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Thesis

on

"Hygiene & Sanitation on Indian
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Of the many adverse circumstances under which one has to work during the construction of a railway there are probably none so great as those connected with hygiene & sanitation.

The Medical Officer is always stationed at a place where the largest amount of "labour" is to be collected, & he must be prepared with a small staff of native co-operators, to maintain as well as he can, with the small amount of material at his disposal, not only the health of the people surrounding him, but also of the people of that portion of the line under his care, & this may range from 120 to 250 miles. Depending on his success will depend the rapidity with which the line is completed; & this success is not to be attained merely by the laying down of drains, or the erection of latrines, but rather by dis-



comacy, or in other words "tact", without which little may be hoped for, although the systems devised be most elaborate and inviting. Humanity on these works is in itself a study: men - of all castes & creeds - from all parts of India are there, & each caste or creed, sect or tribe with its own ideas of right & wrong must be studied in turn, & then & then only may one hope to get a harmonious allegiance of the whole.

The line is being built, & although a certain number of camp or camps are important as centres during construction they may not, after the completion of the line, be of any significance, & in the majority of cases are done away with altogether -

In the first place I propose to deal more especially with the sanitation of the more important camps - in which any number from 500 to 10,000 may for a period be settled, & this period is usually from 3 to 4 years. Due to the fact that most if not all the camps

will be done away with after 3 to 4 years
 Railway Companies are justified, & I
 think rightly, in not laying out too
 much money on any work, which will
 after the time I have indicated, be
 abandoned & useless. As can now
 be understood the money allowed in
 the estimates for sanitation is never very
 much, & consequently the Medical
 Officer has - although considerably handi-
 capped - to do the best he can under
 the circumstances.

For purposes of description the people
 on construction works are best divided
 into 3 classes viz 1. Europeans & Eurasians
 2. Higher class natives 3. Labourers
 or coolies.

As the habits of Europeans & Eurasians
 are precisely the same they have been
 classed together.

Water Supply for Europeans & Eurasians

As Europeans & Eurasians are more in-
 tolerant of bad water than the natives

Special precautions have to be taken in regard to the source from which their drinking water is supplied & in consequence special arrangements have to be made for them. To obtain water from a river or tank would be for obvious reasons objectionable & dangerous, & undoubtedly the best source is from a well: this should if possible be sunk in the "Compound" of a European bungalow, or if this be not possible somewhere within sight. If the Engineers (varying from 2 to 5) & the Medical Officers bungalows be near one another (& they usually are) 2 wells will usually suffice for drinking & bath water, & a third for the "Dhobi" or washerman. The drinking-water well should be made "pucca" i.e. lined with brickwork & cement, have a high & broad parapet & the mouth of the well covered with wood or other material with an opening sufficiently large enough to admit of the entrance of a bucket, & the entrance guarded by a door, which

at sunset is locked, & the key left with one of the Europeans in the place at the time. The well is guarded until sunset by a "chowkidar" (a watchman) who has strict orders that no one is to use the well or wells except the "bhistis" (water-carriers) in the service of the various Europeans or Eurasians. If the Eurasians' parlors be at some distance they are supplied with wells of their own.

After the receiving of the water in the house it is seldom necessary to remind the European or Eurasian that all drinking water before use should be boiled, & filtered - When asked as to the best form of filter, I have been in the habit of recommending a Berkefeld, and exacting a promise that the bougies of the filter in question be boiled & thoroughly cleansed at least once a week & under the direct supervision of the European or Eurasian himself. As is well known all Europeans in India

- rather than run the risk of drinking the local water - although its purity & quality may be beyond question - drink soda-water if procurable - This is to be commended, & if, even at the expense of much trouble soda water on construction works is procurable I always advise its use, provided I am satisfied that the manufacture of the water is carried out on English principles - On one occasion whilst on "construction" an enterprising local "Babu" (a higher class native & educated) procured a soda-water machine, & after some hints from me as to the clean method of manufacture started business: he did well for a time, but eventually thinking the methods to be adopted too rigid got careless, & I compelled him to close, & after this experience I never encouraged local manufacture, but sent for all supplies to a reliable merchant in the nearest large station.

Water for cooking purposes is supplied from the private wells, and although

orders may be given that all water used in the preparation of food should previously be boiled it is very difficult to make sure that this order is always carried out - Since it is impossible at all times to directly supervise the doings of the wary cook & his assistants.

By the side of cook-houses I have always had built a small three-sided place (the fourth side being formed by one of the walls of the cook-house) with a fire place in it for the heating of large quantities of water for a bath or cooking purposes.

Of food-stuffs brought to the table the European runs no little risk from uncooked vegetables (lettuce, cress &c) not because the vegetables are in a raw state but because of the water in which they have been washed. In India at all stations & in fact everywhere where a few Europeans & Eurasians are collected together it is usual to have one large vegetable garden towards which all subscribe - Every morning a basketful, already

apparently cleansed is delivered at each bungalow - The vegetables look clean, & so the table servant usually puts them straight from the basket on to the table, & herein lies the danger - for, whether the vegetables come from a municipal, subscription or gaol garden one may feel sure that the water in which they were washed was at least dirty, if not contaminated. And with this suspicion in my mind I have always requested Europeans to insist on having all vegetables brought to their bungalows washed again - & this time in reliable water - before eating them. I call attention to this point since without doubt cases of enteric & cholera have been traced to water in which vegetables have been cleaned.

Milk Supply.

Milk should never be got from the bazaar or any native vendor, for from such it is always diluted

with water obtained from anywhere, or has been drawn from unwashed udders by dirty hands. The only safety for Europeans in regard to their milk supply lies in having their own cows, buffalo, or goats, & seeing them milked themselves or deputing some one they can implicitly trust. If any European lady be in the camp she will always gladly undertake the necessary supervision - The table servant has an order that all milk must be boiled, & that any milk put on the table when one sits down to must be actually hot.

Animal & other meat.

Seldom is it possible for Europeans on "construction" to get mutton, beef, goats, and fowls - in other words variety - At one place I was at only mutton was procurable, at another only fowls, & at another only goat - beef never.

Here again, as in the case of milk, it is not advisable to have any

dealings with the bazaar, but rather for the Europeans to combine & form a "mutton", "goat", or 'fowl' club of their own, & have the satisfaction of knowing that they are not eating what previously may have been diseased, or objectionable in other ways.

Tinned foods.

These, especially in warm countries, are best avoided, but I have never yet met a European or Eurasian on railway construction who could wholly do without them. The varieties of meat & other food are so limited that the craving for a change of 'menu' is occasionally irresistible; & provided that the tins be got from a reliable European firm in a large city little danger from their use need be apprehended.

A native firm for such foods should never be dealt with, since all their tins are usually procured at auctions. When the contents of a tin are bad

in addition to the flattening or convexity, & tympanitic note of the tops & bottoms the wrapper usually has a suspicious look: it may have changed colour, be separated from the tin in blisters, or have a speckled and mouldy appearance. Only once (& this was in connection with a baby's patent food) have I come across a "blown tin" with the opening carefully soldered: this had been obtained through the agency of a native chemist.

