantity of charcoal to be thrown over the animal or offal. That all interments take place as far as practicable outside the camp, and at as great a distance from the camp as possible, and that no grave be less than four and a-half feet deep.

3. We gave our entire approval to the destruction by fire of all refuse matters that could be so disposed of.

4. During summer, latrines should not be made larger than required for a fortnight's use. That when first dug, a quantity of charcoal should be thrown on the bottom of the latrine, and every day such camp refuse as could not be destroyed by fire to be thrown into the latrine, and peat charcoal thrown over the whole, and then a few inches of earth. This process to be repeated day by day until the matter thrown in reached within two feet of the surface, after which some charcoal was to be put over it, and the earth filled in a little above the level of the ground. No new latrine to be dug near any source of water for the camp.

5. Those parts of the camp where animals are picketted to be kept constantly cleansed, and the dung and refuse removed and burned. It would be very advisable to change the ground for a week occasionally, to allow the air and sunshine to free the ground from exhalations. In any case where there are noxious smells, charcoal or quicklime may be advantageously used for removing the effluvia.

6. It would be very advantageous to strike the tents, and to remove them to a short distance from the ground they occupy, so as to leave it exposed to air and sunshine. After removal, a small quantity of slaked quicklime thrown on the spot where the tent stood would aid materially in preparing the ground for returning to it. We further advised that, in cases where cholera or other epidemic disease prevailed, an additional supply of tents should, if possible, be served out to affected regiments, to enable the number of men in each tent to be reduced.

In making these recommendations, we expressed our opinion that the camp sanitary police should be vigilantly

exercised, and that it would be very desirable that similar precautions should be adopted in the other camps of the allies, so as to preserve the atmosphere of the whole camp in as pure a state as the circumstances of the siege might render possible.

Had it been practicable to obtain the large number of men required for the speedy execution of the sanitary works at Balaklava already mentioned, it was the intention of the Commissioners to have recommended that part of these men should, after the completion of the works, be organized for camp sanitary service, and they further intended to have placed their sanitary inspectors at the disposal of the military authorities for the purpose, as they had done at Scutari.

There were natives already employed in keeping the camps clean, but the small number of labourers at Balaklava required the constant attention of the inspectors in order that the works there might progress, and they could not be spared for the camp. The Commissioners therefore themselves kept up a continual oversight of all parts of the camp, and this was done day by day, unless personal sickness interfered to prevent it. Inquiries were at the same time made of the medical officers as to the health of the troops, and abstracts of the weekly medical states were made up.

It has been already stated that cholera appeared in the army early in May 1855. Immediately on being informed of the occurrence Dr. Sutherland met Dr. Hall and examined the affected camps. The disease showed itself first among men engaged in the trenches, near a place where there was an offensive burial-ground belonging to the Russians, and it attacked by preference new arrivals and intemperate men. The camps before Sebastopol which were first affected were those of the 48th, the Royals, the 3rd Buffs, and the Royal Artillery. The disease made very little progress until after three days of heavy rain followed by a hot sun.

The ground occupied by the affected camps was wet clay which, after the rain, had been worked into a puddle. In some of the affected tents the ground was wet and the men slept upon it. That never-failing source of danger when epidemic disease is present, overcrowding, especially in the

tents, was an obvious evil, and in every instance the ventilation of the tents was deficient. There were one or two offensive latrines to windward of affected camps, and the water used was muddy from causes already mentioned. There was a good deal of diarrhoea among the troops at the time. As the disease progressed its attacks appeared to conform to the usual epidemic laws, and the localizing conditions to be much the same as those observed elsewhere, aggravated by the higher temperature. Removal of affected regiments to fresh ground at times put an arrest on it, but at other times it was not so successful.

After having completed the inquiry, Dr. Sutherland, with the concurrence of Mr. Rawlinson, addressed two communications to Dr. Hall on the 16th May, in one of which the removal of affected camps to better ground, the diminution of overcrowding, by serving out a larger supply of tents to affected regiments, and examination, deodorizing, and covering up of all old latrines and other offensive matters within half a mile of affected tents was recommended.

In the other communication it was pointed out that the existing means of discovering and treating diarrhoea cases were insufficient, and that it was necessary to take steps for discovering the disease at the very commencement, either by an inspection of the troops, by setting a watch over the latrines, or by any method consistent with the rules of the service whereby the malady might be promptly discovered, and the medical treatment carried to the patient without waiting for his applying for it.

During all the recent epidemics of cholera the beneficial results of similar inspections for the discovery and treatment of the earlier stages of cholera have been fully experienced, both in civil life and in the army. The worst cases are precisely those in which the sick are least likely to apply for medical aid, and hence the necessity for seeking them out and treating them on the spot. There are few fatal cases of cholera in which disease has not been neglected in its early and curable stages, and application for medical relief put off till it was too late to be of service. To this general rule the experience of the army, is itself no exception.

While we were occupied with the sanitary inquiries con-

nected with the camps, we at the same time carried out similar inquiries into the condition of the hospitals, and we next proceed to state the sanitary defects we discovered in them, and the remedies which were applied.

#### § VIII.—MILITARY AND NAVAL HOSPITALS IN THE CRIMEA.

At the beginning of April 1855, there were three general hospitals belonging to the British army in the Crimea, namely, the General and Castle Hospitals at Balaklava, and the General Hospital in the 3rd Division. On the 3rd May the Commission was applied to by Dr. Hall to examine a site for a fourth General Hospital which he had selected near the monastery of San Georgeo, and of which we entirely approved.

