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COOK'S RIVER : ITS CONDITION AND ITS DESTINY.

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In a paper* read before this Association in 1887, the influence on the natural streams and watercourses of the outward spread of population from Sydney was described, and the measures necessary to cope with the apprehended dangers referred to in general terms. It is the intention of the author in this paper, which is a sequence to the one just referred to, to treat particularly of Cook's River, its peculiar environment, (Plates VIII. and IX.) and its growing insanitary condition, and to indicate a treatment which, while providing a permanent remedy, will achieve other desirable results.

The valley of Cook's River adjoins the southern side of the Parramatta River basin; the water parting is a range of low hills varying in elevation from 93 to 200 feet above sea-level. The distance between the heads of the coves and bays on the southern shore of Parramatta River and Cook's River varies between two and a-half to three miles.

The western extremity of the valley lies to the south of Rookwood, and is bounded by Pott's Hill and the heights of Bankstown. The river, commencing there as an insignificant watercourse, runs in a general east south-east direction, and enters the north-west corner of Botany Bay, at a point immediately south of, and distant about four miles from, the City of Sydney.

With the exception of an insignificant portion in the extreme west, the valley is covered with incorporated areas.

* "The Sanitary Aspect of the Site of the Metropolis and its Environs," Pro. Eng. Ass. N.S.W. Vol. II., page 92.

For the last three miles of its course to its outfall at Botany Bay, the river originally wound through extensive mud-flats exposed at low tide, and more or less covered with mangrove scrub. In this length two creeks join the river; Shea's Creek comes in from the north, and Muddy Creek comes in from the south. Shea's Creek drains a populous valley which extends in a north-east direction into the southern borders of the City of Sydney, and its waters are much polluted. A few years ago the nuisance caused by the decay of organic matter deposited by Shea's Creek and Cook's River, on the mud-flats, necessitated remedial measures: training banks were therefore constructed to regulate the river channel and reclaim the mud-flats. The improvement of Shea's Creek was next taken in hand: the lower portion has been confined within banks and converted into a canal: work on the upper portion is proceeding. The main object for which these works were undertaken has been accomplished, and a large area has been reclaimed, which is now available for many purposes; but for residential sites its use should be disallowed. The above-mentioned mud-flats are a depressed part of a low-lying sandy tract of country bordering Botany Bay, which is bounded on the west by an abruptly rising ridge which evidently formed the original shore line of the bay.

Through a gap in this ridge Cook's River passes. The basin, which has its drainage outlet at this place, is divided into two valleys by a ridge which, extending from the western water-shed, terminates abruptly opposite the gap. The southern valley is drained by Wolli Creek, and has an area of about 8 square miles: the northern drainage channel retains the name of Cook's River; the area of this valley is about 20 square miles. The total area draining through the gap is 28 square miles, and it is to this area and more particularly the northern valley and its drainage channel that attention is mainly directed in this paper.

The length of the valley is about seven miles.

The eastern part of Wolli Creek Valley is a sandstone formation, often precipitous and with clay shale cappings to the flat-topped elevations. As the valley rises to the west, the sandstone gradually disappears, and clay shales prevail, with their characteristic undulating surfaces. This valley is sparsely populated at present.

The natural features of Cook's River Valley are similar to those of Wolli Creek Valley. Going upstream, the banks are either rocky or consist of small alluvial flats at the base of rocky bluffs. Gradually the high rocky ground recedes from the river, becomes less elevated, and the superimposed clay shales become more conspicuous, until at Canterbury village the sandstone rock disappears. Here the valley opens out, and the river winds through extensive clay-flats, which, commencing at the river banks at an elevation of 8 or 10 feet above the water surface, are almost level for some distance back from the river, then gradually rise into the bordering undulating country.

A considerable area of the valley west from Canterbury is within 50 feet of sea-level.

The clay in the valley bottom is of a friable nature, and easily eroded wherever the flow of water is concentrated over surfaces not protected with turf. On the whole, the valley may be said to have an impervious formation. When rain falls in quantity, it does not take long to saturate the surface soil, and the remainder runs off quickly into the drainage channels. When the rain stops, the flow of water in the channels soon ceases also; the water absorbed by the soil is either evaporated or extracted by vegetation—very little of it percolates to the channels. There are no absorption areas to provide water which will supply a constant stream to the tributary creeks of the river in dry weather, hence the creeks become a series of stagnant water-holes.

