CHAPTER I

THE HYDRAULIC EMPIRE

The Journey from Vihar to Tansa

Most historians, writing on the evolution of the hydraulic system of water supply in the city of Bombay, have focused on the periodical scarcity of this resource on account of the city’s dependence on monsoon fed tanks and wells and the resulting problems faced by the people. The water scarcity of 1845 especially, proved momentous, as the problem seems to have forced the Government to look into the water issue more closely, than hitherto, thereby prompting it to appoint a committee consisting of Dr. Graham and Dr. Andrew Leith. The report of this committee, submitted the very next day, at once established the paucity of water supply and the evils of cholera and brain fevers to which people were exposed as a result.¹ Within the next 15 years, the city witnessed a revolutionary change in the method of water supply in the form of the hydraulic works at Vihar; the creation of the latter, based on two assumptions that the city faced water scarcity, as it could not satisfy the needs of its people, and that only engineers could solve the problem, thereby paving the way for the entrance of hydraulic technology. Hence, this chapter re-examines the nature of water scarcity and the needs of the city as understood by the engineers. Further, it maps the growth and nature of planning and execution of the hydraulic technology, which was used to address the city’s water needs.

UNDERSTANDING SCARCITY AND NEEDS

Water shortages were not an unusual problem in mid nineteenth century Bombay city, which was traditionally dependent on tanks and wells fed by underground springs. Some springs continued to flow throughout the year, while others dried

during summer. The wells on the eastern side of the island, which comprised the suburbs of Mazagon, Umerkhadi, Mandvi, and the eastern portion of the Fort, were generally reservoirs of rain water. Springs could be found occasionally, but the majority of them turned brackish, immediately after the rains and salty before the end of the hot season. The best wells in the island were to be found along the bottom of the eastern escarpment of the Malabar hill ridge. Similarly, wells in Girgaum, Dhobi Talao and Chowpatty had enormous quantities of water. Besides these wells, some of the native houses of the best class had extensive reservoirs beneath them, into which the rain water from the roof was collected. Among the most important tanks that supplied water to the city were: the Byculla tank (168000 square feet); the Baboola tank (234,000 square feet); the Mumba Devi tank (77,000 feet) 3 tanks, between Bhendy Bazaar and Duncan roads; Cowasji Patel’s tank (15,000 square feet) and the Dhobi tank. (48,000 square feet).

Response to scarcity

Prior to the advent of the hydraulic systems, the typical response to scarcity was to add to the existing tanks and wells, as seen in 1803 and 1824. Thus, by the end of 1824, 3-4 thousand public and private tanks sprang up in Bombay. Besides, the traditional native attitude towards water being one of charity and since the construction of wells and tanks required relatively less amounts, people of all creeds contributed to these works and scarcity actually acted as a catalyst in increasing the

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4 David. City of Dreams. op. cit. p 264
number of perennial sources of the city. Wells were even dedicated to poor cattle.\(^5\) Around 1780, the Cowasji Patel tank was built in the native town which was widely used by the local population and in 1846, when the level of water in the tank fell, Cowasjee conceived of overcoming this deficiency by supplying it with water from a nearby oart (coconut garden) known as Mugbhat. We also find that various localities and roads derived their names form these tanks.\(^6\)

In times of scarcity, laying of iron pipes from tanks,\(^7\) throwing open of wells were familiar acts in Bombay. In 1846, help was extended by Sir Jamsetjee Jeejeebhoy, a well known Parsee merchant, for the construction of reservoirs within the premises of the hospital at Byculla,\(^8\) while Jugganath Sunkersett Esq., a notable leader and businessman, at a great personal inconvenience, gave up to the public a private well in Tardeo, containing a large supply of wholesome water, and with his “characteristic liberty” paved a pathway to make the well accessible from Grant Road. At Mazagon, a highly populated area, wells were built by the Chaplain of Christ’s Church, and a Mr. William Sheppard, who left a sum of Rs. 2000 in his will for this purpose.\(^9\) In 1852 the water supply to the Native Town was augmented by the conveyance of water from the Framjee Cowasji Tank, on the Esplanade, to a drawing reservoir situated in the centre of the Native Town (at Poydhowni). The cost of this work was borne by one Raghunathdass Ramlall Esquire who spent Rs. 16,870

\(^6\) Preeti Chopra, A Joint Enterprise: The Creation of a New Landscape in British Bombay (1839-1918), Governance, Mumbai Readers 2010, Urban Design Research Institute. (2011). pp325-27. Hereafter, Preeti Chopra. The Babula Tank was constructed in 1849 and even as late as 1855, when water scarcity was experienced, the Nakhoda Tank was constructed on the Esplanade, paid for by Muhammad Ali Roghay, a prominent Konkani Muslim businessman. Shells, op. cit. pp 451-452
\(^7\) Bombay Times and Journal of Commerce. Proposed Aqueduct Fund. 8\(^{th}\) April 1846, p 228. Hereafter, BTJC
\(^8\) Ibid. 25\(^{th}\) April 1846, p 269
\(^9\) Ibid. 13\(^{th}\) June 1846, p 391
on it. A large quarry at Mazagaon, yielding an abundant and perennial supply of sweet water, was purchased for the use of the public with a view to its being converted into a public Tank. A new well was sunk in the Fort in the neighbourhood of the Bazaar Gate by order of the Board of Conservancy. This too was sanctioned by the Government, but sponsored by Varjuwanndass Madowdass Esq., a rich landlord and capitalist, who offered to contribute Rs. 400. Such was the importance of tanks and wells, at this time, that even the Government sanctioned wells and other works for increasing the supply of water. To prevent frequent failure of the Baboola tank, the most important one in Bombay, on account of the extent of population it supplied, the Board of Conservancy constantly endeavoured to increase its contributing area, thereby increasing its capacity. During 1850, the capacity of the tank was increased, by excavation, to 2, 11,888 gallons, during 1851 by 17, 29,847 and 1852 by 27, 4208 gallons. In 1851, arrangements were also made for leading into the tank, the surface rain water drainage of the high ground of the Sudder Adalat, by which means the area supplying the tank was nearly doubled. Further, wells were also vaulted over to keep the water cool and prevent loss by evaporation.\textsuperscript{10}

Scarcity however, also gave the British an occasion to control the local inhabitants and forcing them into works of charity, by holding them responsible for the problem, through their habits of misuse and negligence. In 1846 for example, it was expected that the Bhandaris, Agris and Kolis of Sion would contribute towards the sinking of a well and since the Kolis were financially better off, they were expected to give half of the entire sum.\textsuperscript{11} One also comes across the organization of Water Police to prevent the waste of water.\textsuperscript{12} In fact, in such times of “extreme scarcity of water” the Government was counted on to give strict orders to the police “that water should not be used for bathing purposes or for washing the dirty clothing of the natives.” Instead, they were exhorted to use sea water as the latter was known for its cleansing

\textsuperscript{11} GD 1846, Vol. 97, Letter to Escombe Esq. Secretary to Government, from Hutchinson, Asstt. Collector of Land Revenue, 29\textsuperscript{th} April 1846, pp 569-574
\textsuperscript{12} BT JC. op cit. 2\textsuperscript{nd} September 1846, p 206.
properties. The natives were allowed to wash themselves, or their clothes, only at the Dhobi tank. But they were not restricted in drawing water freely and carrying it to their houses for all domestic purposes. In order to carry these measures into effect, the Governor in Council placed the public tanks and wells under the charge of the Superintendent of Repairs, who would station peons at them, with strict orders to have these directions observed. Builders too, were prohibited from drawing water from any tanks or wells in the Island for building purpose.

But even though scarcity was an accepted fact, and need was felt to augment water supply, there were no clear indications of how much and for which purposes water was required. Perceptions regarding the means and the agency, which would aid in this work, also varied. Local inhabitants considered the provision of a permanent supply of good water as the “imperative duty” of the Government of Bombay and felt they were entitled to ask for “at least pure water to drink, though you leave their streets and roads in a state of unimaginable filth.” On the other hand, Governor Lord Elphinstone’s desire for the establishment of Water Company, whose works could bring a constant supply of water into all the streets and all the houses of the town, from elevated reservoirs, was underpinned not only by the benefits such a scheme would offer, but also by its ‘remunerative capacity’. A constant supply of water, would not only alleviate the problem of water scarcity, but also would help to fight fires which were so frequent. Matters were however seen differently by Henry Conybeare (Superintendent of Repairs), the future architect of Vihar. Although an engineer by profession, Conybeare, who was an ardent subscriber of the Chadwickian sanitary reform, linked an ample supply of water with the sanitary

13 Ibid. Waste of Water, 3rd June 1846, p 360
14 Selections BG, No. 1, op cit, pp 14-15
needs of the city and thereby the productivity of labour as also its commercial prospects.