This hospital was immediately commenced and extended as occasion required.

Besides the General Hospitals, there were the Regimental Hospitals situated in various parts of the camp. There was a hospital belonging to the Royal Marines under Marine Heights, and the sick and wounded of the Naval Brigade were at that time received on board Her Majesty's ship "Diamond," lying at the head of Balaklava harbour.

With the exception of Kadikoi Church, which was used as a hospital for the Guards, the *General Hospital* at Balaklava was the only establishment built of stone. It had been a Russian military school, and consisted of two divisions, the front one containing large lofty airy wards, well isolated from the ground. The other portion was behind and consisted of a range of smaller apartments built against the slope of the hill, and having windows only on one side. This part was unhealthy, and fever had originated in it.

These two buildings formed two sides of a parallelogram, and were situated on the eastern side of the harbour. The area was completed by two other ranges of buildings, used as stores and offices for the hospital.

Besides the wards in the stone building there were twelve or thirteen Portsmouth huts erected in rows on the sloping ground above the harbour, also used as wards for the sick.



The whole establishment was situated on a sloping bank of ballast under the rocks at the north end of the town of Balaklava. It was subsequently discovered that part of the back range of wards had been erected on the site of an old graveyard.

The main objection to this hospital was its position. Anywhere else it might have been a good hospital, but being exposed to malaria and other injurious emanations, arising from the bad sanitary condition of the neighbourhood, it was not an establishment where the highest results of medical or surgical treatment were likely to have been realized.

The front part of the building had windows on both sides; and at the time of our inspection a plank had been removed from the wooden ceiling of each ward to admit of free passage upwards of the ventilation into a space under the roof, from which it could escape by existing openings into the external atmosphere.

The inner walls of the wards were repeatedly lime-washed and were clean. From having windows only on one side, the wards in the back portion of the building had no thorough draft, but the ventilation had been materially improved through the ceiling in the same manner as in the front part of the hospital. This portion was also kept clean by lime-washing.

We found the ventilation in the huts deficient, but it was subsequently improved by louvred openings in the roof of each hut.

The outside of the entire establishment was lime-washed and always looked clean.

The chief removable sanitary defect in this hospital was the condition of the latrines, the worst of which was filled up at our request. Fever had originated in two of the hospital sheds nearest this latrine. A proposal was subsequently made for removing to a distance the whole filth of the hospital, to which we gave our approval.

Complaints were occasionally made that stable manure and other refuse was allowed to accumulate among the huts in the vicinity of the hospital, but on representing this to the Commandant Lieutenant-Colonel Harding, or by

calling the intention of our own inspectors to the complaint it was immediately attended to.

The water for the General Hospital was obtained from a fine well almost under it, at the edge of the harbour.

From its situation this hospital had to receive not only soldiers as patients but a large number of natives employed in the neighbourhood, and also sailors from the transport service. Sometimes the sick of these latter classes constituted the majority of the inmates. At other times invalid soldiers, sent down from the front, were left in the hospital to recruit before being put on board ship for the Bosphorus.

From these various circumstances the number of inmates was sometimes larger than the hospital could well accommodate, while at other times there was cubic space to spare. So far as the army was concerned, the hospital was better suited for a transit hospital than as a place for the recovery of sick, and latterly it was almost exclusively used for that purpose.

Its sanitary condition, except in the points already mentioned, was as satisfactory as could have been expected, and the Commissioners deemed it sufficient to inspect it from time to time, in case anything should arise requiring their notice.

The *Castle Hospital* was situated on one of the finest natural positions that could have been selected for such a purpose. It occupied the whole of a long narrow ridge running nearly east and west, and joining the Castle Rock with Marine Heights. The ridge immediately overhangs the sea at a height of about 320 feet, and is isolated on the land side by the Castle ravine which cuts it off from the adjacent higher ground.

The natural means of drainage were all that could have been desired, and the esplanade towards the sea was always dry, even after heavy rains. The hospital at the time of our arrival in the Crimea consisted of a number of Portsmouth huts arranged side by side with the ends facing the sea. Several other huts on a model called the "Chester hut," were also being erected. Eventually the

whole ridge was occupied by thirty-one huts, all or nearly all of which were used either for hospitals or stores.

Other two large hospital huts were erected on platforms cut out of the hill slope on the north side of the ravine.

Water was obtained from an old well in the ravine, supplied, in all probability, by a pipe conducting the water from springs on the side of Marine Heights, and besides this source, the stream running down the ravine afforded water, but of a less pure quality. These springs had their origin on the water-shed of Marine Heights, but as this was only of a limited area, the supply would naturally diminish or fall short after a long continuance of dry weather. The porous deposits, however, from whence it proceeded, contained a large quantity of water, which could easily have been uncovered and conducted to supplement the deficiency.

The Portsmouth huts of the Castle Hospital were constructed on the usual model, namely a door opening directly into the external air, a window at either end, three-quarter inch boarding for the sides and roofs, boarded floors, the roof covered with felt, and the cubic contents about 4,000 feet.

The two most obvious defects in these huts for hospital requirements were—1st. The absence of independent means of ventilation; and 2nd. The thinness of the sides and roof, which could not afford sufficient protection from the heat of the sun.

The Chester huts were much better. They were longer and more roomy, and the sides were double, planking being nailed over each side of the uprights, so as to leave a space between. Each hut had a range of swing windows of rough plate glass on either side over the beds, and also an external porch, with a separate apartment for the attendant.