As regards the amount of food to be taken, the daily amount of alcohol to be consumed, & the kind & quality of clothes to be worn by a European it is seldom necessary to give advice; if given it is never taken seriously. The European looks upon these as parts of a personal equation, & acts accordingly — he educates himself, & his liver is his tutor! Sound maxims for his guidance are (1) Of meat take sparingly

- (2). Of exercise daily, but not lazily +
 (3). Of alcohol cautiously.

Residences of Europeans.

The bungalows constructed are built on the principle that they last as long as the construction work lasts + not much longer: in consequence the money allowed for each house is never much + one has to 'rough it' to a greater or less degree. However, irrespective of the kind of house to be provided there are some points to be attended to if the comfort + health of the individual are to be maintained, + of these points it is well to take into consideration (1). The nature of the climate (2). The rainy season or "monsoon" + (3) The nature of the ground + its surroundings

1. The nature of the climate.

Speaking unscientifically Europeans speak of a place as having either a 'moist' or a 'dry heat' - these terms explain themselves, + are only referable

to the time before the beginning of and after the cessation of the rainy season (July to September) during which, of course, a place with a 'dry heat' loses that appellation for the time being & becomes 'moist'. According as a place is moist or dry one decides the direction in which a bungalow should "face" - In 'dry' places where the temperature from March to June usually ranges from 100°F to 125° in the shade, one, for reasons to be presently sketched is glad to take advantage of the prevailing westerly winds: these, almost without exception blow daily, are strong, & intensely hot, & if passed through "kus-kus" (a species of deep underground grassy root) kept constantly moist with water, cool air enters the bungalow & the temperature thereby reduced to 80° or even lower. Inasmuch then, as every alleviation of discomfort to Europeans in the tropics aids in the maintenance of their health it is an advantage

To have the rooms which are used during the day facing west, & the comfort of the individual & his family are assured for the most trying & unbearable months of the year. In stations with a dry heat I have known houses built north & south, & have always felt a keen sympathy for the occupants, who unable to minimise the heat appreciably get irritable & neurotic & are glad at the first opportunity to change their house for one facing east & west.

Secondly, that side of the house which is exposed to the sun all day, or to the afternoon sun should always be protected by a verandah; otherwise, the room which has the exposed wall as one of its limits becomes intolerably hot - I have off "construction" known such a room, & unless necessity compelled never used it. Where a moist heat exists no particular stress need be laid on the facing of a bungalow, for beyond

"punkabs" no other means for the reduction of heat are possible.

(21. The rainy season or "monsoon" -

Almost throughout India there is what is called the 'rainy season', or more briefly the "rains" - when, extending through a period of 3 months, more or less (July to September) tremendous downpours of rain occur at varying intervals - To counteract as much as is possible the effect of these rains I have always requested Engineers on construction works to allow high plinths to the bungalows, & press thatching on the roofs at least a foot deep. If these 2 conditions be not complied with the house becomes Exceedingly damp from above & below, to the detriment of the health of the occupants. I know nothing so annoying as a leaky roof, since in addition to the discomfort by day one is often up at night endeavouring to find a dry spot for one's bed.

3. The nature of the ground and its surroundings. The site for the European's bungalows should be as far away as possible

from the proposed site for the bazaar, the cookie lines, & any pre-existing native village, & this for obvious reasons needs no explanation. If the ground be hilly as high a point as presents itself shall be chosen: this allows of good drainage & thereby not only obviates dampness, but prevents any accumulations of water in which mosquitos may breed.

The servants quarters should be well away from the bungalow, & if possible at a lower level, & any swampy or marshy ground near filled in.

The type of bungalow usually allowed a European is well shewn in figure 4: by a glance at this a knowledge of the number of rooms allowed, their sizes & distribution, arrangement of verandahs, doors & windows, drains &c will be more easily gained than if I were to go into a detailed description of each point. The walls are usually of brick, & the roofs of jungle grass supported on a bamboo framework & covered with open channel tiles.

Drainage round Europeans bungalows.

In connection with temporary houses only small drains for the removal of bath-room (hot water only) & pantry water are provided. To build, in addition, drains large enough to cope with monsoon water would be considered too expensive and superfluous. The small drains referred to are usually constructed of well burnt bricks laid lengthwise & at various angles & cemented & it can always be arranged for all bath-room & pantry water to discharge into a common drain, which in its turn is led away, or empties itself into a large "stop bowl" such as is depicted in figures 15 & 16. The contents of the bowl are removed morning & evening by "sweepers" & discharged on a piece of ground previously selected. Sometimes, owing to the inclination of the ground & proximity of jungle, one may lead the water away into the jungle, & there let it loose itself.

The disposal of Excreta (Europeans).

Outside the larger cities Europeans use "Commodore" - a compound name signifying a china or tin pan enclosed in a partitioned wooden box, & provided with a lid: this is always placed in the bathroom & after use the pan is removed by a "sweeper" & the contents emptied into a large iron receptacle with a closely fitting lid. The receptacle should always be at least 70 yards away from the bungalow, hidden from view by corrugated tin or other form of screen, & have placed by its side a large "gumlat" (Earthenware vessel) containing some disinfectant powder. If a receptacle be not provided the sweeper will deposit the contents of the pan anywhere, but for choice usually behind the stables or servants quarters. The contents receptacles with their contents are early next morning removed in a sanitary cart to the trenching grounds. After transferring the contents of the Commodore pan

into the receptacle outside, the pan is washed out & this is necessarily followed by a good deal of offensive splashing; & it is with the object of remedying the disagreeableness of this that a "Gumlati" of disinfecting powder is kept near at hand - By the side of the powder is another vessel containing water for the purpose already indicated.

Accommodation for Natives.

Natives on construction works are conveniently divided into 2 classes (1) the higher class native (2) the labourer or cooly. Amongst the higher class natives are clerks, bridge or tunnel supervisors, accountants, storekeepers, sanitary inspectors &c - & the majority of these are Bengali Babus - educated, Hindoos by caste, & speaking English - And it is accommodation for these that I shall write first.

Be the higher class native Mohammedan or Hindoo he is, more for his own

fratification than anything else, almost invariably accompanied by his wife & family, & in consequence when accommodation is being provided special latrine arrangements have to be made - since their women folk being "purdah nashins" i.e. ladies of the zenana, are not allowed outside their doors.

The accommodation provided consists of one or 2 living rooms (according to the official position of the man) - a verandah, & a court-yard - In one corner of the court-yard is placed a small cook-house, & in another the latrine (see figs 5 & 6).

The walls of the houses are usually built of burnt bricks with a plastering of mud on either side, this in its turn is covered with "chunam" or white-wash. I have at times known all the walls to be made of unburnt brick, & at others some walls of burnt brick & the remainder of unburnt - "Estimates" will not always allow of all the walls being solid, but

I am convinced the whole thing is false economy, for times out of number I have seen unburnt brick walls fall to pieces in the face of heavy rain during the monsoon & the condition of the Babu's residence in consequence becomes unhygienic. The court-yard should always be paved with one or 2 layers of bricks cemented over, & sloped towards the entrance door - for such a place to remain unpaved means, that during the monsoon it becomes a regular miniature fountain & holds in solution any filth that had previously accumulated. It is almost unnecessary to state that the plinth of the living room should be higher than that of the court-yard & that of the court-yard higher than the ground outside. To have a cook-house & a latrine in the same court-yard does not sound correct, but taking into consideration the scanty accommodation

allowed I can suggest no alternative distribution of these 2 places. As a matter of fact I am led to believe that most of the cooking is done in the verandah, & the cook-house used only for minor purposes such as the paring & peeling of vegetables.