THE MOVE TO VIHAR

In 1845 therefore, when the city was faced with an alarming water shortage the Government immediately recoursed to the skill and ingenuity of the engineers of the city to resolve the problem. Reports submitted, within the year, suggested the creation of elevated reservoirs in the city from where rain water could be collected and distributed to the existing tanks. Thus, a scheme by L.C.C Rivett, proposed the construction of a reservoir at Neat’s Tongue, (present Trombay) Basing his calculations on the assumption, that there were 18000 houses and that the people consumed around 50 gallons per day, he placed the total consumption of Bombay at 328, 500, 000 gallons per annum. This scheme, which was to cost Rs. 7 lakhs aimed at addressing only the 3 months of scarcity faced by the city and would have rejuvenated its tanks.\(^\text{18}\) The plan submitted by the Chief Engineer, Lt. Col. Jervis’ on 16\(^\text{th}\) June 1845 also recommended the provision of three reservoirs in areas near sandstone strata, saturated with water throughout the year, from where water could be pumped and distributed through iron pipes. These sites were the Dhobi’s Ghat on the Esplanade and the Oarts at Girgaum and Mahim.\(^\text{19}\) Yet another plan, submitted in 1846, by the civil architect of the Presidency Captain T.M.B. Turner, similarly.


proposed the creation of an elevated tank on Malabar Hill.\textsuperscript{20} Even though none of these plans materialized, it needs to be noted that scarcity was looked at as a temporary issue and that the needs of the city could be satisfied by merely reinforcing water supply to the existing Tanks.

Although the move to explore the distant resources of Salsette, originated with Capt. J.H.G. Crawford, (Acting Superintendent of Repairs) even this only aimed at keeping the tanks and wells full, up to December, so as render the city scarcity proof. Crawford put forward two projects, the 1\textsuperscript{st} of which was to intercept a stream, which arose near the village of Vihar at a place near Kurla. As an alternative, he also suggested that the Kurla valley be drained by a system of underground channels to a point from where the water could be pumped up.\textsuperscript{21} Though aware of the existence of hydraulic schemes in England, a doubtful Crawford felt that the immense money that the latter required could be better spent on improving the status of the existing tanks and wells in the island itself.\textsuperscript{22} Even Lt. DeLisle, who became associated with this scheme, at a later stage, echoed the same since he felt that “Hydraulic formulae in the present state of science are not yet to be relied on with implicit confidence.”\textsuperscript{23}

However, a different perception of needs, put forward by Conybeare, to whom the Vihar scheme was forwarded, changed the scheme of things. In his two reports, submitted to the Board of Conservancy, although Conybeare accepted that some districts of the island were well supplied with water and that works of a perennial nature had increased in the city considerably since 1850, and that improvements to the tanks and wells could have rendered the city drought proof, even in the months of summer, he defined the need of the city on the basis of what ‘ought to be’.\textsuperscript{24} “But

\textsuperscript{20} Ibid, Letter from Captain TMB Turner to The Secretary to the Military Board. 21\textsuperscript{st} March 1846, pp 16-17

\textsuperscript{21} Ibid. Letter no. 108 of 1846 from Capt. Crawford to George Hancock, Clerk of the Board of Conservancy, 16\textsuperscript{th} May 1846, pp 25-28

\textsuperscript{22} Ibid, 2\textsuperscript{nd} Letter from Crawford, 27\textsuperscript{th} August 1846, p 31

\textsuperscript{23} Ibid, Lt. DeLisle’s Report on Captain Crawford’s Project. 3\textsuperscript{rd} March 1851. p 44

I do not think that this is all that will content or even suffice the inhabitants of such a city as Bombay is likely to become within twenty years of the opening of an extended railway communication into the interior; and I do not think it is all that ought to content the inhabitants of the island even at present" wrote Conybeare.\textsuperscript{25} Thus, the scarcity in Bombay came to be calculated on the basis of the future needs of the city.\textsuperscript{26} Conybeare's idea, that the valley of Goper, as proposed by Crawford and DeLisle, in Salsette, was the only possible source from where an adequate supply could be obtained, was adopted by the Bombay Government and he was selected as the engineer, to prepare the surveys and estimates and to design and execute the works.

**The Economics of Vihar**

Both Conybeare and Crawford differed in the conception of the design of Vihar. Conybeare's scheme was conceived on a bigger scale. The needs of the city were kept at 4000 million gallons annually. Even Conybeare admitted that this would be in addition to that derived from existing sources. Estimating the storage capacity of Vihar at 10800 million gallons, and after allowing for a loss of 1000 million gallons through evaporation, it was calculated that 90800 million gallons would remain for consumption. As the annual rainfall on the gathering ground, available for storage, greatly exceeded the consumption at Bombay, the lake would have surplus water.

\textsuperscript{25} Selections BG No. 1, op cit. Report By H. Conybeare On The Amount Of The Existing Water Supply Of Bombay, With Reference To The Population, And On The Various Methods Which Have Been Proposed Or Might Be Adopted For Increasing The Supply, Both From Sources Within The Island, And From Salsette, 22nd December 1852, pp 105-106. Hereafter, Conybeare, First Water Report

\textsuperscript{26} Graber, op. cit. The scarcity of water was a concept created by the eighteenth century scientists, engineers and entrepreneurs who tried to convince the government that there was a lack of water. The idea of need was invented by these technicians. Ibid pp 315-316. On a similar note, Baviskar asserts that scarcity was earlier accepted as a way of life and part of a frugal environment that affected everyone, more or less equally. But under the British it was presented politically as a crisis that created anxieties and demanded dramatic solutions. Baviskar op. cit. p 9
notwithstanding the quantity used by the town, from the beginning of the monsoon till its termination. However, in the absence of reliable statistics, regarding the population and availability and consumption of water in the city, Conybeare had to count on his knowledge of similar schemes in England. As per his calculations, for a population of 700,000 at the rate of 20 gallons per head, for 9 months, a supply of 3700 million gallons would be required. Even after deducting this, from the remaining 90800 gallons, more than 6000 million gallons, or nearly 2 years supply would remain in the lake as a reserve. On the other hand, Captain Crawford preferred works on a smaller scale that would later admit of a further development as the demand for water increased. He was also doubtful about it since it would provide more water, than required. Considering its population, and the existing supply of water, Crawford felt that a small scale project would have sufficed the then requirements of Bombay.

Conybeare however, convinced a reluctant Crawford, that the cost of duplication, at a later stage, would be against the principles of economy. Moreover, there was 'a big economical advantage' in a copious supply of water to Bombay. Not only did he anticipate a return on the outlay, by the imposition of a general tax on all except the poor, but also handsome revenue, once the demand for water was established, by its sale to the rich people with gardens and fountains and baths. A scanty supply, on the other hand implied no surplus to sell and consequently no income.

Sale of water was anticipated in a large number of establishments such as the Jamshetji Hospital and Grant Medical College, the Byculla Club, the Railway stations, the Barracks in Fort St George, the Castle, European merchants' houses in

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28 Selections BG op. cit, No. XXII, Major Crawford’s Observations on Mr. Conybeare’s Second Report on Supply of Water to Bombay, 20th April 1855, pp 71-75

the Fort, the Mint, Dock Yard, Hydraulic Cotton Press, and Steam Press. All private European houses, beyond the limits of the Fort, and Town, to which the water could be brought were most assuredly expected to use it in preference to the then method of having their daily supply brought by the bullock loads. From all these sources, considerable revenue was undoubtedly expected.\(^30\)

That it was indeed ‘true economy’ made sense even to the Government, since a large number of European families, who lived on and about Malabar Hill and in places, where water was not easily procurable, had to pay Rs. 200-300 and upwards, per annum, for the limited supply of water (6-15 puckawls a day). But, under the new scheme, it would require only 200 houses, paying only the lower of these rates, for which they could obtain a comparatively unlimited supply of water. The lowest of rates would give an income of Rs. 40,000 per annum which was calculated to defray all the expenses of the distribution. Moreover, the Government felt, “that the consumption of water by Europeans would always bear but a small proportion to that by more numerous class of the wealthy native gentry” Thus, the Government was convinced that the extended works would prove profitable and help the Municipality unburden itself of its financial debts and that the distribution network could be gradually increased as more demands for private water supply presented themselves. Provision, however, could be made for a few public fountains and supply pipes to existing tanks which would at once insure the public against any destructive dearth of water.\(^31\)

The execution of the magnified Vihar scheme was indeed, immensely advantageous to Bombay which, at this juncture, possessed enormous commercial significance to the colonial powers in more than one way. With its expanding railway network, Bombay was characterized as the “rising presidency” in the country and the population of the capital had increased rapidly, on account of the advantages of its geographical position, as the nearest point of contact with Europe, and also to the

\(^{30}\) Ibid. Letter to W. Hart Esquire. Secretary to Government by JHG Crawford. 20\(^{th}\) April 1855. pp 182-84

\(^{31}\) Ibid. Letter from Secretary to Government. G.D., to the Acting Clerks of the Justices of Peace. 8\(^{th}\) May 1855. pp 199-204.
excellence of its harbour. In 1854, with the establishment of the first mill (Bombay Spinning and Weaving Company) at Tardeo in Central Bombay, Bombay had begun to transform, into an industrial and manufacturing centre. Increased water supply was likely to prove immensely beneficial to such a promising city.