The Commissioners found that by taking advantage of this construction, these huts could be further improved, and rendered very suitable for hospital wards.

All that was required was to raise the ridge pieces so as to have ventilation along the ridge of each hut: to make a few openings in the lowest plank on the outside boarding to admit the air between the outside boarding and the

inner lining, and to have a clear passage upwards for the air entering by these openings, between the outer and inner planking of the sides and roof up to the ridge ventilation where it would be discharged. By this means the interior of each hut would be preserved always thoroughly ventilated, and a current of air kept up between the outer boards and the lining, so as to prevent the heating effects of the sun's rays on the outside from affecting the temperature of the air within the hut. Dr. Jephson, the medical officer in charge of the Castle Hospital, took great pains to make these huts and their ventilation as perfect as possible.

The excellent character of the position of this hospital rendered very little preparation of the ground necessary, except for the two huts on the north side of the ravine, where we found that after the huts had been erected, the earth had been filled in behind them, and rested for several feet against the sides.

The latrines for the hospital were situated in the ravine at a considerable distance from most of the huts.

Few Hospitals can show more favourable results than were exhibited by this establishment. It was primarily intended for the treatment of wounded men. Amongst this class of patients the mortality at the commencement of the year 1856, had been under three per cent. of the admissions. A number of sick had been from time to time admitted along with the wounded, and the mortality from sick and wounded together did not exceed three and a quarter per cent. of the admissions.

Judged by its results, this hospital must be considered as one of the most healthy of which we have records.

*The General Hospital at San Georgeo* was formed of a square of huts, similar to the Chester hut. It was situated upon a nearly level piece of ground not far from the top of the great ravine, and about 500 feet above the level of the sea. The ground consisted of stratified limestone, thinly covered with a layer of light loam. The site was well isolated and drained by trenching, and each hut was also drained.

The sides and roof of the huts were double, and the ridge pieces were raised so as to insure ventilation, and to allow the air to escape from the space between the side and



lining. Each hut was fastened down at the angles by holding down timbers. There was a porch at each end, and a row of swing windows of rough plate glass on either side.

There was one large hut belonging to this hospital constructed of corrugated iron, which from its conducting power for heat is a bad material for the purpose, whether used for walls or roofs. It is sure to become overheated by the sun's rays in summer, and to be cold in winter, and is at all times subject to those sudden variations of temperature between day and night which are so injurious to the sick in many cases.

The water supply for the establishment was obtained from wells belonging to the Monastery Farm at a short distance off.

The site naturally was a good one, and there were no local sources of malaria, excepting what might have arisen from a large cattle-yard belonging to the French Commissariat, about a quarter of a mile away. The chief cases sent to the Monastery Hospital were convalescent and ophthalmia cases, from regiments in the front.

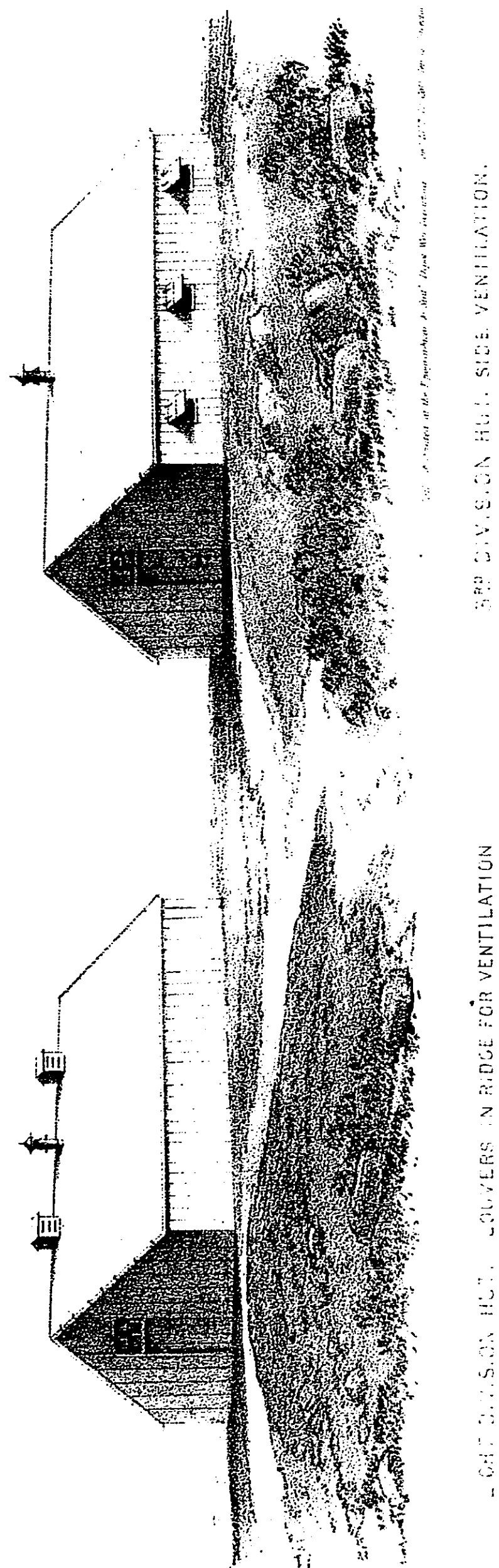
*The General Hospital in the 3rd Division*, at the time of our first examination of it at the end of April 1855, consisted of a number of Portsmouth huts, ranged in parallel lines, situated behind the 3rd Division, and surrounded by the huts and tents of several regiments. The space it occupied was considerably raised above the general level of that part of the plateau, and it had ample means of natural drainage. Unfortunately, however, the ground consisted of a deep tenacious clay, hardly admitting of improvement by drainage, and becoming a complete swamp after rain. The huts were too close together, and were too nearly encroached on by regimental camps. They were undrained. They had earth raised against their sides, and were imperfectly ventilated. Considered as a whole, this hospital was, therefore, less favourably situated than the other General Hospitals.