And, although the cook-house and latrine are near one another one must not lose sight of the fact that they are both in a well ventilated court-yard, & that the latter is not adjacent to any living room.

For the sake of extra privacy desired by Babur I always select a site some distance away from a public road, & then not much importance need be paid as to the relative positions of the living room and court-yard - But, should proximity to a public road be unavoidable, it would then be well to face the living room towards the road, & provide an additional verandah in front. The court-yard being *pucca* & sloped

all water falling into & on it runs into a grooved channel, which passing under the door discharges itself into a drain.

Disposal of Excreta of higher class natives.

As no scavenger or sweeper may enter a court-yard or house in which a 'purdah nashin' woman lives, the builder of a Babus quarters always arranges to leave an interval low down in the outer wall of the court-yard, & corresponding to the future position of the latrine; & it is through this opening that the pail is pulled out - The opening is provided with a flap door which can be raised or let down; or better still with a sliding covering of wood or metal - preferably the latter. At both ends of the Babus quarters, or at such places as one considers suitable are large iron receptacles (screened from view) into which the contents of all pails

from the latrines are emptied -

As all Babus & "theirs" in common with all natives prefer to "squat" & defecate directly on to the surface of the ground, one can understand how very objectionable this would be, if allowed, in a private latrine - in consequence, a raised seat about 2 feet high is built in with bricks or other material with the necessary opening above; & below an interval large enough for the reception of a pail is provided. Even then the native will not sit over the opening but "squats" i.e. plants the soles of his feet one on either side of the opening - This being so, the urine is liable to be shot anywhere but into the pail, & the disposal of this is then to be considered.

To meet the urine as it was shot forward & to "gutter" it back into the pail I once had devised a few pails with sloping tongue-like projections in front - The projection of each pail came forward through the opening: its breadth was six

inches, & at its highest point it was
 15" from the seat - To prevent the urine
 escaping over its sides the lateral
 edges were incurved. The Experiments
 proved a failure, for some of the urine
 escaped over the top, & a little lateral
 splashing also occurred - moreover,
 complaints were raised that the con-
 tribuance was distasteful to the
 women-folk, in addition to being an
 impediment to getting on to the seat
 The children didn't understand it
 & as often as not defecated down
 the "tongue" & urinated against the
 outer wall of the latrine! The Babes
 own objections were that if they
 urinated forcibly they themselves got
 splashed! They got no sympathy
 for they were expected to use the
 modified Horbury's latrines outside
 their quarters, & not their private ones.
 But knowing that most (I won't say
 all) preferred their private latrines
 I experimented with a new shaped
 pail as described above -

Well, as some of the urine occasionally shoots beyond the seat into the interval between it & the anterior wall of the latrine the only thing to be done is to have a communication between this interval & the space which holds the pail & this can always be arranged for during the construction of the seat. The channels of communication must be large, for then the pail space & the interval beyond are the more easily flushed out by water forcibly thrown in by the sweeper from behind.

If procurable - but this is not always an easy matter on 'Construction' I always arrange to have 2 or 3 low caste women on my sweeper's staff: they have a free entrée into the private latrines & can be conveniently employed in washing up the interior of the latrine, applying disinfectants & brushing up & flushing the courtyard.

The drainage system in connection with the quarters of the higher class natives is

simple in the extreme.

One drain (brickwork & cement) to receive any water from the court-yards & latrines is sufficient: this may be led into a "stop-bust" or to a distance to discharge onto a miniature filter bed of broken stone, gravel & sand.

As the higher class natives derive their water supply from the same sources as the coolies, the remarks made later regarding water supplies for coolies will be applicable also to the better class men.

Accommodation for Coolies.

As soon as any new construction work is sanctioned the first thing essential is to begin planning out & making arrangements for the housing of the labourers or Coolies, & a rough estimate of the number expected at each place along the line may be gauged from lists supplied by the Engineers, or by European & native Contractors.

Having got an idea of the number expected the following principles in regard to the houses, or "lines" as they are usually called, should be adhered to. (1). They should be - if area of ground taken up permit - at least $\frac{1}{2}$ mile away from the European settlement. (2). Some attention paid to "caste" i.e. Hindoos + Mohammedans kept separate - Quite 90% are usually Hindoos. (3). They should be at a safe distance away from any pre-existing bazaar or village (4). Should, if practicable, not be too near a river, or pre-existing bank or banks.

I have stated that the Hindoos and Mohammedans should be kept separate - & although differences of caste have no direct bearing on the subject of this thesis, yet indirectly they have - since, if this matter be neglected the hospital has sometimes to take in cases resulting from "differences of opinion" between the 2 people.

The fact of having the "lines" away from bazaars & villages will not prevent

the men going to such places, but it at least prevents them sleeping in them, & thus overcrowding a place which already probably harbours more people than it can comfortably hold: & this precaution against overcrowding is, as is well known, a great factor in preventing the starting of - & if it has already broken out - the propagation of plague.

And lastly to put a horde of coolies near a river means, with all their abominable practices, contamination of the water in a very short time. A coolie will, if allowed, go to the water's edge, or to any collection of water, which on subsidence of the river has been left, for nearly all his purposes, & of these may be enumerated (1) bathing (2) washing his pots & pans & (3) anal abluition after defecation - To tell any one that coolies never go to the river - even when rules against it are in force - would be as absurd as to say that Vesuvius was never in eruption; but to allow

a native full scope in his inclinations is one thing, & to minimize a practice or danger, by doing the best one can, another.

It sometimes happens that proximity to a river is, in the interests of the work in hand, unavoidable (see figs 1 & 2) - But here the men were working at the erection of a bridge, which when completed measured short of a few yards - 2 miles - As the work progressed some of the men would be working at the other end of the bridge, & this in itself would entail on some a walk of 4 miles a day - a considerable tramp, especially as it had to be done thro' thick heavy sand, & at certain seasons of the year in a blazing sun.

Although the major part of the bed of a large river may - for the greater part of the year - be dry, there is always a little running water in the scoured out portions of the bed, & here & there 'stick' collections.

In dealing with a large number of workers such as were employed on the bridge shown in figure 1 (the largest in India & 2nd largest in the world) one had to face the fact that some, if not most, of the coolies when desirous of attending to the calls of Nature would, rather than walk through a considerable portion - greater or less according to the spot at which they were working - of the bed of the river & then into the country on a latrine, relieve themselves at a comparatively near spot. This they did do, & would do, & to have prevented them, would have necessitated a small army of Inspectors Well, knowing the native, anticipating his methods, & recognising the futility of thwarting him. I determined to prevent to as great an extent as I could, pollution of the river bed itself, & I proceeded as follows :- but here I have wandered from the subject of "accommodation" so will defer the sanitation of the river bed till I speak of Conservancy.

Having decided on the site for the houses the next matter is their construction & arrangement. (vide figs 7 & 8).