Thus, in view of its potential for expansion and Conybeare’s perception of scarcity and needs of the city, the initial Vihar scheme became vastly extended beyond the original object. When at first conceived, it was intended primarily to meet a temporary, though annually recurring, scarcity. However, as Crawford observed, it gradually transformed into one that sought to place the town and island of Bombay, with respect to its water supply, on a footing equal if not superior to many English towns and that, irrespective of the supply already existing in the island.

A Controversial Structure

Vihar was mired in controversies right from its inception which impacted the execution and ultimately the quality of its work. With the approval of the modified Vihar plan, by J.H.G. Crawford on 20th April 1855, Conybeare departed to England with a threefold mission: to acquaint himself with the practical working of the latest improvements in hydraulic engineering, which could help in the perfect completion of the Bombay water works project; to prepare detailed drawings and specifications, for letting the proposed work to contract; and finally to make arrangements for carrying such plans into execution at Bombay. Surprisingly however, the Court

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32 Sharda Dwivedi and Rahul Mehrotra, Bombay the Cities Within, India Book House Pvt. Ltd. 1995, Hereafter, Sharda Dwivedi, p 83. Edwardes mentions 1857 as the year in which the first cotton mill was set up in Bombay- the Alliance Spinning and Weaving Company’s Mill. By 1860 there were 6 more. See Edwardes Bombay, op. cit, p 264.

33 Selections B G, Vol. No. XXII, Major Crawford’s Observation, On Mr. Conybeare’s Second Report On The Supply Of Water To Bombay To W Hart. Secretary to Government. 20th April 1855, p 71

was unaware of any of these plans.\textsuperscript{35} And as luck would have it, Conybeare himself was unable to return to India, his health having suffered while surveying the Vihar basin. \textsuperscript{36} To make matters worse the, the work on the dams was suddenly commenced in Conybeare’s absence, by a surveyor Mr. West.

In the very next year of its initiation, the country was shaken up by the Mutiny. Stricken, the Government now directed that all further works on Vihar were to be deferred and that the “advances for the present be restricted to the sums that may be necessary to protect the existing works from deterioration” By this time 14 lacs had already been spent\textsuperscript{37} A reluctant Government had to be persuaded to continue the works with the argument that it was advantageous to continue with the same contractors. Halting of the works, otherwise, would have entailed payment of large sums of money, to them as well as the engineers and the establishment for the maintenance of the works and freight, which was yet to arrive. Additionally, the water works would have lost the favourable points of the contract, which had been executed when more than half of the works had been paid for. The dam too had not yet been severely tested. Moreover, no water had yet been admitted to the pipes, while the contractors had been paid, for all the pipes they had laid.\textsuperscript{38}

But the most enduring feature that characterized the entire construction of the water works was the intra professional rivalry displayed by the engineers which severely impacted its quality. The contentious role of Heneage Walker, the Chief Resident Engineer at the site of the Vihar Water works highlighted this rivalry. Unknown to the Municipality, Mr. Walker furnished Mr. Conybeare, no longer associated with

\textsuperscript{35}Ibid, Letter from James Melville, Secretary, to Henry Conybeare, East India House, 12\textsuperscript{th} June 1855, p 6.
\textsuperscript{36} Ibid, Letter from E. Macnaghten and W H Sykes and others, 23\textsuperscript{rd} January 1856, London, pp 2-3
\textsuperscript{37} GD1858. Vol. 83, Letter to the Secretary to the Government of Bombay by the Secretary to the Government of India, Fort William. 30\textsuperscript{th} November 1857, p 109.
\textsuperscript{38} GD 1857. Vol. 91, Letter to Hart Esquire from Rivers. 10\textsuperscript{th} October 1857, p 133
the works, with reports and received his instructions. Walker claimed that he had not been informed, either officially or otherwise, that Mr. Conybeare was no longer the home agent to these works or that he had been deprived of his position as its Consulting Engineer.

As for Conybeare, till as late as 1857, he considered himself the designer and the consulting engineer of the water works and hence professionally responsible for them. Hence, as he later insisted, his communication with Walker was to be considered a part of his professional responsibility. He even claimed that triplicate copies of this communication were apparently sent to the Court, to the Board of Conservancy and to Major Crawford. Despite this, surprisingly, the dams were not constructed according to the strict specifications laid down by Conybeare. Captain Rivers, the acting Consulting Engineer and Mr. Mylott, then Assistant Engineer, were a testimony to this fact.

This was so, since Walker admitted of no interference from the Government. His dealings of the works, right from the beginning, smacked of gross corruption. Having been given immense powers in the execution of the waterworks, he exercised full control over his subordinates as well. Such was his control over the works that he could independently alter them in any fashion he chose, and make payments to the contractors as he pleased. It was due to him that a large sum of money was granted to the contractors for a portion of the bank, constructed before their arrival in the country, and one in which they had neither spent labour or capital. Other embankments were constructed of inferior materials. Yet, in both these cases

40 Ibid. Letter from Mr. Walker to Capt. H Rivers, 14th October 1857. pp149-50
41 Ibid. Letter from Henry Conybeare, Consulting Engineer, Bombay Water Works. to Chief Secretary of the Government of Bombay, 17th May 1857. pp 170-71
42 GD 1859, Vol. 64. Letter to Young Esq. from HG Crawford, 18th May 1859. pp 142-143
43 GD 1858, Vol. 84. Resolution 2 of 834. 25th March 1858. p 19
alone, thousands of pounds were given away to the contractors without any return.\textsuperscript{44} Crawford, who had been designated the Consulting Engineer was not consulted in any of the alterations or additions involving extra expenditure of large sums of money. But the terms of the contract made Walker’s position unshakable.\textsuperscript{45} On account of ‘mismanagement of the works’ a large percentage was allowed to the contractors, amounting to 50\% on the estimated cost of the original work, for material that was never used.\textsuperscript{46} Eventually, the Municipality accused Walker of “an evident leaning towards the interests of the Contractors” \textsuperscript{47} and he was dismissed on grounds of misconduct.

The blame game followed soon, with Conybeare, a civil engineer, and Crawford, military engineer, pointing fingers at each other. Caught between these two professionals, Vihar also personified the contemporary divide between the civil and military engineers and threw light on the disparity in their status as well. Civil engineers had begun to be appointed to the PWD, a highly neglected department at this time, from 1853 onwards, when civil works of public utility were commenced under Dalhousie. Even so, military engineers, who drew more than the civil engineers, continued to predominate,\textsuperscript{48} since the latter were regarded, contemptuously, as men with only a theoretical knowledge of their profession, who could be ‘bought cheap’ and ‘sold’ on any occasion” \textsuperscript{49}

The root of the Conybeare- Crawford controversy lay in the former’s insistence on letting the construction of the earthworks by contractors in England, as he was

\textsuperscript{44} GD 1859, Vol. 63, Letter to Young Esq. from JHG Crawford, 8\textsuperscript{th} April 1859, pp 209-11

\textsuperscript{45} Ibid. Report by HG Crawford, 7\textsuperscript{th} April 1859, pp 213-217

\textsuperscript{46} GD 1859 Vol.64, Letter to Young Esq. from JHG Crawford, 26\textsuperscript{th} April 1859, pp 35-36

\textsuperscript{47} GD 1858 Vol. 84, undated Correspondence with the Court of Directors. Compilation number 657, pp 144-159


\textsuperscript{49} Ibid. 6\textsuperscript{th} July 1868, pp 25-26
convinced about their skill. While Crawford, the referee of the Bench, on the other hand, from the beginning had emphasized the need for careful superintendence more than any peculiar skill, as he felt that dam building could be quite as effectively cared for by the superintendence provided by Government, as by a contractor from England, a stranger to the country. In fact, he felt that the contract system, in this particular instance, would not be advantageous as regards cost, time, or perfection of execution.\(^{50}\)

It ended in an ugly manner with charges and counter charges on both sides. Conybeare concluded that some jealousy existed between the military and the civil branches of the engineering profession.\(^{51}\) He charged the military officers, who were expressly appointed to oversee the Resident Engineer, of incompetence in discharging the civil engineering functions, with which they were entrusted. In his opinion “The total inefficiency of supervision exercised by Government Inspecting Engineer in the case of Bombay Water Works is only a fresh proof of the inaptitude of the late Company’s military engineer to the discharge of such civil engineering function, as require some degree of technical knowledge, and lie beyond the scope of their professional training, and out of the ordinary routine of their circumscribed local practice”.\(^{52}\) Noting this hostility, between the two branches of engineering, the Bombay Times and Journal of Commerce commented that “it appears the military and civil engineers, appointed to control the execution of the works, were at war with each other during their entire progress,” and “such difference is a fertile source of extra expenditure”.\(^{53}\)