Had it been possible at the time to have removed the whole to better ground, it would have been the best course to have taken. Otherwise the only thing to do was to improve it as much as was practicable, and to use it only on necessity.





Fig. 8.



The huts were gradually otherwise appropriated, and very few sick remained in the Hospital after the commencement of 1856.

The *Regimental Hospitals* were formed for the most part of two or three Portsmouth huts, generally placed among the tents and huts of the regiments. In a few instances hospital marquees were in use. The site of each hospital was of course determined by the position of the regiment. The ground was sometimes porous and good, at other times it was clay. In the majority of instances the medical officers had had the drainage of the huts improved to a greater or less extent. There were instances, however, in which no such improvements had been carried into effect.

The walls of all the regimental hospital huts were single, and they had the usual arrangement of one door and two windows. In most instances we found that the medical officers had remedied the defects in the ventilation to a greater or less extent.

One method of doing this was by drilling a few inch or inch and a half augur-holes through the wood in the triangular space between the ridge of the hut and the top of the window at each end of the hut, and placing a projecting board above the holes to keep the rain from driving in (*Fig. 7*). In other instances a triangular opening was cut at each end, in the same position, and protected in a similar manner (*Fig. 7*): or the upper board under the eaves on each side of the hut had been hung on hinges to admit of its being opened or shut. Sometimes two or three vertical slits, with sliding covers, were cut on each side of the hut, these slits being occasionally protected by a wooden penthouse (*Fig. 8*).

A freer ventilation was obtained by cutting out large square windows, generally two on each side, with wooden shutters instead of glass.

All these methods, however, were more or less defective, because they did not make sufficient provision for the escape of the heated foul air from under the roof.

The best method of accomplishing this latter object which we found in use was in some of the hospitals of the Light Division, in which a square opening was cut in the middle of the roof at the ridge, and covered by a louvred

turret (this is shown in *Fig. S*). In some cases no provision had been made for ventilating the hospital huts.

Generally speaking, the huts were more or less isolated from the surrounding ground, but not unfrequently earth was heaped up against their sides, and there was consequently no protection for the subsoil from damp.

Sometimes the floor was boarded all over, but generally only the sides where the beds were, and the passage between the two rows of beds was either rammed hard and covered with a thin layer of lime, or it was paved with rough stones.

The roofs of the huts were generally covered with felt.

Admitting exceptions, of which there were some, the regimental hospitals, from the care bestowed on them by the medical officers, were in a good sanitary condition, and, with the occasional application of limewash, outside and in, they were preserved as clean and healthy as their defective structure admitted. They were apt to become overheated on account of the thinness of the walls, but this defect could be partially remedied by a more perfect roof ventilation, although the radiation from the heated wood still remained.

In pitching hospital marquees, the usual way was to dig a trench round the site, and the bedsteads were generally placed on the ground. Sometimes the interior was boarded over, when boards could be obtained, and it was astonishing to mark the difference produced on the aspect of the interior by this addition.

The best example of a marquee hospital was that belonging to the Guards, after they went to the front, in June 1855. It laying it out, a considerable area of porous sandy soil, on a good elevation, was selected. It was trenched round to ensure dryness, and the marquees were arranged in two parallel lines, at a distance from each other—a marquee in one line being opposite the interval between two marquees on the other, an arrangement admitting of a free circulation of air. The interior of nearly all of the marquees was boarded, the boards being generally laid on joisting. The usual method of ventilation in marquees is by opening or raising the sides; but this can hardly be said to be suffi-

cient, even in favourable weather, and still less is it so when from rain or high wind the sides cannot be opened. Even in fine weather it was remarked that the air under the roof of the marquee was hot and stagnant, although the sides were open, because there was no provision for its escape above. What is really wanted to render the ventilation sufficient is to make large and properly-protected apertures round the top of each pole. Were this done, a marquee would be rendered far more suitable for a field hospital than it is at present.

The whole question of ventilation, as regards field hospitals, is one of great importance. The limited means of transport admit only of a small amount of hospital accommodation being carried with an army, but it happens that a deficiency of cubic space can be, to a large extent, supplemented by free ventilation; and hence, so far as the rapid recovery of the sick and wounded is concerned, well-ventilated field hospitals answer the same purpose better than it would be fulfilled by a much larger amount of ill ventilated cubic space.

To ventilate a field hospital well, is, in other words, to save transport.

Even with all the advantages possessed by a stationary camp like that before Sebastopol, backed by so large an amount of sea transport, the actual cubic space which could be set apart for the sick was very much less than in the hospitals on the Bosphorus. Each Portsmouth hut had from twelve to fourteen beds, which would give about 300 cubic feet of space per man. The hospital marquees generally accommodate from twelve to fifteen beds, and give about 250 cubic feet per man. It very generally happened, however, that from the improving health of the army, a considerable proportion of beds were left unoccupied, and the cubic space for each patient was, thus, much greater than the amount specified. Where a similar advantage does not exist, the only way of meeting the defect is by carefully attending to the ventilation, and ensuring its amplex according to the state of the weather and season, by the most scrupulous attention to cleanliness, both within and without the hospitals, and by seeing that there are no latrines, dung heaps, dead animals,



or other nuisances in such a position as to affect injuriously the purity of the air in the vicinity. These precautions, which are at all times necessary to be observed, are the more so when the necessities of the case require the sick to be limited to a small amount of cubic space. Permanent and independent means of ventilation are particularly required at night, when the doors and windows are closed.