The houses are usually built in parallel rows or lines with an interval between them varying from 15-30 feet. I have often seen the lines built back to back but for reasons to be presently stated never liked this method. I always advised that the front of one row should face the back of the next, & so on. When put back to back there is a tendency for the backs of each line to be almost touching, & the interval between them is never very great - usually 4 feet, & herein lies the objection. The interval being narrow & more or less private, i.e. never used as a thoroughfare, is a place 'par Excellence' for all children (and sometimes even men) who wish to 're-trieve' themselves, & the smell in a short time becomes abominable. But, if the front of one row faces the back of the next this nuisance is avoided, for

Some natives are always to be found sitting at their doors or moving about & in consequence no privacy is ensured. Between each row I like to see a road (if it may be called such) of a least 20-30 feet.

All the houses are of mud & wattle i.e. timber supports with a bamboo framework interlaced with a peculiar, dry, absorbent & long grass, & over all a thick covering of mud: the roofs are of a bamboo framework with a thatching of grass about 2" thick laid on: tiles are not provided. The plinth is about 6" high & made of mud well beaten down & subsequently "lepoed" i.e. sprinkled with "cow-dung water" which has the power (according to natives) of solidifying the mud by its astringent action, & so increasing its lasting power. If the floor be not "lepoed" for the coolie, he will invariably do it for himself.

I always wish on one window for each hut, & this should be high up in

the wall so as to be protected by the eaves during rain - at its best it is crude, & is merely a portion of one wall where the bamboo framework remains uncovered with grass & mud.

Coolies, & even other natives who ought to know better have an abhorrence of ventilation, & at the first opportunity, fill up with all sorts of materials, the window or windows provided for them: they state that during the cold weather it makes their huts too cold & in the hot weather too hot - However, to have them is important - for, in the event of an outbreak of plague the window is there, & the necessity for breaking down a bit of wall is avoided. When on "open line" I was on one occasion asked to inspect & report on a large bazaar in which plague had broken out, & in not one of the living rooms attached to the shops was there a window, & in fact no means of ventilation beyond the small door through which one entered, & this in

the majority of cases had a thick heavy cloth - acting as a curtain - hanging down it!

No fire-places & chimneys are ever provided: the cooly prefers to make his own arrangements for cooking his food. The smoke finds its Exit through the door or window, but if not the man has no objection to its presence, since, in addition to keeping away mosquitos & other insects he maintains that "it is healthy".

Drainage round coolies lines.

The only drains required here are one on either side of the so called road, which slopes from its centre gradually incline towards the drains in question (vide fig 8) - These drains carry away dirty water from the washings of pots & pans &c into what I have in the sketch termed a "slop bowl", the contents of which are twice a day ladled out & carried away by "sweepers". If

the nature of the ground permit, & there be a sufficiency of it there is no reason why each drain should not be continued on & discharged into a filter bed - a pit about 10 feet square, & filled in with chipped stone, gravel & sand.

Water supply for all natives.

Although a river may be in near proximity to a camp I have always advocated the sinking of wells - Since water obtained from these is, under proper supervision, always safer than that from rivers.

River water in India is, almost without exception, (except during a late period in the S.W. monsoon) contaminated & one is hardly surprised when it is known that uncontrolled villages & small towns up stream use the rivers freely for all manner of conceivable & abominable purposes.

On arrival at a new camping ground one often finds old wells & tanks: to

fill up the former is an easy matter, but in regard to the latter, especially if they are large, the undertaking - by reason of the Expense involved - is prohibitive: in consequence, means have to be taken to prevent, if possible, their use altogether.

As to the choice of type of well one must be content with the ordinary shallow well, & according to the money available or for the purpose required, certain of these are made pucca (lined with brickwork &c) or kucha (crude and unlined).

Shallow wells do very well, for if one or 2 fail others can, in a very short time be sunk, & at a low cost; & provided their proper supervision be attended to they serve their purpose admirably. Having decided on the number of wells, the very important question of their safeguarding is next to be considered; & if this be thoroughly done half the battle in connection with the maintenance of the health

of the people is solved.

The Indian labourer or cooly as ordinarily met with on railway construction work possesses not even the most elementary ideas on hygiene & sanitation, & in consequence a good deal of argument & coaxing is required to shake the conservatism he & his ancestors have followed for centuries!

If the wells be not supervised what happens? 1. Their immediate vicinity becomes the bathing place of all who care to come. 2. All dirty clothes - & dirty they emphatically always are - are washed at the mouth of the well. 3. Each native dips his own lotah (vessel) into the well - without thought as to what was in the lotah at the time of its immersion, without thought as to what the lotah had previously been used for, & without thought as to where he picked it up from. 4. He will, because of the proximity of the water often defecate near it in case he requires

a second vessel full for purposes of anal ablution -

The first thing to be considered now is the protection of each well from surface & other pollutions, & having done this its further protection from Contamination by the wily cooly.

As many wells as possible should

1. Be lined with brickwork & cement or hydraulic mortar
2. Have a parapet well raised & extended outwards for 3-4 feet & sloping away from the mouth of the well.
3. Have a wooden frame or covering with a sufficient opening in it to admit of a bucket, & the opening provided with a trap door which is closed at night (see fig 10)
4. Have a "chowkidar" or "chowkidars" to carry out the orders of the Medical Officer.

The wells having been constructed as described above the first imperative duty of every Medical Officer is to appoint for each a "watchman" - who for preference should be a Hindoo - This

man is provided with a galvanized iron bucket - of capacity about 3 gallons - & a stout rope of the required length, & is given the following orders 1. That nothing but the bucket supplied is to enter the well, & that the water be poured from this bucket into the various vessels brought by the coolies. 2. That no clothes are to be washed within at least 200 yards of the well. 3. That no bathing be allowed within the same distance. 4. That no "gossippers" be allowed to congregate near (a common meeting place for the gossiping women of an Indian village is round the mouth of a well!) 5. That the 'door' of the well is at 9 p.m. to be locked & the key left at the Medical Officer's bungalow till next morning.

The parapet may have one or more series of steps & immediately below where the watchman stands, a ledge should be constructed (see fig 10) on which the vessels stand preparatory to getting their supply of water: this

arrangement prevents the re-entry of any water into the well, & thereby lessens the risk of fouling.

If the well be 'kucha', which implies that it will not be locked at night it will be necessary to appoint 2 Charkidars who for a set number of hours alternately watch the well day and night - (Charkidars are plentiful, & as the wage is only 5 shillings per month per man, there is no excuse for not employing them). Though the well be 'kucha' I always contrive for some arrangement round its mouth against surface pollution.

To state definitely off hand the number of wells required for a given camp would be absurd, for many factors have to be considered before an opinion can be given, & amongst these may be enumerated 1. The season of the year 2. The depth of the subsoil water 3. Nature of the soil 4. The probable population 5. The number of tanks in the vicinity 6. The proximity & size of rivers 7. Elevation &c &c

Generally speaking all Railway construction work in India begins in October, for at this time not only is the weather becoming cool, but more important still the "rains" (with their concomitant flooding of the country) are just over, & will not re-occur for 9 months. From October till about March the ground water is usually within striking distance, & one may as a preliminary measure, & in a very short time sink 2 or more wells for the people to go on with - and this enables one to proceed more leisurely in regard to sites &c for better types of well, calculations on the lasting power, & the number of wells which will in view of the probable population expected be eventually required.