Disputes regarding engineering techniques also revolved around the type of dam that was built. Engineers, such as Captain Hector Tulloch, regarded an earth embankment dam as wasteful of material, and probably costly and difficult to build without skilled masons. Though British dam building practice in the 19\(^{th}\) century

\(^{50}\) GD 1856, Vol. 7, Letter from Crawford to Hart Esq. 23\(^{rd}\) April 1856, p 206.
\(^{52}\) BTJC op. cit, ‘Conybeare vs. Crawford’, 5\(^{th}\) December. 1859, p 2301
\(^{53}\) Ibid. Letter from Henry Conybeare 7\(^{th}\) November 1859, p 2109
was dominated by the use of earth embankments with puddle clay cores. However, at this time, their performance in England was found to be far from satisfactory. Earthen dam building was then, an innovation in engineering and therefore not in an advanced stage. It was a common practice to lay the outlets or supply pipe through or under the embankment, and in some cases, even without preparing a special foundation for it; a feature found at the Bradford reservoir in England, which ultimately burst, causing great loss of life and property. Eventually this system had to be stopped. Unfortunately however, the outlet pipe from the Vihar Lake for the town had been placed under one of the dams. It was even opined, at a later stage, that masonry dams were better suited for the Konkan region because good clay for puddle, the essential part of every earthen dam, was not to be found here, as it had vegetable matter. On the other hand, good stone was available. Lastly, earthen dams with leaks were liable to destruction, sometimes to a very sudden one, whereas masonry dams with leaks were always safe against sudden destruction, and never liable to be washed away bodily at all. Yet another disputable issue was the supply from leaden pipes, which was considered injurious to health. As a result, the Government was informed that the water pipes would have to be tinned from inside.

The water works proved to be troublesome to the locals too. Water pipes, laid through their private property, in the town, rendered properties unfit for use for any

54 Mike Chrimes, A Forgotten Chapter in Dam History: Masonry Dams in British India in the Nineteenth Century, Proceedings of the Third International Congress on Construction History, May 2009, pp 363-366. Hereafter, Mike Chrimes. Dams could be made either in earthwork or in masonry. But earthwork was found to be more economical of the two. It was also the one usually employed in Great Britain.


56 Ibid. pp 86-89

other purpose. Despite this, adequate compensation was not offered.\(^{58}\) Pipe laying in the town was done haphazardly since pipes had to be laid as and when they arrived from England. In very many cases, the pipes were not connected, for want of special castings which should have been delivered to the contractors. Thus, the streets had to be left open for further work which inconvenienced the public. Poor communication between the various civic bodies, and lack of clarity regarding the terms of the contract between the Government and the contractors and the neglect of a systematic supervision, during the progress of the work caused immense problems as carelessly arranged water spouts caused a nuisance on the streets.\(^{59}\) The Board of Conservancy too, refused to take the responsibility of the grievances of the people as it maintained that since the water works were being executed by the Government, the latter was supposed to take the measures against the contractors, to prevent the inconvenience thus caused to the public.\(^{60}\) Compelled on some occasions, the Superintendent of Repairs had to personally employ workmen and restore the road surfaces. Even these expenses fell on the Municipality. Walker not only denied the reports of the poor state of the roads, but also considered any corrective action taken by the Repairs Department, as an interference with the contractor's duty.\(^{61}\)

Bray and Co. on the other hand, not only claimed to have completed their work they even warned the Department of Repairs not to interfere as that would only increase their liability.\(^{62}\) At the heels of this refusal, came the claim for a sum of Rs. 4 lakhs as compensation by contractors since the delay, in the arrival of pipes, from England, prevented the completion of the work of pipe laying by the stipulated date.

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\(^{58}\) GD 1858, Vol. 84, Letter by Wittoba Mancojee to Mr. Hutchinson Esq., Collector of Land revenue, Bombay, 22\(^{nd}\) March 1858, p 47

\(^{59}\) BTJC, op. cit. Letter to the Editor, 24\(^{th}\) September 1859, p1812

\(^{60}\) GD 1857, Vol. 92, Letter from John Hutchinson, Clerk to the Board of Conservancy to Hart Esq., 9\(^{th}\) September 1857, p 205

\(^{61}\) GD 1858, Vol. 83, Letter to Mr. Aher by Mr. Walker, 18\(^{th}\) March 1858, p 65

\(^{62}\) GD 1857, Vol. 92, Letter from Pollock Walker and faithful to Henry Aher Esq. 14\(^{th}\) August 1857, pp 211-12
which forced them to continue maintenance for a longer time.\textsuperscript{63} Government however refused to do so, and asked for penalties instead, on the grounds of breach of contract.\textsuperscript{64}

**The Financial Conundrum**

Although a distinct understanding had been arrived at with regard to the expenditure of the Vihar water works, that it would not exceed Rs. 25 lakhs, the final expenditure amounted, with interest, to the large sum of 65 ½ lakhs of rupees. \textsuperscript{3/5} of the original estimated cost of the Vihar Water Works was for a main of 41 inch. However, the actual laid down was 32 inch. In spite of the reduction in the size of the main, the major cost of the work, the water works cost 2 \(\frac{1}{2}\) times the original project. Though the project had been executed for the town, reimbursement was expected from the Municipality. It was stipulated, that the Municipal Commissioners would pay to the Government, out of the Municipal Fund, at least Rs. 1, 75,000 on the expenses of the Waterworks, uptil the clearance of the entire charges, as also the cost of the maintenance of the work.\textsuperscript{65}

The controversy regarding Walker, Conybeare and Crawford dragged on even after the completion of Vihar. Emerging as one of its strongest critics, the Bombay Times and Journal of Commerce, berated Colonel Crawford for his incompetence “in allowing himself to be made the tool of a man like Walker” ----and further claimed that “the public can have little confidence in Colonel Crawford we think after that.”\textsuperscript{66} Yet, the strongest criticism was levelled at Mr. Heneage Walker who was referred to as Mr. Conybeare’s protégé\textsuperscript{67} and the work was titled as “Vihar Water Works swindle”\textsuperscript{68} The extravagant work at Vihar, according to them, could be explained by only one hypothesis “the existence of a corrupt understanding between

\textsuperscript{63} GD 1858, Vol. 84, Letter to Walker, CRE, by Bray Sons and Company, 17\textsuperscript{th} July 1858, p 377
\textsuperscript{64} Ibid. Opinion on Bray Case by the Advocate General, 7\textsuperscript{th} October 1858, p 390.
\textsuperscript{65} Hector Tulloch Report, op cit. pp30-31
\textsuperscript{66} BTJC, op. cit. 1\textsuperscript{st} Sept 1859, p 1652
\textsuperscript{67} Ibid, Vihar Water works’, 5\textsuperscript{th} August 1859, p 1469
\textsuperscript{68} Ibid. 16\textsuperscript{th} September 1859, p 1757
the contractor and the chief resident engineer." Conybeare was not spared either. He was referred to as "the most guilty party in the transaction."^69

As time proved, the first urban water works of the country were simply implanted in the city, in a stereotype mould, with constant reference to English models, without altering them with circumstances. The soil of Bombay proved unfavourable and many pipes, having been placed underground on the British model, became corroded very soon, due to the action of saline water. Many, not being of the desired quality, failed immediately as the Vihar water was let into them,™ due to which the town had to go without water for hours together. Many, despite all the precautions taken to operate them, could not withstand the pressure of water, in the first monsoon. These had to be repaired within a year.™ The reservoir too surfaced as an arena of problems since the intense tropical sun led to rapid growth of plant life in it. To add to the woes, the works at Vihar had not been finished in a workmanlike manner, according the Articles of Agreement between the contractors and East India Company. The three embankments were found leaking in many places, with portions that had settled; the Tower was not water tight; the railway girders, used as stream crossings, were badly put together thus weakening their hold over the pipes.™ The dams that finally emerged were defective in structure, since the work was of a slipshod nature.

HYDRAULIC HEGEMONY

Yet, Vihar created a blueprint for all subsequent water works which hegemonised the city in the course of the next century. It grew as a 'standard against which other

[^69: ibid. Letter from Henry Conybeare, 7th Nov.1859, p 2109]
[^70: GD 1859, Vol. 65, Letter no. 198 of 1859, from JHG Crawford to H Young Esquire Secretary to Government, 6th August 1859, pp 93-95]
[^71: GD 1860, Vol. 44, Letter from Rowland, Chief Resident Engineer to Crawford, 14th March 1860, p 261.]
schemes were judged'. It marked the inauguration of the concept of the ‘minimum amount’ required by the city. By considering the supplies to the ‘whole’ city from a single source via the hydraulic technology, it created the basis for the dominance of engineers and centralization of control in the hands of the Government, in the area of urban water management. From now on, the city never looked back. Within a span of 100 years the city’s water supply had to be augmented 5 times in response to its changing needs. Additionally, technology combined with the new Victorian sanitary norms to completely overwhelm the indigenous water resources. Thus, this period witnessed the emergence of ‘noso-politics’, with water supply and drainage and sewerage as the tools of control.  