*The Royal Marine Hospital* was situated on the western slope of Marine Heights, about 500 feet above the sea, and at the upper end of the Castle ravine. It consisted of several wooden huts erected on a platform cut out of the slope, the huts being so placed that part of the ground rose several feet against the sides, and the earth was further heaped up, so that, in reality, the huts were partially buried. There were no surface drains, and no independent ventilation. The floors of the huts were damp, and had the hospital been occupied while these defects existed, it would have been decidedly injurious to the sick.

The attention of the Commissioners having been called to the condition of the hospital, they addressed a representation on the subject to the Commander of the Forces, on the 25th April, 1855, recommending that the huts should be isolated from the surrounding ground, the site drained, trenches cut to carry off surface drainage, and each hut ventilated at the ridge. Sketches representing the improvements required were at the same time sent to the Commander of the Forces, who approved of the changes, and directed their execution.

These sketches were intended, also, to exhibit the chief sanitary defects which we found in the barrack and hospital huts, and the manner of remedying them:

The object was, first, to cut off the surface drainage from the site by means of catchwater drains; next, to isolate the hut entirely from the earth, which should never touch its sides, by leaving a clear space all round, about four feet wide, to allow the air to circulate freely, and to cut off damp from the boards; and, lastly, to drain the site of the hut by a trench carried round the cleared space, about a foot below the foundation of each hut, and by sloping the earth from the foundation to the drain.

The sketches, also, showed the manner of introducing ridge ventilation, as recommended by the Commissioners.

There was still one desideratum in all the huts, which could only be supplied in those about to be erected, and that was a means of effectually protecting the air in the interior from the damp of the subsoil. The way in which we had this done will be presently mentioned.

At the date when the recommendations for improving the Royal Marine Hospital was made, there was no hospital ashore for the sick and wounded of the Naval Brigade, who were, at the time, received and treated on board Her Majesty's ship "*Diamond*," the main deck of which had been given up for the purpose.

To enable this to be done, the crew of the "*Diamond*," consisting of about 200 men, were sent to sleep on the lower deck, and the whole sick accommodation which was obtained in this way was sufficient for no more than twenty-four patients, without crowding.

We considered this arrangement, in the then sanitary state of the port of Balaklava, at the upper end of which the "*Diamond*" was lying, as alike compromising the health of the crew and the recovery of the sick, in which opinion we were sustained both by Captain Hamilton and by Dr. Smart, who had charge of the sick. At the same time, a number of transports were being fitted out in the harbour to be used as floating hospitals, so that it became necessary to consider the whole subject.

We examined the hospital arrangements on board the ships "*Orient*," "*Poictiers*," "*St. Hilda*," "*Clifton*," and "*William Jackson*." We found them generally good, and sufficient for conveying sick to a distance, but we were decidedly of opinion that, in the existing condition of the port, no ship could be used there as a hospital with safety. We accordingly stated this opinion to the Commander of the Forces on the 19th April, and recommended, in so far as the sick and wounded of the Naval Brigade were concerned, that hospital huts should be erected on sites we had examined on the high land above Cossack Bay, which presented many obvious advantages for this purpose. The step was the more pressing as two cases of cholera had already appeared on board the "*Diamond*."

The huts were immediately granted. We explained to the ship carpenter the plan to be adopted in their erection, and went, from time to time, to examine the progress of the work.

The ground was cleared, levelled, and drained. A foundation of large rough stones picked off the adjacent surface, about a foot high, was formed, and the timbers and flooring of the hut laid on these stones (as shown in *Fig. 9*). By this simple means, the air was allowed to circulate freely under the hut, and all risk of damp was removed.

The sides and roof of each hut were double, and a current of air was allowed to pass upwards in the space between the outer boarding and the inner lining, in the manner already mentioned. As the result of this arrangement the temperature was the same inside the hut as it was outside in the shade.

Ridge ventilation was introduced, and the external air was admitted a little above the level of the floor by simply raising the lower edge of one of the boards a little outwards, and one of the inner boards a little inwards, to permit air to enter. *Fig. 10* shows these provisions for ventilating the interior of the hospital, and carrying off the hot air from the walls.

A covered porch was erected over the door at each end of the hut, and projecting eaves were carried over on the sunny side to afford shelter to convalescents, and additional protection from the sun's rays.

Each hut had the usual swing plate-glass windows, along either side. Dr. Smart bestowed great attention in having the construction and internal fittings of the huts completed in a proper manner.

The result of the arrangements were highly satisfactory, and, as already mentioned, these hospital huts were indicated by us as models for other huts to be erected in the camp. The materials used were all at hand, and very little more labour was required in putting up the huts in a healthy manner than was expended on those of the usual construction.

*The General Hospital at San Georgeo* afforded another good embodiment of sanitary precautions similar to those advised for the Naval Brigade Hospital, and whenever it was examined the air within was cool, fresh, and wholesome.