As to the "power" of a well - by this, I mean its capability of supplying water through & to the end of the hot weather - much information may at times be obtained from Europeans who have been

on survey work in that particular district at a previous date, or from villagers. I found learn that the wells will fail - say in May & June - other arrangements will then have to be made.

At one of our camps - 4 miles from my headquarters - at an elevation of 1000 feet the water in the wells was said never to last (& this was confirmed) - so a small artificial lake was constructed in the course of a small river, & this satisfied all wants till the break of the monsoon. The lake, it might be thought, would be an ideal place for the breeding of mosquitos: no, it was not - the place was too exposed & "gusty".

As regards the distribution of wells there is one important fact to be borne in mind & that is, to have the well or wells - compatible with safety - as near the men as possible: if not, they will, from their inherent indifference & laziness go to the nearest collection of water - irrespective of its condition - for their supply.

One is aware of the conditions to be followed

in selecting sites for wells that these not be to any further extent touched upon. If one be doubtful regarding the "circle of influence", the doubt should stimulate one to extra care.

The wells being in working order extra precautions may from time to time be taken of chemicals used for purification. I have always been satisfied with the Permanganate of Potash: of this I threw in, as necessity arose, about 3 ounces per well - Owing to the constant presence of frogs in all wells & tanks, too much permanganate must not be thrown in at one time, otherwise the frogs are killed, & are, in a short time seen floating on the surface. The chemical was always thrown in between 9 & 10 p.m. & early next morning examined; if any "pinkish" continued this was expelled by the addition of a little alum. If the discoloration caused by the permanganate be not removed, the cooly at once concludes the water has been poisoned.

& may not use that particular well again for days or weeks! Once in six months each well should be dredged, & this may safely be left in the hands of the Engineering department.

Tanks.

Of these there are thousands scattered throughout India, some very old, others recent (famine relief works) - & wherever one goes one usually comes on a tank, or an excuse for such. The native loves a tank, inasmuch as it has associations & attractions for him which nothing can break. For has he not in his earlier days played for hours round one, drunk of it, fished in it, & fouled it in every conceivable way? The guarding of a tank then is essential, for do what one will the native is intent on going to it.

Well, to begin with all tanks should be fenced in & have their banks raised & the surface of the bank looking towards the water should be made as steep as possible, so that in the darkness

at least the native will be afraid to go down it - To defer the use of the tank for as long as possible, or altogether it is always sound practice to sink a well by its side - to build it up, parapet it &c (vide fig 10) as already described, & put a man in charge. If the tank be water-tight or almost so - either artificial or as result of natural agencies - it becomes a simple matter (& is cheap) to siphon off the water from the tank into the well (see figs 9 & 10): - the Engineering department can always supply metal piping of some kind, & as long as this is water tight it will do. To prevent interference with the piping it should be covered in.

I have heard & read of wells being sunk by the side of tanks, & of the water from the well or tank being lifted by means of a pump to a covered metal tank on pillars, & the last supplied with a discharging pipe & tap. All this would do, but for simplicity and

cheapness is not to be compared with the siphon method just described -

Before the leaving the question of water I may here remark that I have always been in the habit of allowing the Europeans "Dhobies" or washermen, a well to themselves for the cleansing of the 'Sahibs' clothes. Two men always suffice to do all the "washing" & the arrangements I make for them are well shown in figures 11 & 12 - What I have termed a "water chute" (built into the ground with bricks & cement) runs from the well into a small masonry tank in which the men stand (surrounded to any point between their ankles & knees in water) & beat the clothes on the "beating stone" in front of them. The clothes of Europeans & Eurasians only are allowed to be washed at this "Dhobi's Ghat". The men are "private" & are not allowed to take in "washing" from any native, be he rich or poor. The 'ironing' and 'starching' are done in a special room

provided for the purpose.

Disposal of Excreta (Cooties).

It sometimes happens that no sooner has the site of a camp been chosen than an influx of "labours" takes place - it then becomes necessary to improvise temporary arrangements to minimize fouling of the site & its surroundings. And as a preliminary measure, and before the erection of the permanent latrines to be described in course, trenches may here & there be dug. The length of these varies - 20 feet is a convenient length - width 2-3 feet & depth 3 feet. The man "squats" across this facing the length of the trench. The earth thrown up in preparation is seldom sufficient to act as a screen all round, so other means for privacy have to be adopted, & this may readily be done by means of bamboo, grass & leaves. The trench should be divided off into partitions, & in each partition

there should be a plentiful supply of Earth, & disinfecting powder (usually Chloride of lime). To expect every native to cover up his Excreta would be expecting too much, so a scavenger is told off to do this, & with orders that disinfecting powder is, occasionally, to be sprinkled on the deposits - When the trench is nearly full i.e. a foot from the surface a good thick layer of powder is laid on, the trench filled in with Earth & abandoned.

Whilst these trenches are in use time is given over for the erection of permanent latrines; & of the type always preferred by me was a modified "Horbury" (vide figs 13 & 14). These were of corrugated tin, arrived in pieces, & were easily put together. The number of partitions - according to requirements - varied, Each had a raised seat, & under the seat was a pail, which when partially full was extracted through a door at the back & lower part of each partition. Each latrine

with partitions from 6-12 - was placed on
 on a solid brick or masonry platform
 by each of which was always to be
 found a vessel or barrel of disinfect-
 ing powder, a large quantity of water,
 & a covered-in receptacle for the
 contents of the pails. As mentioned
 before the native squats on the seat
 with the result that some of his
 urine is shot forward: to meet this
 objection I always arrange that
 the platform be built with an in-
 clination towards its drain at the
 back (figs 13 & 14). This drain may
 if conditions permit be led away
 into jungle, or other unused ground
 or be made to discharge into a
 'stop bowl', the contents of which are
 transferred into the large receptacle.
 It is never advisable in view of the
 present or probable population of the
 people engaged, or to be engaged on
 the works to form a rapid estimate
 of the number of latrines required - since
 the number of natives using them will vary

very much in different places - The number using them or other contrivances will vary according to 1. The part of India they have been imported from 2. Their habit of all methods, European 3. Sex. 4. Caste. 5. Their previous railway work & amount of European supervision

The same applies to the provision of sanitary carts & sanitary staff. Rather, I would say, proceed cautiously, & appoint staff, & order latrines & carts &c as necessity demands.

Those who refuse to use latrines have no alternative, but to go into the surrounding country; & provided they be made to go outside a certain area marked off by flag posts, I see no great objection to the system.

There is almost invariably an enormous track of country near, & as this precludes the collection of any large amount of excreta in a small and limited area no offensiveness is produced. If, as sometimes happens the camp is situated in an area sur-



rounded on all sides by dense and dangerous jungle (see fig 3) the system of flags referred to above does not answer so well, for, as there is never much clear ground beyond the camp the flags have to be nearer habitations than one wishes. There is never any trouble during the day, for all will go into the jungle, but it's quite a different matter after sunset, since the dangers of entering the forest are more real than imaginary. It might be argued, that even in the absence of jungle, the people would, once it became dark, not go beyond the flags - but here, in the absence of danger there was no excuse, & if at any time I noticed that the people had been committing a nuisance within the area I insisted on my sanitary inspectors doing a round after sunset, & reporting all offenders - Even when unable to go into the jungle

in the Evening the offensiveness created is never very great, for the majority 'relieve' themselves once & once only in the morning - those doing so a 2nd time usually while it is still light, or they go into a latrine. Many natives have told me that they always use the latrines in the evening or at night, since they had no desire to foul their own nests - so to speak - within the flags, & certainly had no desire to go into the jungle!