The Sanitary Sword

Sanitation emerged as the buzz word in the post mutiny years in India. In fact, the revolt added new dimensions to the cause of sanitation. These were ‘safety, loyalty’ and ‘civilizing’ the people of the country. A contemporary author noted, that after the revolt, particularly, the Government, wished to channelize their vigour and energy to conquer the country by new means viz. - sanitation, which replaced the sword in this era of empire formation. In this the British were greatly aided by their advanced knowledge of science and technology

Further, in 1859 it was found that the average annual death rate among the British soldiers in India, since the year 1817. had been 69 per 1000. In Bombay too, the

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73 Graber, op. cit, pp 319-21
75 Veena Talwar Oldenburg, the Making of Colonial Lucknow 1856-1877. OUP. Delhi 1989, p xv.
77 Florence Nightingale, How People May Live And Not Die In India. published by Emily Faithfull, London. 1863, p 4. Hereafter Nightingale
health of the soldiers at Colaba, caused acute anxiety to the administrators. In 1863, each soldier cost the Government a sum of pound 97 annually, while a sum of 388,000 was spent per annum on sickness. The death rate in the Bombay Cantonment was higher than in any other town in the Presidency. This shocking discovery culminated in the appointment of the Royal Sanitary Commission for the three Presidencies of India, in 1863, to enquire into the condition of the army, at the instance of Florence Nightingale. The Commission was to advise and assist in all matters related to the health of the army and to supervise the gradual introduction of sanitary improvements in barracks, hospitals and stations as well as in towns in proximity to military stations.

The Commission attributed the mortality rate to a faulty water supply and drainage. But, not ever having visited India, and ignorant of its language, concepts and ways of hygiene, and obsessed with the new science, Nightingale and the Commission condemned Indian villages as dung heaps and Indian waters as fouled by Indian people and cattle. Thus, provision of sanitation to the army, emerged as one of the biggest security concerns of the British at this time. Since the army could not provide itself with the necessary water supply and drainage, Government intervention in these areas was a must. The move, towards the achievement of this objective, resulted in the physical separation of the army and British officials from the indigenous people through the creation of cantonments, and the emergence of water supply and drainage systems as vital components in urban planning and the consequent transformation of Bombay. The health of the soldiers however could not be considered in isolation since physical segregation could never be done in totality. Hence, need was felt to clean the immediate surroundings as well. But the tendency to view the Indians as a part of the sanitary problem prevented the

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78 Chandavarkar, Indian City, op. cit, p 42
79 I T Prichard, op. cit, pp 280-81.
diffusion of the benefits of the new hydraulic technology that was to supply copious amounts of water for the cause of sanitation. Besides, the ‘transfer of technology’ was not an easy task as the latter itself was imperfect owing to its experimental nature, poor execution and uneven distribution.

Unsurprisingly therefore, this phase of water management was marked by considerable uncertainties. These related to various aspects of water distribution and consumption, such as finance, water rates, usage, duties of the various water works officials, quantity of water, quality of the water pipes and mains and especially the method of distribution of water for the natives. The latter especially showed a pronounced colonial bias. The settlement of many of these issues resulted in the segregation of the natives. The chaos was intensified by interruptions of services, resulting in water famines, which soon came to be accepted as a regular feature of water supply. Moreover, the new piped water supply changed the distribution, allocation and consumption patterns in the city. The overall picture, that thus emerges, is one of confusion.

The Water Works Department was badly organized to begin with. The duties of the Chief Resident Engineer were not defined and a large part of these were performed by the Surveyor’s Department. The latter, however, instead of being well informed of the status of the lake and the main pipe conveying water to the town and other supervision duties, was made to perform the duties of the Assessor. Almost a decade later in 1869, Arthur Crawford, the Municipal Commissioner, observed, about the Department, “I regret to be obliged to state. I found, to my great surprise, that it was not (if it ever has been) properly prepared for a serious job of this kind.”

Faulty mains continued to be a botheration throughout.

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The distribution system proved to be inadequate as the pipes were insufficiently sized on account of which the Post Office could not be saved.\(^85\) Intermittent water supply and carelessness displayed in the Water Works Department made the fire management ineffective despite new supply systems. Management of fire also meant denial of water supply to some people. Thus, fire fighting, which was an important item on Conybeare’s agenda, was completely defeated.

**Sectoral Consumption: Social Prejudices and Strategies Of Control**

Till 1859, there were no clear plans for the distribution of the water.\(^86\) In 1858, permission had been sought for an advertisement in the Government Gazette and the daily newspapers twice or thrice, to ascertain the demand on the water works in the shape of private supply at the commencement and to provide accordingly. Government sanction would be required for each application, which would be made.\(^87\)

The earliest beneficiaries of the Vihar water supply proved to be the Government institutions, the army and the private parties. By 1865, the supply was extended to the Gunpowder Works at Mazgaon,\(^88\) the House of Corrections,\(^89\) and all the infantry barracks and Officer’s Bungalows at Colaba. But, here due to the smallness of the Vihar sub main and insufficient pressure, water was supplied only at night, except at the lower end of the barracks.\(^90\) Later in 1867, with the proposal of a cantonment in Colaba in sight, the Acting Sanitary Commissioner recommended a supply of 30

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\(^85\) *Times of India*, 8\(^{th}\) May 1871, p 2

\(^86\) GD 1859, Vol. 65, Letter to SD Birch Esq. Accountant General from JH G Crawford Consulting Engineer. 22\(^{nd}\) November 1859, pp 233-34.

\(^87\) GD 1858 Vol. 84, Letter to William Hart, Secretary to Government, by Crawford Consulting Engineer, 19\(^{th}\) June 1858, p 67


\(^89\) RABP. op. cit. 1861-62. p 95

\(^90\) Ibid. 1865-66. p111
gallons per head per person. The Government, accordingly, resolved to make available the requested quantity. Several petitions, made on the supply of water to the vessels in the Bombay Harbour, led to the delivery of water there too. In fact, by 1866, The Elphinstone Reclamation Company, in a way, monopolized the water supply and was evidently favoured by the Municipal Commissioner Arthur Crawford.

The ‘modernity’ of the piped water supply, however, evaded the locals who were to be supplied by 870 standpipes fixed on the roads. Even here, there was a visible lack of consensus between the engineers and planners. While Captain Crawford had shown preference for fountains, Conybeare was in favour of standpipes. Economy, evidently, was the long term objective of the Government, in creating this form of a public water supply for the larger part of the inhabitants. Consequently, as Matthew Gandy says, Bombay changed from a “private” to a “public” city where privately organized access to potable water or sanitation was gradually incorporated into a centralized, networked and municipally controlled metropolitan form. In fact, by making water supply ‘public’ the Government deliberately attempted to control the consumption of water by the natives. Later, Municipal Commissioner Arthur Crawford openly acknowledged that the poorest class should be supplied only from public sources, on the assumptions that the “demand for water amongst the poorer people is very much greater than we can supply them” and a lot of water would be wasted by them. Therefore, he was completely opposed to the idea of introducing water into the houses of the poorer natives. Since their houses were built

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92 Bombay Builder, op. cit. Vol. II, 5th November 1866, p 106
93 GD 1859 Vol. 63. Letter to H. Young Esquire, from HG Crawford 24th December 1858, p 33
94 Gandy, Modern City, op. cit. p 8
‘indifferently’ and by custom they were "drawers of water" house connections were to be avoided. Naturally, the locals were always at a loss, as the standpipes were almost always out of order, besides being situated in densely populated areas.

It was also equally clear that the Government ultimately intended relying on public generosity for provision of water to the poor. Even at the time that Vihar was conceived, some of the natives of Bombay felt scruples in approving of a scheme that involved the sale of water, a scared resource and a necessity of life. The Governor, therefore, appealed to the native Justices of Peace, to explain to their countrymen, that the proposed measure would not preclude the institution of free reservoirs for the poorer classes. Wealthy men, who were desirous of being public benefactors, were actively encouraged to gratuitously provide large or small fountains according to their means, to the poor. Conybeare too had openly suggested the idea of donations from the natives for the creation of fountains for the poor, as such kind of work received public approbation in India. Contribution was expected from the rich Indians even where the water works were concerned.