Cook's River was originally subject to tidal influence as far up the valley as Hilly's Ford, Enfield, where the Burwood

road now crosses. This point is about half-way up the valley, and the river water was more or less salt according to the season.

From Hilly's Ford, upstream, the river consists of a series of pools and bars, and the bed gradually rises. At the Liverpool road it is 35ft. above sea-level. Long before this point is reached, the river has lost all claim to be so designated.

In the early days of the colony the causeway known as Cook's River dam was constructed across the river where it passes through the gap before referred to. Probably, when first built, the causeway differed somewhat from its present condition. However, as far back as the writer can recollect, it has been provided with two sets of flood-gates—one at each end. The sills of the gates are at such a level as to retain the water, level on the upstream side 1ft. 3in. below mean high (sea) water-mark. The causeway excluded the salt water, and the river water above it freshened; it also prevented high spring-tides from overflowing the low flats near the river.

Another dam, or, more correctly speaking, a weir, was constructed across Cook's River at Canterbury, near the old sugar-works, and commonly known as the sugar-works dam. The weir now raises the water surface about 1ft. 3in. above the reach on the down stream side, and is thus about level with high sea water-mark. This level extends in one long reach to near Hilly's Ford.

These two reaches at one time contained a fair depth of water all through their lengths, but silting up has occurred in places between the junction of Wollie Creek with Cook's River, and the causeway there is an expanse of water covering an area of about nine acres. The check which flood-waters here receive has caused silt to be deposited in this locality, and mud banks are now visible above ordinary water-level. The decay of organic matter in the mud creates a nuisance, and a project has been submitted by the Public Works Department to the

Government for improving the river in this locality by dredging and reclamations. The execution of the work will be beneficial.

The natural features of the river and valley having been described, and also the modifications made in the former by the construction of the two dams, the influence of the settlement of population has now to be considered.

The removal of forest and scrub, hardening of surface of ground by traffic, construction of roads and surface water channels, erection of buildings, all tend to increase the volume and velocity of off-flow to the natural channels and outfalls. This general result becomes more accentuated as population increases, and cannot be compensated for by absorption areas created by the cultivation of the soil. The concentration of the rain water thus brought about increases its erosive power, and large quantities of silt are moved by each rainfall. With this silt is also washed down decomposable organic refuse from the neighbourhood of dwelling-houses and manufactories.

The quantity of silt and refuse deposited in the waterholes of the creeks and in the two long reaches of the river will depend on the amount of rainfall. Heavy continuous rainstorms will convey a great part of it to the outfall at Botany Bay, but small storms, insufficient to produce a strong flow of water in the river, will leave the bulk behind to eventually undergo decomposition. The insanitary condition of the river will thus become more and more intense as population grows.

The sewerage system, in course of construction, will be gradually extended where required, and will prevent the bulk of the worst kinds of filth and liquid refuse from reaching the natural watercourses, but the washings from road surfaces will not be admitted to the sewers, and rightly so, and, together with a vast amount of rubbish from inhabited areas, drainage from manure heaps and rubbish tips, will always contribute heavily to the pollution of the river water. Now, if Cook's River possessed only a moderate current seaward, the organic

matter conveyed into it from an area, the sewage of which is intercepted and properly treated elsewhere, would not cause a serious nuisance, or one that could not be remedied by dredging. But, unfortunately, Cook's River is not so circumstanced; on the contrary, its present condition and environment are such as to cause its waters to be stagnant for long periods of dry summer weather.

Stagnant water containing decomposable organic matter is extremely liable to spontaneous changes in this warm climate, and serious nuisances may be expected. As the dissolved matter would contribute to this result as much as, if not more so than, the solid matter, it is evident that dredging will eventually prove an insufficient remedy.

The two long reaches of still water and innumerable water-holes in the tributary creeks are so many leaching vats on a large scale for the refuse washed into them, and summer droughts will secure the conditions for the process to be successfully accomplished.

An important principle, carefully observed by experienced sanitary engineers, is this—sewage should have no resting-place; it must be kept always on the move, from the time it originates until its discharge. Otherwise serious putrefaction with resulting contamination of the atmosphere will ensue. This principle is of equal application in the treatment of channels which receive the surface drainage from populous areas.

The study of the bacteriology of river water has shown that there are natural agencies at work in the water, which under favourable conditions will modify the processes of decomposition which proceed therein, and tend to produce innocuous results. The favourable conditions are movement and aeration of the water—seen to its greatest advantage in the rapidly-flowing rivers.