A very favourite place for a Cooly to go to is a brick-kiln. Here he usually finds ample room between the stacks of bricks, & is protected from the wind: in this case, it is usually the brick Contractors coolies who are at fault, & if the nuisance persists I hold the Contractor responsible for any further trouble, or put my men on to clear up & debit him with the cost.

And now to revert to the sanitation of a large river bed - a subject of

left abruptly on page 31.

Down stream + 200 yards away from the fringe of workers a series of flags were laid out, inside which no nuisance of any description was allowed - immediately beyond these a number of 6-partitioned Horbury's latrines were distributed here and there. The sand underlying the future site of a latrine was primarily well rammed down; + next, a platform of brick, or rubble and cement, 18" high, + of larger dimension than the latrine, was erected. On each platform + outside + behind the latrine stood a receptacle with handles - * of about 8 gallons capacity, + a saucer-shaped vessel containing disinfecting powder held in position by a depression in the platform. Immediately below the platform stood an enormous Earthenware vessel filled with water, + covered in, + held stationary by a bed prepared for it in the sand. Ablution waters + urine were led into

a small drain "let into" the platform, & discharged into a "gumlati" immediately below it - The contents of the pails & "gumlati" were periodically emptied into the "receptacle" which when nearly full had its lid tightly adjusted, & carried away, to be emptied into a larger receptacle on shore, which in its turn was dealt with by a sanitary cart. As it was impossible to get carts into the river, each receptacle was slung on a bamboo pole & carried away by 2 men. With the object of having the river work done efficiently I engaged "sweepers" who did no other work whatsoever. With a little personal supervision I found the system worked satisfactorily. At the onset of the South-West monsoon each latrine was dismantled & if necessity arose again used on shore. During the "rains" all bridge work is suspended.

Sanitary carts.

Of these there are many varieties & shapes: some are

simple, others compound - whatever the arrangement I have not yet seen - even in the largest stations of India - a "cart" perfect in every detail.

On construction works the roads are not so one meets with in a well laid out station, or defined district, where the District Engineer has little else to do than attend to their condition: they are instead usually laid out in a hurry & are unpaved, with the result that in a few months they become "rutty", & in the rainy season almost impassable - Under these conditions the lighter the cart the better, & nothing answers better than one made almost entirely of bamboo - These carts are light & strong & will stand any amount of knocking about, & there are few places they can't go. They can often be hired from the brick or timber contractors, or if not can easily be made up in the Carpenter's section of the local work shops. When ordering to measure the platform of the cart

was made oblong $5\frac{1}{2}$ feet long + 4 feet broad. To prevent some of the contents of the receptacles, - when splashing occurred - passing between the layers of bamboo constituting the platform + sides of the cart - + so on to the road I always arranged for the provision of a light tin box (without the lid) which fitted the interior of the cart accurately. The side of the box which allowed of the admission of the receptacles worked on a hinge + could be raised or lowered at will - The 'box' was held in position by thin rope passing through the tin + encircling any convenient rib of bamboo.

As Each cart came round it deposited a clean receptacle for each fouled one removed; + when it had its full complement returned to the trenching ground, + handed over the consignment to the men on the spot, who after emptying the receptacles into the trenches, washed

them, put in some M^e Donnell's powder (lime & carbolic), put on the lid and left them till next morning when they were picked up by the cart-men. Each cart was drawn by 2 bullocks. Although it would have been preferable for all concerned to have had all the carting done late in the evening, yet I found this unpracticable; - since 1. The supervision of the cart-men at that time could not be satisfactorily attended to 2. The men hurried over their work because it was late. & 3. Did the work carelessly, blaming the darkness - a very common Excuse was, that the oil in their lanterns had given out, & in consequence could not see what they were doing.

One may be given the services of an Eurasian Sanitary inspector, whose chief business is to attend daily to the substitution of receptacles, to visit the trenching ground & see that the drains round all quarters are regularly flushed. A water-carrier

is specially engaged to attend to all water supplies for latrines, and trenching ground.

It may arise that the country is so undulating & "nullified" (i.e. nullaks - portions of ground scoured out by heavy rain) - & this was the case at the camp shown in figure 3 - that the employment of carts is impossible. Then, & I know of no alternative method - the receptacles must be carried by hand to such place selected as a trenching ground, or remote jungle, & the men are pointed out certain paths along which they must travel.

Trenching ground.

If possible a piece of ground of about 4 acres in extent, & at least $\frac{1}{2}$ mile away from railway limits should be tented & laid out as will be subsequently described (vide fig 2) - Satisfied that the ground is suitable, & well away

from any supply of water, & will not in its relation to the wind prove offensive to any community, orders are given for the formation of trenches, and these are dug a few at a time (especially in the rainy season) according to requirements. The trenches are dug in parallel rows with an interval of 2 feet between each row. The measurements I give are 6' long, 3' deep, & 3' wide. As soon as the entire length of the trench is filled to within a foot of the surface the whole is covered in with earth, & continued till a grave-like appearance is produced - Barrels of disinfectant powder are always to be seen on the ground. During "the rains" each trench as it is dug is protected by a sheet of corrugated tin.

Bazaars.

If by chance there be a bazaar near, the necessity of a railway bazaar does not arise. But, it may be said that to attract railway employees

to a bazaar under control, would surely be better than allowing them to go to one uncontrolled, & perhaps the centre of endemic disease. True, but no power on Earth, will even in the presence of a Ry. bazaar prevent them going from one to the other. The absence of a railway bazaar is an advantage than otherwise, inasmuch as 1. There are fewer people to make arrangements for 2. There is no attraction for villagers & bazaarites, & in consequence the lesser likelihood of the outbreak of disease.

If a bazaar be a necessity (vide fig 3) the one great essential in its construction is allowance for the free permeation of air everywhere. Tales of Indian bazaars - with their narrow streets, high houses, overcrowding, unmanageable insanitary conditions, want of light & air &c - most are familiar with. To counteract these then, in the planning of a railway bazaar, one has every opportunity.