Thus, Cursetjee Furdoonjee, a well known merchant, offered to erect a drinking fountain, to be maintained by the Municipality, in the memory of Sir Jamshetjee Jeejeebhoy. Sir Cowasji Jehangir, a prominent Parsi leader, provided 40 drinking fountains to be placed in the various parts of the city. Some individuals showed willingness to bear expenses for erecting fountains for the poor, provided the Commissioners were willing to sanction water free of cost. The Provincial Government however, proposed to establish a meter at all such charitable fountains and put the so called charitable motives of the donor to test by requiring him to pay

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96 BDWS 1869, op cit. p 29 and 35
97 GD 1855, Vol. 55. Letter from the Secretary to Government, GD, to the Justices of Peace. 23rd April 1855, pp 149-50
99 Bombay Gazette, 18th November 1861. p 1103
for the water as well as the fountain, since they wanted to be sure that the water was indeed given to the poor and was not wasted either. Similarly, even later, want of drinking water being felt in Dongree Coolee in the district of Mandvee; a drinking fountain was proposed by Mr. Kesowjee Naick in that area. While the Government appreciated the public spirit of Mr. Naik, it refused to bear any expenses.

But not all such works were motivated by philanthropic purposes. David Sassoon, a rich Baghdadi Jew, who was convinced that the city had been amply provided for by the colonial administrators, wished to provide one, which was meant to be highly ornamental. It was to be such, as would add to the attraction of the Esplanade. Anticipating nuisance from this work, as it would be resorted to, in the evenings, by crowds of water carriers, Sassoon even proposed restricting the use of the fountain to certain hours of the day.  

**Reaction of the Locals**

As far as the new form of piped water supply was concerned, the reaction of the people was a mixed one initially. Resistance was visible in the opposition posed by people like Jagannath Shankersheth and the other Hindu gentlemen to the tanks in Walkeshwar being supplied with water from Vihar. Even in 1868, there were many who would not drink it and preferred to acquire water from wells and tanks situated at considerable distances.

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101 Pelly Report, op. cit. pp 46-47
104 GD 1858, Vol. 84, Resolution by the Government, 19th July 1858, p 259. Also read Dossal’s Imperial Designs and Indian Realities The Planning of Bombay City
But to the marginalized locals, who were denied access to Vihar water, bursting of water pipes was an occasion to rejoice since they had no notion of public property.\textsuperscript{106} Water was also often collected, by them, from the leaking hydrants in the town. Many tried to prise them open and draw water with the help of hollow bamboos. In fact, the practice became so common, that even Parsi ladies were found using the technique and it was feared that the method would soon be used to convey water to all dwellings.\textsuperscript{107} In 1859 itself, about 150 hydrant covers had to be replaced at a cost of 60 rupees each. A fine of Rs. 5 was charged to each of the offenders and it was aimed to increase the sum of the fine if the practice did not abate.\textsuperscript{108} These damages proved risky to the equestrians as well as public health since many hydrants were in gullies, where their water mixed with the street drainage.\textsuperscript{109}

\textbf{Post Vihar Policy towards Tanks and Wells}

The onset of Vihar water saw the gradual obliteration of the tanks and wells that studded the island. A complex set of factors guided the strategy towards these traditional water supply systems of the natives. Scarcity of land for commercial and residential purposes, the new sanitation paradigms and above all, the desire to extend complete hegemony over the city decided the course of action regarding these tanks.

Within 3 years of the creation of Vihar the necessity of roads was acknowledged by the Commissioners, who candidly declared that the requirement would steadily increase. “On the other hand, the necessity for the construction of tanks, which in 1851 was urgent, has now, owing to the introduction of Vihar water, almost if not, indeed, entirely disappeared.” But good roads could not be constructed since the

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\item \textsuperscript{106} Bombay Gazette, 5\textsuperscript{th} April 1859, p 322
\item \textsuperscript{107} Ibid. 9\textsuperscript{th} June 1859, p 542
\item \textsuperscript{108} BTJC. op cit. 23\textsuperscript{rd} November. 1859, p 2221
\item \textsuperscript{109} GD 1859, Vol. 65. Letter to Crawford from Rowlands Acting Chief Resident Engineer, 13\textsuperscript{th} July 1859, pp 67-69
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Municipality was low on funds, due to the construction of Vihar. To solve the problem it was decided to improve the Flats and sell the land set aside for tanks.\textsuperscript{110} Moreover, the possibility of wealth generation, through the control and distribution of water, was also realized. Engineers like Conybeare, unabashedly favoured reservoirs, such as Vihar, as commercial undertakings. The most important element, in the whole venture of construction or maintenance of storage reservoirs, was the economy in the storage of water. No possible case could be made out for tanks at all he argued.\textsuperscript{111} They were also considered a drain due to their tendency to silt up.

The new model of sanitation too emerged as a convenient instrument which could be used for the acquisition of the land thus required. As per the latter, a healthy environment could be engendered only by the provision of open spaces which allowed the free circulation of air. This could be had by the closure of tanks. The Report of the Commissioners Appointed to Inquire into the Sanitary State of The Army, 1863, only strengthened the prejudice against the traditional method of obtaining water in India. Consequently, sanitarians like T.G. Hewlett (Health Officer to the Municipality), following Andrew Leith, Deputy Inspector General of Hospitals, took exception to many tanks. Leith suggested the closing of Mumba Devi, and others. The ground of the Cowasji Patel tank, in Girgaum, and the Khandia tank was suggested for the construction of a public market.\textsuperscript{112} while the ground created by the filling up of the Nowghar tank, in Mazgaon, was recommended for the construction of latrines, which were deemed a more important


\textsuperscript{111} Minutes and Proceedings Of The Institute Of Civil Engineers Other Selected And Abstracted Papers Vol. XXXIII 1871-72 Pt. I. George Gordon “ On The Value Of Water And Its Storage and Distribution in Southern India” by MICE. 30th January 1872, pp 410-15.

need of the area. In 1868, the Municipality attempted, twice, to close the Baboola tank but failed. Henceforth, the Municipality zealously undertook the task of filling in several old tanks. Not content with this, wealthy individuals were also induced to fill up tanks with promises that fountains would be erected in commemoration of their relatives.

Wells were treated in a similar manner. In the 1860s, when the ramparts of the Fort were demolished, a number of wells were erased. When the donors of these wells protested and asked for compensation, an anxious Government passed a resolution in 1864, stating that since the inhabitants of Bombay had been amply supplied with water, these charities had ceased to exist and it had been forced to take this action to prevent them from becoming a public nuisance. No compensation was granted.

But the biggest weapons in the hands of the Government proved to be the Nuisance laws, which were increasingly resorted to during this period for the closure of these water bodies. The highly insanitary conditions of a rapidly developing Bombay, in the 1860s, proved ideal for the imposition of these laws. Inspired by Chadwick’s ideas, of enforcing norms of cleanliness, in certain areas and classes, along with legislative penalties and provisions, required to maintain the sanitary conditions among the poor, these laws basically told people how they could and could not use their lands. Thus, they regulated the activities of people on land in such a way that no harm was caused to the public. Nuisance consequently came to be a “Government controlled land use restraint.”

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114 BDWS 1869, op. cit., p 66
115 Bombay Gazette. 15th August 1861, p 774
116 Preeti Chopra, op. cit., pp 328-329
117 Engineers And Officials. op cit. pp 43-46.
By 1862, nuisance laws were embodied in the penal code, and recognized a person as guilty of public nuisance, if s/he carried out "any act or is guilty of an illegal omission which causes any common injury, danger or annoyance to the public or to the people in general who dwell or occupy property in the vicinity, or which must necessarily cause injury, obstruction, danger or annoyance to persons who may have occasion to use any public right". "Fouling water of public spring or reservoir", was a typical instance of Nuisance. However, Nuisance, as defined in India covered a rather wide spectrum of activities, many of which were not recognized as Nuisance even in England.\(^{119}\)

In Bombay, these laws were exercised more frequently and in particular with reference to water supply and drainage. They helped the Government appropriate land and waterways, for 'public' use, thus dispossessing individuals and communities of their customary entitlements to common property resources.\(^{120}\) Based on the spirit of these laws, Legislations such as the Act of 1865, authorized the Municipal Commissioner to fill up, or draw off and remove stagnant water, from unwholesome tanks on private premises. Notices could be served to the owners and if these were ignored, then he could enter the premise and do the work and recover the cost from the owner. This was done in the case of the Bhuleshwar tank. The matter was subsequently taken to the Court because the owners disputed the right of the Commissioners, to recover the cost of cleaning and repairing the bottom of the tank.\(^{121}\)

Interestingly however, the nuisance laws were used for a dual purpose by the natives. In many cases this law found support of the natives, when they felt that it could be used to compel owners of private tanks to maintain them and prevent them from becoming harmful to public. At times, the same were also used to transcend

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\(^{121}\) BDWS, 1869. op. cit. pp 35-36.
religious barriers, imposed in case of several tanks, which prevented their use by members of different communities. Therefore, the Municipal Commissioner’s action, of cleaning the tanks of the temples at Mumba Devi and Bhuleshwar, and suing the trustees, was approved by many inhabitants, since these tanks were used only by Hindus of certain castes. On other occasions, however, people protested against them, when used for the closure of tanks and wells used by the poor.¹²²

THE ROAD TO TULSI

By 1860s, Conybeare’s dream of a vastly expanded Bombay had materialized, with the town metamorphosing into a pivotal presidency capital next only to New York. The opening of the railways and the cotton boom, caused due to the American civil war, spurred this growth. The opening of the first section of the B.B and C.I. in 1860 and the completion of the Ahmedabad, Broach and the southwards sections by 1864, gave a further impetus to this growth. There was a significant expansion of the mill industry too, which could be gauged from the fact that the number of mills increased from 13 in 1863-69 to 42 in 1880. In 1885 they numbered 68.¹²³ Besides cotton mills, there were numerous other factories such flour mills, workshops etc that grew up during this period. Vihar was therefore no longer sufficient to meet the needs of the growing city. The opening of the Suez Canal in 1869, the formal establishment of the Municipal Corporation in 1872 and later the Bombay Port Trust in 1873, reclamations and new roads transformed the town into a modern cosmopolitan and commercial entity. This growth was complemented by a rise in population.