The author has under his charge a water supply to a large population. The supply is obtained from a river, the water of

which is constantly flowing and is well aerated. A large storage reservoir is provided as a stand-by to be resorted to when, in flood times, the river water is too turbid for use. It is largely replenished from the river. There are, under present conditions, no means for circulating and aerating the water in the storage reservoir; and as there is unavoidably dissolved vegetable organic matter present, some most peculiar changes occur in the water. This behaviour of the water is due to a deficiency of oxygen. The decomposition of the organic matter proceeds under unfavourable conditions, and produces a marked contrast to the river water. When the water is taken for use, it is aerated by spraying and is passed on to filter-beds, where the effect of aeration is intensified, and the conditions are made exceedingly favourable for the ubiquitous friendly bacteria to perform their benevolent offices, and a pure effluent is obtained suitable for all domestic purposes.

These waters have been referred to as an illustration of the result of stagnation in this climate of water containing only comparatively innocuous vegetable matter, and to indicate what may be expected of stagnant water, which is largely contaminated with matter of animal origin.

The remedy for the present condition of Cook's River is to produce a constant flow of water. The problem which now presents itself is how is this to be accomplished. No water is available from its own watershed unless storage reservoirs are constructed at the western end of the valley to retain rain-water for this purpose. But, even if the cost of such reservoirs were not prohibitive, there are other objections, and a better solution of the problem is attainable, the features of which will now be described.

The two dams which are built across the river should be removed. This will allow tidal action to range in the river to the vicinity of Hilly's Ford, and in flood times there will be less obstruction to the discharge of silt. A freer get-away for

flood-water will be provided, which will, in a measure, tend to reduce the height of flood-water level, and thus counteract the effect of the quicker off-flow of water from the drainage area brought about by the various causes before enumerated. The channel of the river should be regulated; all areas which would be exposed at low tide to be dredged out or embanked and reclaimed; low-lying areas, such as occur in Marrickville valley, to be protected with embankments provided with flood-gates.

The water in the river channel under these conditions would be of variable quality. At the end of a dry period it would attain its maximum degree of saltness, and might contain sufficient organic matter to be a nuisance; in flood-times the water would reach its maximum degree of freshness; between these maxima the quality would fluctuate. In dry weather the ebb and flow of tide would only move the water to and fro—not change it. To accomplish a proper circulation, a large controllable body of water must be brought into the upper part of the river. The proximity of the Parramatta River indicates the source from which this supply may be obtained, and a canal at tide level the means.

Two favourable routes for a canal between Parramatta and Cook's Rivers exist.

The first is from Long Cove along the new canal in southerly extension thereof to Marian-street, thence along Long Cove Creek in a cutting, increasing in depth as the ground rises, as far as Pigott-street, Petersham, a length of 90 chains from Marian-street; the ground surface level at this point is about 52 feet above high-water mark. Thence by a tunnel 50 chains in length extending southerly under the dividing ridge into Cook's River Valley, ending some chains to the north of Terrace Road; thence by open cut 25 chains in length to Cook's River, entering at a point between Garnet-street and Wardell Road, Marrickville. The total length of the canal would be 165 chains. The summit of dividing ridge where the canal

would pass under in tunnel is only 96 feet above high-water mark.

The geological formation is of a character favourable to the execution of the work—the open cuts would be in clay shale and underlying sandstone rock: the tunnel would be mainly in sandstone rock, and probably a large amount of lining could be dispensed with.

The dimensions of the tunnel and canal would have to be regulated by the amount of water that might be found necessary to effect the desired circulation in the river, and by the requirements of navigation. It will probably be found that a width of 20 feet, and a depth of water of 3ft. 6in. at low tide will answer both requirements. By means of gates, similar to lock gates, suitably placed at each end of the canal, the water could be made always to flow in one direction from Long Cove to Cook's River or the reverse. It might, however, be found, as the result of observation, that sufficient difference in level and time of high tide exists at the ends to cause a satisfactory flow in the canal.

The construction of this canal, the removal of Cook's River dam, and the regulation of the channel as far up stream as the sugar-works dam would be a sufficient remedial measure for that section of the river now contiguous to the area of densest population.