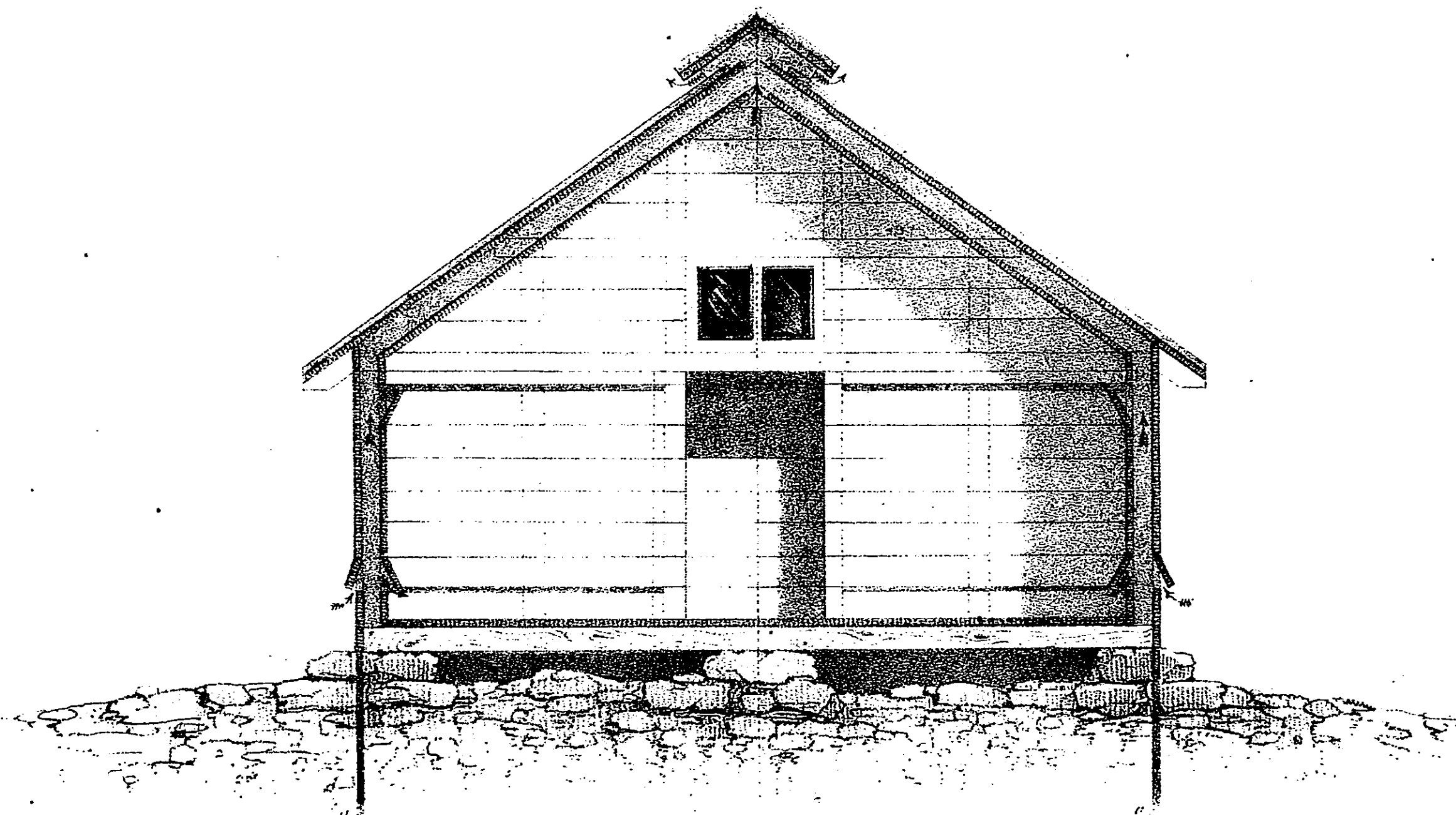


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d wholesome.

An architectural drawing of a building elevation. The structure features a rough, stone-textured base. Above this base is a horizontal band of dark, textured material. The main wall is light-colored with horizontal lines. Three rectangular windows are positioned along this wall; the central window is slightly larger and has a dark, angled interior. To the right, a dark, rectangular opening suggests a doorway. The drawing is framed by a grid of dashed lines.

Fig. 9.

Fig. 10.



*Lith. & Printed at the Topographical & Sheet Map Department, War Office, London.*

NAVAL BRIGADE HOSPITAL HUT, COSSACK BAY.

CROSS SECTION

*A. B. The Naval Brigade Huts, Cossack Bay, were constructed out of scantling and boards sent from England. The floors were isolated from the ground by pillars of rubble stone the uprights being secured in place by holding down bolts &c. The huts were double boarded, having projecting eaves. By leaving boards open there was provided bottom, side and ridge ventilation as shown. A Porch was erected at each end of the huts.*



The improvements recommended in the drainage, isolation, and ventilation of existing hospital huts, were carried out where they were required, and lime-washing, both inside and out, was diligently practised.

In connection with the subject of the Army Hospitals, we may state that soon after the arrival of the Commissioners at Balaklava, they received a request from Lord Raglan, asking them to examine the peninsula of Sinope as a site for a hospital.

The bad sanitary condition of Balaklava, and the necessity of completing the inspections, and forwarding the works there and in camp, prevented us complying with Lord Raglan's request until the end of May, but on the 30th of the month we sailed from Balaklava for Sinope. The anchorage at Sinope was carefully examined, and found to be good, and jetties for landing the sick could easily have been constructed.