Naturally therefore, within 5 years of its formation, Conybeare’s calculations, regarding water supply to the city, based on his reckoning of the gathering grounds, which he had estimated at 5000 acres,¹²⁴ as well as those related to rainfall proved

¹²³ L Michael, op. cit. p 372
wrong. Although he had assumed the rainfall at Vihar to be 100 inches, due to its height, it received only 90 inches. Consequently, the issue of water famines in the city brought to the forefront the subject of the inadequacy of the Vihar water supply. A survey, conducted by the Corporation, showed that it was not possible to augment the Vihar catchment area.

Fears of dam failure dominated the issue as well. At Vihar, the dams posed a double risk as the outlet pipe, went through the embankment and the main that supplied water to the city, was injudiciously located along the railway. Any accident here was likely to damage both to the railway line as well as the water pipe. A minor accident on the GIP railway near Coorla had resulted in the stoppage of water for a day or two.

Leakages in the dam were an additional source of anxiety. Although repaired in 1865, they were seen leaking in 1870 once again. Since the work of repair was considerable, the best engineering talent in Bombay was recommended by Capt. Hector Tulloch: this being Col Kennedy, Colonel Trevor, Mr. Ormiston and Mr. Le Mesurier. But disagreement surfaced at once, showing once again that there were no standard norms, in the country itself, for dam construction. Engineers like Ormiston disagreed with Tulloch that the dam showed any symptom of immediate failure. Others like Kennedy opined that there was nothing serious about the leakages. “It is tighter than 9 out of 10 of the irrigational bunds to be found throughout the country that have been in existence for generations; in Dharwad for instance it would be considered a remarkably good bund” he remarked. Trevor too was of the opinion that the leakage posed no immediate danger. Le Mesurier on the other hand, condemned the structures as ‘exceedingly unsatisfactory’ and in need of thorough repairing.

125 Hector Tulloch Water Report, op. cit, p 19
126 BDWS 1869, op. cit. pp 4 and 9
However, what added most to the urgency of the problem was the fact that this scarcity affected Colaba, which with its European troops, got a scanty measure; as well as the harbour where water was received so slowly that it delayed vessels ready to sail. Want of pressure made it difficult to send water to the elevated parts of the city, such as Malabar and Cumballa Hills as well.

Faced with scarcity, once again, the ordinary native houses and chawls were now encouraged to store water in ‘garras’ and ‘chatties’ on the assumption that these cost next to nothing, and that people would soon learn to store their day’s supply in them, just as they did when they had to get it from wells. For better and larger houses and manufactories however, service cisterns large enough to store one day’s supply, were recommended, which would give a constant supply from taps. But the Health Department continued to use a constant supply of water at the night soil tanks, at Carnac Over Bridge.

Finally, in July 1868, Mr. Russell Aitkens, the Executive Engineer to the Municipality, submitted a “Report on the Extension of the Bombay Water Works” in which he proposed 4 different schemes. This envisaged schemes at Shewla, Kanheri, Tulsi and Powai.

Re-interpreting scarcity

In spite of the water problem, there was not a single issue on which administrators, engineers and the medical fraternity could see eye to eye. This time the very issue of scarcity was questioned by many, since it was difficult to trace whether deficiency, was due to original defects in the pipes, want of sufficient water or the manner in which it was distributed. The sufficiency of water, accepted by engineers like

notes in his book of 1889, on page 202, that within two –three years of its creation leakages were discovered in the dam and that the problem could never be resolved.

128 General Administrative Reports of the Bombay Presidency, 1874-75; p104. Hereafter, GAR

Ormiston was stoutly denied by administrators like Arthur Crawford who strongly recommended doubling of the supply. But the addition of another main to Vihar, to do this, was not feasible, as the water in the Lake was not sufficient.\textsuperscript{130}

Once again, absence of the exact water supply statistics, regarding the actual consumption of Vihar water, per head per day, complicated the matters. Leith’s report of 1864 had calculated it to be only 5 gallons,\textsuperscript{131} while Dr. Thomas Blaney, a medical practitioner, felt that despite all the claims to the contrary, the largest proportion of the population limited themselves to a daily supply of 2 gallons of water per head, since they had to travel long distances; sometimes as much as a quarter of a mile.\textsuperscript{132}

Discontent was expressed by natives who calculated their supply at 1 gallon phpd from various sources. They, it seems, were more anxious for an extension of water supply. Mr. Cursetjee Framjee, a graduate of the Grant Medical College, calculated that although it was claimed that 10 gallons of water per head per diem reached Bombay, it could not be more than 6 gallons, as loss by evaporation, wastage and leakage had not factored in this calculation. Natives, naturally, also strongly pressed for the preservation of public wells for future want. Appeal was made for the extension of water supply to the houses of the poor as well as to the landlord, at a minimal cost, and provision of at least 5 gallons of water, free of cost through meters. As regards the standpipes, 3-4 every hundred yards were desired.\textsuperscript{133}

There were yet other influential natives like V.N Mandlik who strongly advocated the provision of a second main from Vihar, the opening for which was already provided to allow water to escape at the height of the monsoon season. While

\textsuperscript{130} BDWS 1869. op. cit. pp 7-9

\textsuperscript{131} Leith, op. cit. p23. One finds different estimates in different reports showing that no one knew exactly how much was being received per head per day. As per Rienzi Walton, although the supply on paper was 13.5 gallons, only 12 gallons per day was available to the people: Professional Papers. Lang. op cit. pp 323-324

\textsuperscript{132} BDWS 1869. op. cit. p 55

\textsuperscript{133} Ibid. pp 70-72
appreciating the benefits of Vihar, Mandlik strongly disapproved the closure of wells which he regarded as, "interference with private property, unless it were absolutely required for the public good." Even at this time there were plenty of good wells in the city and many parts had good water. On the other hand rich businessmen like Bayramjee Jeejeebhoy, were totally in favour of the extension of the water works.\textsuperscript{134} Empathizing with these needs of the natives, there was a class of the British too, who confessed, that the city was "worse off now than we were before Vihar water works were made" and pressed for the preservation of tanks and wells as a source of water security.\textsuperscript{135}

Lack of consensus was visible, similarly, as regards the minimum quantity to be provided in future. Estimates varied from 10-16 gallons per head per day. Health Officers like Dr. Lumsdaine felt, that the requirement could be as high as 30 gallons per day, since Bombay was a manufacturing town. But there was also a feeling that the more the water allotted, the greater would be the wastage. Such wasted water would be absorbed by the ground and the resulting dampness would cause diseases, especially malaria.\textsuperscript{136} Amongst engineers, while Russell Aitkens preferred larger quantities for the drainage requirements, Trevor apprehended nuisance if the extra water was unable to pass off.\textsuperscript{137} Besides, an improved water supply would have necessitated improved bathing arrangements in the native houses, as also house connections with drains for every house to drain off waste water. People like Dr. Hunter, member of the Bombay Drainage Commission, pressed for these arrangements, even before an increase in water supply. Religious perceptions also coloured the idea regarding the daily water requirement. Parsees, for example, felt that Hindus required more water than they did.\textsuperscript{138}

The dominant factor, in the adoption of any scheme, for the extension of water supply however proved to be finance. The Government was interested in a scheme, which would combine the least expenses with a minimum of engineering risks and

\textsuperscript{134} Ibid. Appendices B&C, p142
\textsuperscript{135} Ibid, pp 5-6
\textsuperscript{136} Ibid, p 27
\textsuperscript{137} Ibid, p 53.
\textsuperscript{138} Ibid, p 39
one which could be extended, from time to time, to meet the requirements of a growing population. Therefore, rejecting all the other schemes, the Scoble Commission of 1869 finally recommended the Tulsi scheme because it would give a 50% increase to the water supply at a small cost. Besides, it would augment the Vihar supply in those years, when the latter did not have sufficient water to meet the drain upon it.\textsuperscript{139}

But even with the addition of Tulsi, the supply from Vihar was likely to be sufficient only for an intermittent service, a minimum supply for domestic uses and an unreliable supply in case of fires. Therefore, the measure of Tulsi was considered a temporary one. Hence, it was recommended that in order to get a continuous service, at full pressure, what was required for Bombay, and “Bombay should be satisfied with nothing less”, was a low level reservoir from which water could be brought by a covered masonry conduit. Survey for the location of this reservoir was recommended. Such a reservoir, would not only accommodate any possible increase of population, but the water not required, could be made available for the service of towns, on the road, for the supply of the Railways and for irrigation. “In this point of view the work might be regarded as an Imperial work, and not one of a merely local municipal character.” The Government too, concurred with the Commission’s decision.\textsuperscript{140} In the absence of any clear picture, about the actual quantity of water received from Vihar per head per day, the Commission concluded that 15 gallons of water, per head per day, would suffice the domestic and other public requirements of the city.