Once a week there is always a big market day, when in addition to the permanent

residents of the bazaar arrangements
 have to be made for the sitting & standing
 accommodation of scores or hundreds,
 who swarm in from the surrounding
 country - some to buy, others to sell -
 And with this object in view the bazaar
 is best built in 4 rows enclosing a
 square (vide fig 3): this square confines
 the people to the bazaar & prevents them
 roaming here & there outside it. To allow
 of the free ventilation of this square, it
 itself should be totally uncovered; the
 houses should at their highest points
 be never more than 12 feet high, & in
 the rows bounding the square there should
 be interruptions to allow of a free draught.
 The houses built provide a front room
 used as a shop & a back one cor-
 responding to a private bed & sitting
 room: to the back of this again is a
 fenced in courtyard, a mere excuse for
 one & nothing more. The shops & rooms
 made either of unburnt bricks, or mud
 & wattle with a thatched roof are let out
 to vendors, who under sanction may make

any additions or improvements they desire, & this they generally do. A "head man of the bazaar" corresponding to a policeman at home - strong & reliable - is appointed to supervise the bazaar generally: he hears all complaints, makes notes of any insanitary condition or sickness in any house, & reports daily to the Medical Officer. For the prevention of looting & committal of nuisance at night another policeman - or more - is always on duty. People coming in to "bazaar day" often bring their merchandise or food-stuffs on pack animals, & arrangements for the temporary segregation of these is delicious: a cattle pen may be erected, or better still a series of tethering-posts - away from a well or river - erected. The "deposits" left by these animals are carried away either by the people to whom the animals belong, or by the residents in the bazaar - left they seldom are, for cattle dung is held in high esteem by all, who after drying it in cakes use it as fuel. On the departure of the

animals disinfectant powder is copiously laid on round the tethering posts.

In regard to the water supply of a bazaar the well or wells should be conveniently near, never in the bazaar; & the same precautions enumerated in speaking of wells generally taken.

In figure 3 the ground inclined from the bazaar to the river, & as a consequence the 2 wells were sunk at a higher level than the bazaar itself.

I have not yet touched on the subject of "refuse pits": these are simply large pits dug in the ground - usually circular of diameter 6-10 feet & 4 feet deep. Into them is thrown - by the householders themselves - ashes, vegetable parings, fruit skins, broken bottles, & such like.

Segregation camps.

On "construction" the only 3 diseases which cause the Medical Officer much anxiety are (1) Plague, Cholera, & Small-pox. And to avert a panic amongst the "labour" he

must as regards segregation, & other means proceed with the utmost tact & discretion - otherwise, the losses to the Railway Company, & contractors may be - from despoison of the said labour - enormous!

Plague.

It is now common knowledge that the Government of India after adopting every conceivable plan for the arrest & propagation of plague, met with so little sympathy from the people - in fact, usually strenuous opposition - that they gave up the matter as hopeless, & came to the conclusion that it would be well to give up all interference, & let the people educate themselves - so, as matters at present stand, very little compulsory action can be taken on the outbreak of the disease. However, with a little tact, a good deal to which the native has no objections, can be done.

1. The position of the segregation huts. These should never be too far away otherwise they will remain unoccupied!

Once when on "open line" plague broke out in a bazaar close to railway ground & I was ordered to erect huts - at a safe distance - for the railway native Employees, the majority of whom lived quite near the bazaar in question - I erected thirty, a mile away. What was the result? Not one of them was occupied although every persuasion was used - Persuasion failing the men jumped to the conclusion that compulsion would next be tried, with the result that within 4 days every hut was burnt to the ground! I then had built 10 more in a field not more than 50 yards away from the infected area: these were occupied at once & others had to be built. Many others in India have had the same experience. As it is well recognized that the predisposing factors in plague are overcrowding, insufficient ventilation, rats & filth I am of opinion that the distance of the segregation huts from the infected area is of little consequence.

provided the predisposing factors are remedied - Plague - due to the importation of infected blankets from the Durpant - broke out in the bazaar depicted in figure 3 - in the row immediately in front of where the separation huts are shown. Huts sufficient to accommodate, without overcrowding, the whole of that row were put up 10 yards away, & in the shops in the row closed for 3 weeks. The people willingly went into their temporary quarters taking with them the little allowed - knowing that no one would buy from them for a considerable time to come they did not look upon my action of closing their shops as compulsory - Not a man, woman or child left the place, & what may have involved the whole bazaar and others outside, died or after 6 cases. Thirty miles away 60 deaths a day were being recorded! To allow of a free play of air round & through the huts these were made of grass & grass only.

Under the promise that all things destroyed or burnt would be paid for no difficulty was experienced in destroying everything suspicious. The infected shops & rooms were morning & evening, thoroughly sprayed with strong acidulated corrosive sublimate solution (1-1000) & the drains soured with a strong solution of phenyle. Any rats caught (scores of cheap wooden traps were laid throughout the bazaar) were at once drowned in their traps in the same solution & their bodies thrown into a lime-kiln furnace. There seems to be little doubt now that rat fleas play an active part in the dissemination of plague, & it is known that on the death of their host they immediately leave it, & in their transigrations often bite & infect man.

Rats are caught & killed by the hundred throughout India, & their bodies thrown anywhere, & herein (from what I have already said regarding

the fleas) lies the danger; & I am inclined to this belief from the remarkable instance of a large native railway coal colony in Lower Bengal which, though surrounded on all sides by plague infected villages escaped entirely; & here the system consisted in the immediate immersion of the rat in its trap (i.e. whilst still alive) in the corrosive sublimate solution, & its subsequent disposal in a furnace - Burning of the bodies was carried out in case any of the fleas escaped destruction in the chemical solution.

Having turned the people into other huts & burnt or chemically treated their things more than extra care requires to be paid to sanitation viz clearance of all rubbish heaps, attention to latrines & drains, & destruction of all discharges, fomites &c. As the disease may be communicated through the medium of the faeces, urine & sputum special attention was paid to the disposal of these - The infected

were supplied with earthen ware vessels to expectorate into, or with bed-pans of the same material for their urine & faeces - after use each was sprinkled with carbolic acid solution (1-20) or undiluted phenyle, & deeply buried at a distance, or if opportunity offered - vessel & all - thrown into a brick-kiln furnace.

Before the Mulhawal disaster in the Punjab from tetanus - following inoculation with Haffkine's serum - one seldom had any difficulty in inoculating hundreds of all classes employed on the works - but after the disaster all attempts were futile.

The manner of disposal of those dead from plague will depend on whether the victim was a Hindoo or Mohomedan: if the former the body is burnt, if the latter buried in a deep grave & copiously covered with Chloride of lime (large quantities of which can always be had on construction works).

Cholera.

Here as in plague the segregation huts are built continuously near the centre of the outbreak - the patient & all those who have been in contact with him are isolated, & particular attention paid to the destruction or disinfection of fomites - It is usually a simple matter tracing the cause of the outbreak, & in my Experience it has never been a well, but usually some foul collection of water lying in a borrow-pit, or remaining somewhere after the subsidence of heavy rain - or it may be slowly running water, the bye-wash or eddy of a stream.

Cases of cholera occurring in the bazaar or cooly lines were isolated with those in attendance on them, & no one else was interfered with. This I know is against all doctrines of management of infectious disease but as the one great thing where many natives are collected together is the avoidance of panic it is in my opinion

the only course open. If any anxiety
 be shown by the medical man, and
 drastic measures adopted such as
 one reads of in text-books, every man
 woman & child will leave the work,
 & not return for weeks or months.
 This means heavy losses to the Con-
 tractor, & still more important retards
 all work for a very considerable
 time. My advice then is "keep the
 men together as long as possible"
 for once they go they will spread
 the news that the place they have
 come from is 'Choleraic' & no return
 of labour need be expected for
 at least 3 months. It may be
 said that with the meagre methods
 adopted the disease may become
 endemic - But, with due attention to
 the water supply, appropriate disposal
 of all alvine discharges, disinfection
 or destruction of fomites, & segregation
 of those infected I deny this.
 One can understand how in the
 large cities of India an epidemic of

Cholera soon becomes established, but here - by reason of the hordes to be dealt with, & the work involved - it is impossible for a mere handful of Europeans & Sanitary inspectors to satisfactorily cope with the disease. On construction works on the other hand it is possible - in regard to the numbers - & there is no excuse for failure to check the spread of the disease.