When the time should arrive for dealing with the higher part of the river, the sugar-works dam can be removed, the river regulated to Hilly's Ford; thence excavate a canal following the river channel to the northern side of the Liverpool Road, near the place where the Sydney water supply main pipes cross the channel, a distance from Hilly's Ford of 195 chains: the ground level here is 48 feet above high-water mark. Thence in tunnel 73 chains long, passing under the dividing ridge, which here attains an elevation of 110 feet, to near Albert Road, Strathfield, where a creek crosses; thence in open cut following the general course of creek, along the

western side of Rochester Street, under railway and across Parramatta Road to Powell's Creek, a length of 80 chains from north end of tunnel; thence along Powell's Creek to Homebush Bay. The total length of canal from Hilly's Ford to Powell's Creek is 348 chains.

As the first canal would provide sufficient accommodation for traffic, the size of the second could be limited to that sufficient to ensure the necessary circulation of water, which could be arrived at from the experience gained with the first. The excavation for open cuts would be in clay and shale, and the tunnel would be in hard shale, which would necessitate lining throughout.

The question will naturally arise: Is there sufficient justification for providing a canal to carry traffic? This feature will now be dealt with.

The topographical features of the site of the Metropolis will ensure the heart always remaining in its present location, on the area bounded by Parramatta River and Port Jackson on the north, and Botany Bay and Cook's River on the south; this will always be the busy commercial and manufacturing area.

The proximity of Botany Bay and Cook's River to the Metropolis, together with abundant supplies of soft fresh water obtainable from the immense sand-beds which lie along the north shore of Botany Bay, between Cook's River and La Perouse (comparatively cheap land), and the proximity of the sewage farm, affording convenience in the treatment and disposal of manufacturers' wastes, are conditions favourable to the location of manufacturing industries; a commencement has already been made in the neighbourhood of the old water-works. The advantages of an inland water route, which would afford cheap conveyance of goods from the bay and river to the ship's side in Sydney Harbour, and the wharves which line the shore, are obvious. George's River would also, by the canal be placed in easy communication with Sydney Harbour. The

prospect of the reclaimed land below Cook's River Dam and at Shea's Creek Canal being utilised at an early date would be increased.

The distance by ocean route from the old Water Works Wharf, Botany Bay, to Dawes' Point, Sydney Harbour, is 25 miles; by Cook's River and proposed canal the distance would be one-half that length. The ocean route being available for large vessels, the canal would provide only for barges and launches. As the barges would have to traverse the open waters of Botany Bay and Sydney Harbour, horse-traction would be inapplicable—they would have to be tugged or have means of self-propulsion; but this is the system already developed in Sydney Harbour.

The opening of a canal route as indicated between Sydney Harbour and Cook's River would accomplish two desirable ends—improve the sanitary condition of Cook's River and provide an inland water route connecting the northern water frontages of the city with the southern.

Other possible uses for the canal will present themselves for consideration; only one need be mentioned; it might be advantageous for the defence of Sydney to have available a means of passing torpedo boats by an inland route from Port Jackson to Botany Bay.

In connection with the improvements to Cook's River it would be highly desirable, in fact necessary to the future usefulness of the river, to resume the frontages on both sides for its whole length, also all adjacent lands the level of which is near that of high water. If the future can be estimated by considering the conditions of the present and the experiences of the past, it must be manifest to all thinking persons that the metropolis of New South Wales has indeed a great future before it.

Endowed with an unrivalled port on the great ocean highway—in the centre of an inexhaustible coalfield—with railways radiating into the rich agricultural, pastoral, and mineral

areas of the coast district and interior of the State; a terminus of several ocean trade routes; a British naval depôt, and well fortified against attack; provided with an abundant water supply—it possesses, in a high degree, elements favourable to solid advance.

To a large extent, and in common with the growth of most large cities, the metropolis has in many ways developed along hap-hazard lines, but this condition is happily changing, and the construction of large water and sewerage works and other important public undertakings during recent years is in no small degree due to the development of a steadfast belief in the solid and permanent growth and prosperity of the City. And this confidence should secure a close and serious consideration of the merits of projects which, even if considered somewhat in advance of immediate requirements, are intended to meet the demands of a more or less distant future.

A demand for the relief and accommodation which would be afforded by the construction of the works briefly outlined in this paper is already arising. A scheme on the lines described could be designed for the whole valley, and the execution of the work proceed systematically, but gradually.

The cost of the canal from Long Cove to Cook's River cannot be reliably estimated from the levels available, nor until the relative proportions of rock, shale and clay are ascertained; and, no doubt, in working out the scheme in detail, a better adjustment of length of open cut to tunnel would be found expedient: but very roughly the cost might reach as high as £80,000.