There were no buildings in the town of Sinope itself which could have been rendered available for a hospital, but there were several excellent sites on the peninsula. The mass of the peninsula consists chiefly of igneous and tertiary rocks, the natural drainage is sufficient, there are no marshes, or local sources of malaria, and the sea almost surrounds the lofty table-land of which it is composed. It is, perhaps, the most healthy site along the north coast of Asia Minor; fevers were stated to be unknown, and invalids come from the neighbouring districts to recover their health. The supplies were abundant, except in the matter of vegetables. The water was good, but limited in quantity, and a sufficient amount could not be obtained for a hospital of any large size, without incurring considerable cost for engineering works.

This was the main objection to Sinope, which, in other respects, was as good a place for a large hospital as could have been desired.

The Commissioners returned to Balaklava on the 8th June, on the 10th Mr. Rawlinson was wounded at the front and sailed for England on the 21st, where, subsequently to his arrival, he continued to act as Commissioner, and to give his aid, especially in the works required for the more permanent improvements at the hospitals on the Bosphorus.

Dr. Sutherland went at the same time to Constantinople, and made an inspection of the hospitals there, returning to Balaklava on the 14th July, 1855.

#### § IX. PROGRESS OF THE SANITARY WORKS IN THE CRIMEA.

About the middle of July, the services of the two inspectors, Messrs. Freeney and Aynsley, were urgently required in Liverpool, and they gave notice of the fact to Dr. Sutherland, on his return.

An inquiry was therefore made to ascertain the extent to which the recommendations and instructions for the sanitary improvement of the town of Balaklava, contained in the communication addressed to the Commander of the forces on the 11th April, had been carried out. On the 16th July, the state of the works was as follows:—

1. The British burial-ground at the head of the harbour had been deodorized and covered with gravel and earth, under the superintendence of the inspectors.

2. All old collections of offensive matter had been deodorized and efficiently covered; and such refuse as could be most easily disposed of by burning had been so destroyed.

3. Four additional latrines had been erected—three of them by the inspectors, and they were all kept deodorized by charcoal, lime, and earth.\*

4. An efficient cleansing staff was in full operation for keeping the town clean.

5. There were two barges more or less in use for removing filth out to sea.

6. The lime-washing of houses, and levelling the sites of those pulled down, had been completed.

7. The shoal water at the upper end of the harbour had been filled up in the way recommended, on the side nearest the town, and the work was progressing.

\* It may here be stated that, for such purposes, charcoal powder was found to lose its deodorizing quality when wetted. Lime acted best when wet. Sand or dry earth, in larger quantity, were found to be very efficacious. Perhaps the best deodorizing compound was one used by the inspectors in all their works. It consisted of one part of peat charcoal, one part of quicklime, and four parts of sand or gravel.

8. Nearly the whole of the worst part of the east side of the harbour had been temporarily quayed, about two-thirds having been done under the inspectors, with materials found in the village. The margin of the harbour which had been formed with filth, dead animals, and offal, had been covered with lime, charcoal, and earth, and temporary quays carried outside of it, so as to have a depth of from three to six feet of water.

9. Covered channels, for draining surface water into the harbour, had been formed by the Royal Engineers.

10. The streets had been named by the Commandant.

The works still remaining to be done were—covering the marsh; covering the Turkish burial-ground; the completion of the slaughtering-place, begun by the late Rear-Admiral Boxer; and covering over the water-stream running down the Castle ravine.

It will be seen that a considerable extent of work had been done, and contemporaneously with it the health of the town had improved.

The results obtained by the use of deodorizing substances were certainly not satisfactory, at least so far as concerns the public health. They diminished the odour, but disease did not decrease in a corresponding ratio. The Commissioners are decidedly of opinion that these substances should never be trusted to for protecting health, if it be possible to remove nuisances at once and to a distance. Burial of putrid refuse to a sufficient depth, when removal is impossible, or when the substance cannot be destroyed by fire, is a safer expedient than merely removing its smell by charcoal, or by any other deodorizing agent scattered over its surface. Smell is indeed the natural index of danger, and removal or destruction of the offensive matter is the remedy. There is reason to fear that after the smell is removed the danger remains. The use of earth or sand in bulk mixed with charcoal and lime, as already mentioned, is unquestionably a better expedient than trusting to charcoal alone.

Another work, which had been the substance of previous communications with the Commander of the Forces, had not at this time been carried out, namely, the construction of a proper brow or jetty for the more easy shipment of sick and wounded for Scutari.



At the beginning of April 1855, the sick transports were generally moored at the lower end of the harbour, which at that period was very full of shipping. There was a jetty or wharf at the upper end of the harbour, nearly under the General Hospital, called the "Sick Wharf," to which the sick were brought from the front in ambulances. There was a small office on the wharf for the officer in charge of the embarkation, and accommodation was provided close to it for giving the sick such refreshment as they might require after the journey and before going on board.

The ambulances brought down two classes of sick, those who could sit up and those who required to be kept in a recumbent position. The former class was accommodated in an open part of the ambulance waggon. The latter were laid on stretchers inside, which were so arranged that the sick could be drawn out on the stretchers, and carried to the boats without change of position. At a later period a convenient form of mule ambulance (*cacolet*) was introduced, each mule carrying two sick, one on either side, in a sitting or recumbent posture, as was required.

The sick wharf was nearly on the same level as the side of the boat into which the sick were placed. The boat was drawn up alongside; the sick on stretchers were deposited in the middle, and those who were able to sit up, at the two ends. The ambulance generally drew up within a few yards of the water side.