If the collection of water, from which the patients derive their supply be large (e.g. a borrow-pit) the collection is fenced off & a day & night guard put over it: if it be small (pools remaining after the rainy season) undiluted phenyl is mixed with the water, which is then ladled out & the depression which held the water filled in with earth. Those infected could not, & when convalescent were not allowed to go & get their own water: an earthenware vessel with a covering stood outside the hut & this was filled 2 or 3 times a day through bamboo piping

(from 20-30 feet long) on supports. The attendants lived in a separate hut, & had separate vessels for their drinking water, in addition to water specially reserved for the ablution of their hands & feet after attendance on the patient. All vomited matter & discharges were collected in "gumlati" (open earthenware vessels costing a farthing each) - & one cannot have too many of these distributed through the infected hut - thoroughly mixed with strong carbolic water or phenyl & deeply buried, or burnt.

During an outbreak it is always well to go round the shops & condemn all unripe or over-ripe fruit, mouldy rice, & in fact anything which strikes one as a danger to the community - A favourite meal for a cooly when "hard up" or saving money is some cheap fruit (ripe or unripe he cares not) followed by copious drinks of water! His digestive organs are upset & if cholera be about he falls an easy victim - After the segregation huts have served their purpose they are

burnt, & this should be done by myself & not left to a native.

Small-pox.

The Government of India have Vaccinators throughout the Country: these men at fixed periods go from town to town or village to village vaccinating infants & the unprotected - In addition to the Gov^t men there are many, who after qualification make vaccination (or "inoculation" as they call it) a "business". And one can at once decide whether a native has been 'vaccinated' or 'inoculated': in the former case he usually shows 3 or 4 cicatrices on the upper arm, & in the latter one large cicatrix on the posterior aspect of the fore-arm. There is as a rule no difficulty in vaccinating the people, for extraordinary, as it may seem the majority actually believe in its beneficent action, and the 'Conscientious objectors' are few and far between - In consequence one seldom sees many cases of variola, certainly

not the number one is led to believe on first going to the country.

One now never meets with an epidemic of small-pox, in the same sense as Cholera or plague - Sporadic cases only are met with now & again, & occur chiefly in children who through ill health have had their vaccination postponed. One must always be on the look out for such cases on large works. On one occasion when doing a round along the bridge shown in fig 2 I noticed a woman carrying a bundle coming towards me :- as she saw me she stopped, set down & began to bestow special care on the covering up of the bundle in question - My suspicions being aroused I insisted on her taking off the cloth from whatever she had in her arms - She did so reluctantly, revealing an infant literally covered from head to foot with small-pox pustules! I made enquiries regarding her & learnt that she was not camped on railway ground, but belonged to a village shown on the Extreme right

of Figure 1. She had been given temporary work on the bridge the day before, & had come to work with the intention of leaving the child on the river bed whilst she earned her daily wage! Necessary precautions were taken in regard to the village, & no further cases were at any future time seen on the works. As the disease never causes a panic (unlike cholera & plague) amongst the natives, one may with impunity follow out any measures conformable with one's dictates - These, & remembering that the virus can be carried by the air for long distances - consist in segregation at a far point from the outbreak, & the felling off of attendants who have already had the disease, or are "protected". The patients are put into grass huts, & put on "cherpoy" (cheap rope beds with a wooden framework) covered with a mattress of soft grass, which during the stage of pustulation soozing was, with the sheet, removed

daily & burnt. To counteract the offensive odour always so noticeable where small-pox is, & also for the benefit of the patient himself, weak carbolicized vasoline was daily smeared over the patient's body, & 5% carbolic freely sprinkled everywhere - The patient was not allowed to mix with others until all scabbing following pustulation had ceased, & no evidence of crusts remained.

Of other diseases on construction which may give the medical man trouble are malaria & dysentery.

Malaria.

Against this any big measures such as the formation of 'mosquito brigades' are, by reason of the expense involved, prohibitive - All one can do is to have all unnecessary collections of water removed & in fact anything in which mosquitos may breed, such as water held in broken bottles, tins &c - These bottles &c, should be collected & thrown into refuse pits. All swampy ground, such as shown in fig 3,

should be drained or filled in.

Dozens of packets of Quinine (2 grams in each) were made up in the hospital, & all were invited to come for a packet every morning if they so wished.

For a European the avoidance of malaria is a comparatively simple matter - since at night he invariably sleeps under a mosquito net, & in the evenings sits in a 'mosquito room', i. e. a room in which a mosquito curtain large enough to hold a chair & small table is placed.

The native cannot afford curtains - in consequence he covers up the whole of his body & head whilst sleeping.

Dysentery.

This probably is almost always water-borne, & I am inclined to think so from the fact, that man for man, I invariably got a larger number of cases from my smaller camps, where it was impossible to supervise the water supply as satisfactorily as it was in the larger camps. The disease never produced any

stir amongst the men, each case was treated on its own merits, due attention being paid to the disinfection & disposal of the discharges. No segregation was necessary. Izal is 'par excellence' the drug in this disease - I not only used it diluted as a spray for the disinfection of the rooms & fomites, but also gave it 'per os' in doses of 25-30 minims & always with the best results.

Rail-head sanitation.

By rail-head is meant the point to which the rails have for the time being reached - the 1st day it may be $\frac{1}{2}$ mile away from the base of operations, the 2nd day a mile & so on.

Whilst this process of laying the rails is progressing one is always anxious in regard to the health of the 'gangs' employed - gangs varying from 200-500 men. The whole problem now resolves itself into that of a small army on the march, & necessary precautions -

always a most difficult matter - here to be taken. Changing country with its varying supplies of water, & with its villages good, bad, & indifferent is passed through every day, & it is against these one's energies must be directed.

On either side of the line - for the greater part of its extent - are "borrow-pits" (pits left after the excavation of earth for the railway embankment), & in these water is usually to be found - water which one may even without a cursory examination justly condemn. To these pits then, because of their proximity, all the men will go for their drinking supplies. To discourage this practice then, the only thing to be done is to arrange for a good & plentiful supply of potable water & put it under their very noses. This is easily done. "Tank tenders", filled at the "base" from a reliable source are twice daily taken out by the engine to rail-head: the water

is tapped off from these tenders, & put into buckets, which are placed out on the line in 2 rows - one for Hindus, the other for Mohammedans.

The men were usually 'housed' in 'Shul-dari tents'. To prevent fouling of the ground near the line the 'flag system' was invariably in vogue.

In conclusion I may state that of my 12 years Experience on Indian railways 9 were spent on lines under construction.

The sketches submitted with the thesis were kindly done for me by Mr C. F. W. Atkinson, Architect, Bradford, & entirely under my guidance & suggestions. Mr Atkinson has never been abroad.

M.B.