During the many opportunities we had of seeing the sick placed in the boats, it was always done with great care. After the sick were taken on board, the boat was rowed out into the harbour, and down the middle between the rows of shipping for a distance of perhaps 450 yards and brought up alongside the ladder of the "sick ship." This ladder was like an ordinary steep stair, the outer side being protected by a rope rail. The sick who were able to do so either walked up the ladder by themselves or with a little assistance. Those on stretchers were lifted on board by a simple contrivance, consisting of a rope with four ends, each end having a loop. The four loops were placed in the four projecting handles of the stretcher, which was then hoisted on board by means of a pulley, and kept in a horizontal position. Arrived on

board, the stretcher was carried below by two men, and the patient transferred to a swing cot.

It appeared to the Commission that this method of shipping the sick was rather too complicated and fatiguing. It involved two changes of posture where one would have done, and the whole process might, as it appeared, be at once simplified by bringing the ambulances down to the shore under the stern of the "sick ship," and by having a brow constructed by which the sick might be carried directly on board.

After conferring with Major Mackenzie, Acting Quartermaster-General, and Dr. Anderson, principal medical officer at Balaklava, as to the practicability of the change, the Commissioners communicated with the Commander of the Forces, and advised its being carried out. His Excellency authorized the construction of the works on the 21st April, 1855, but the pressure of the siege operations prevented their being executed at the time.

It may be well to state that the average shipments of sick during the months of May, June, and July 1855, were 337 per week. In August, September, and October, the weekly average was 380. During November and December 1855, and January 1856, the weekly average fell to 164, and during the ensuing three months the weekly average was 113. During the whole period the Commissioners had every reason to be satisfied with the careful and considerate manner with which the duty of embarking the sick was performed by the officer in charge.

The proposed jetty for shipping the sick was constructed at the sick wharf towards the end of the year 1855.

In consequence of the notice of leaving the Crimea given by the inspectors, Dr. Sutherland made application to the Commander of the Forces for two competent persons to succeed them in their work, and the appointments were made forthwith. Mr. Newlands had already returned to England on the 7th June, having visited the hospitals on the Bosphorus on his way home, where he found that the system of cleansing which had been organized, was being efficiently carried out. All three inspectors left the East on the 28th July, and from the date of their departure the Sanitary

Commission ceased to exercise any direct superintendence over the sanitary works, which were henceforth carried out solely by officers appointed by the military authorities. Very considerable improvements had been already effected, and the foundation had been laid for a system of procedure, which, if fully carried out, would accomplish the objects aimed at in the instructions.

We are desirous of expressing our opinion that the ability and practical skill displayed by Mr. Newlands in directing the defective and irregular supply of labour and materials placed at his disposal were of great value to the public service, and that the three Liverpool inspectors, Messrs. Wilson, Freeney, and Aynsley, who acted under him, discharged their difficult and often dangerous duties at Balaklava and Scutari with zeal, discretion, and success.

At this date the principal sanitary measures in the camp and hospitals were in a forward state. The most important of the improvements, the isolation, drainage, and ventilation of the huts, though progressing, were not completed.

An inspection of the camp was made by Dr. Sutherland immediately after his return from Scutari. The measures for checking the diarrhoeal stage of cholera were then being carried out, more or less perfectly, in the different divisions; but there is reason to believe that although many cases of the epidemic were checked in the early stages, the inspection was not so successfully carried out, at least in so far as concerns the discovery of the disease in its earlier stages, as it has frequently been in civil practice, and in the army itself, under other circumstances.

A number of unburied carcases of animals were found in various parts of the camp, belonging chiefly to the French commissariat, but some also to the British camp. The fact was represented to the Commander of the Forces on the 18th July, and the evil was abated. On the same day another communication was addressed by Dr. Sutherland to General Simpson respecting the bad sanitary condition of certain parts of the trenches. At one point the works had to be advanced through places where interments had been made, and offensive emanations had arisen in consequence.

It was also difficult to dig graves deep enough for the burial of those who fell. From the nature of the service, it was found to be impossible to make any proper latrine arrangements, and the effluvia arising from this cause were highly dangerous to the health of the troops, and there was reason to believe that both cholera and diarrhoea had arisen in consequence.

To remedy these evils it was suggested that peat charcoal might be carried in bags to the trenches, and spread over all graves or accumulations of offensive matter. General Simpson at once agreed to adopt this precaution.

At this period there was a great deal of diarrhoea and cholera prevailing among the Land Transport and other camps in the lower levels of the valley of Balaklava, obviously connected with the malaria arising from the ground. Many buffaloes and other animals were pastured in the plain, and the ground was trodden and turned up so that even under the hot July sun the surface was wet and muddy to a considerable extent, showing the wet character of the subsoil. The camps were moved to better ground with advantage to the health of the men.

### PART III.

#### § I. CAVALRY CAMPS IN THE AUTUMN OF 1855.

In the middle of June Dr. Milroy was called on by your Lordship to join Dr. Sutherland in the Crimea. At the same time the Admiralty deemed it expedient to put the Commission in communication with the naval authorities in the Black Sea.

Dr. Milroy left England on the 1st, and arrived at Balaklava on the 22nd July, 1855. Two days afterwards a set of instructions were drawn up by the Commission, for the guidance of the inspectors who had been appointed to succeed those belonging to the Commission. These instructions were similar to those under which the works had been previously carried out, and henceforth the duties of the Commission, so