That the future water supply schemes were also planned with a commercial intent is brought out unmistakably by the Shewla scheme, where Aitken plainly stated “In considering the revenue to be obtained from water works in India there is one item which appears to have been always overlooked, viz. the income which might be derived from the sale of water for the purpose of driving cotton spinning or other machinery.” Water from this scheme could have been used for the cotton mills.


\textsuperscript{140} Hector Tulloch Water Report, op. cit. pp 44-48
which hitherto ran on coal power. Shewla, with its promised supply of water, thus would have fitted into the colonial scheme of things but for its cost.

At the same time the policy of trial and error, in the area of engineering, loomed large. The Kanheri scheme, proposed by Aitken, was to have a dam 136 feet high, although he himself was acquainted with a dam, only 114 feet high, which had then been built at Manchester. Yet, he ambitiously designed a dam, 136 feet high, for the Kanheri scheme. Such a dam, if constructed, would have been the first one of its kinds. In fact no dam, at that point of time, was higher than the Manchester dam. The British themselves knew nothing about handling water under such great pressure; this being one of the reasons why water was never filled up in reservoirs to their proper height. Luckily though this scheme did not take off. it was openly accepted that “the city may be compelled to have recourse to it at some future period, just as Dublin, Glasgow and other large towns are now driven to seek water at great distances, to supply their increased population.” Thus, the trend set by Vihar, was carried forward by all the schemes designed for the extension of the water supply of Bombay in future.

To Be or Not To Be: Independent

Like its predecessor Vihar, the story of Tulsi, had many twists and turns. Bureaucratic delays and differences of opinion came in the way of its execution, as a result of which it was completed six years after its sanction. Commenced in 1872, a large portion of the rainfall of the Tulsi Valley was passed into the Vihar Lake, in the monsoon of the same year. At this stage, Tulsi was to be merely an auxiliary to Vihar, and was intended to fulfil two objects. Firstly, to have a reserve of water independent of Vihar, of about six gallons a head daily, so that in case the Vihar dams failed, Bombay would still have a water supply. Secondly, it was intended to

142 BDWS 1869. op. cit., p 17
enlarge the gathering ground of Vihar, which would restore the equilibrium between its supply and the demand made on it, by passing the surplus water of Tulsi i.e., the rainfall which, when Tulsi was full, would run, otherwise, to waste over the waste weir on the Tasso, into Vihar.

When originally conceived by Russel Aitkin in 1868, the lake was to be constructed as an auxiliary to Vihar. A dam, 35 feet high was approved. In 1869, Dr. Blaney, a popular private medical practitioner, suggested that it be made independent. For this, he proposed a dam 70 feet high and a 24 inch main from Tulsi, 21 miles long. Major Tulloch, in his report of June 1870, adopted Dr. Blaney’s suggestion, but proposed a dam 90 feet high and a 30 inch main. The advisability of Major Tulloch’s scheme was however questioned by General Tremendheere’s committee of July 1870, chiefly because it was then very doubtful about the supply which the Tulsi valley was capable of yielding. The scheme then appeared likely to be hung up. But anticipating a water famine, Health Officer, Dr. Hewlett, acknowledged in 1871 the “urgent necessity” to supply pure drinking water to every person. The prevalence of cholera in the city, at this time, attributed to this deficiency of pure water, galvanized the Municipality into considering the Tulsi as an auxiliary to Vihar therefore. This proposal was adopted by the Bench on 20th November 1871. But the publication of Mr. Rienzi Walton’s (Executive Engineer to the Municipality) report on 24th December 1871, proposing a main dam 74 feet high, once again ignited disputes and antagonism amongst the engineers of the city. Walton’s scheme would have enabled the Tulsi Lake to be made either into an independent source of supply or into a storage reservoir only auxiliary to Vihar. However, the designs submitted by Walton were condemned by Mr. Ormiston, Executive Engineer and the referee of the Bench, who even proposed that the former be censured for going against the wishes of the Bench. Walton and Ormiston differed on the one vital issue of whether the lake should be made an independent or an auxiliary source of water supply. Ormiston’s suggestion that the city could have two independent sources of supply, which would insure it against any drought, in case of a failure of the Vihar

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144 Pedder’s Proposals, op. cit. p 35
dams, was adopted by the Bench, which ordered this revised scheme to be carried out. Ormiston’s report changed the whole complexion of the plan.

Immediately, the Commissioner, the Bench and the Government locked horns over the nature of the proposed Lake. Since Tulsi was viewed by the Government as merely a stopgap arrangement, pending Tulloch’s report of the nearby areas, from where a far greater supply of water could be had, it had favoured, in 1871, the cheaper project of 4 lakhs, by which Tulsi was merely to be a reserve, to supply the deficiencies of Vihar from year to year. Hence, any additions to the project were considered a waste. The Justices, on the other hand, desired that either a fully independent scheme should be adopted or the work on Tulsi should be completely suspended till Tulloch submitted his report.

Yet another row erupted, this time between the consulting engineers of the Bench of Justices and the Government. Col. Kennedy, Government referee, was against the modification, while Mr. Ormiston, referee to the Bench, obviously in its favour, as it would meet not just the ordinary requirements of the city but also “extraordinary”. The scheme, as adapted by Ormiston, was to cost Rs. 5 lakhs and since the Municipality was low on funds they had applied to the Government for a loan for that sum. At this time the Justices seemed to have been under the impression that they could go ahead with their plans without the consent of the Government. But section 82 of Act II of 1865 gave the Government of India the power to approve or prohibit the carrying out of any extension to the Vihar Water Works. Therefore, a stalemate was reached. Ormiston was criticized for the unprofessional manner in which the modifications were made and the matter was transferred by the Government to the Public Works Department.

However, it was it was not easy to get sanctions, because the machine of the Government was cumbersome and the secretaries to the Government slow. While the

145 GD. 1873, Vol. 79, pp 8-9
146 Ibid. p 13
147 Ibid. Proceedings of the Bombay Bench of Justices. 8th April 1872. p 37
148 Ibid. G.R. No. 1842. 25th March 1872. pp 32-34
projects for the improvement and extension of water supply originated from the Municipal Commissioner and had to be approved by the Government, the task of the Bench was to get funds out of the Municipal Funds. This was also subject to the control of the Governor in Council. Moreover, when any matter related to engineering questions arose in the General Department, the Government of India referred it to the PWD, where it had its own officers, and after the professional advice on that matter had been obtained it was re-transferred.\textsuperscript{149}

It would be germane at this point to understand the financial arrangements between the Government of India and the Indian Municipalities. In the post-mutiny period the Government, with a debt of 98 million pounds and inelastic land revenue, recourse to financial decentralisation. In order to relieve the imperial funds of any extra expenses for the purpose of provincial development, local bodies were given charge of their local works. Thus, all financial support from the Government of India ceased. This move gained further momentum from the reports of the Royal Sanitary Commission of 1863, which threw a search light on the dirt and disease of many towns in the country. Further, Viceroy Lord Lawrence’s Government decided that, post 1865, all municipal institutions, were to raise their own revenues, for the purpose of developing their respective areas as they desired. All the same, bigger and newer projects were subject to the control of the Provincial and Imperial Government. Lord Mayo’s Government promoted this policy in the 1870s.\textsuperscript{150} Tulsi was one of such big projects.

As expected therefore, the loan applied for, by the Corporation, was recommended by the Provincial Government to the Government of India, in view of the great improvement it would secure, by increasing the water supply. But it took time to scrutinize the scheme. When charged of delay, it denied and put the blame, instead, on the Bench for not accepting its proposition of the scheme with the reduced budget\textsuperscript{151} of Rs.4 lakhs. The Bench, however, insisted on their earlier modified plan which would cost Rs. 5 lakhs. The Commissioner, being the representative of the

\textsuperscript{149} ibid. pp 26–28


\textsuperscript{151} GD. 1873. Vol. 79. Memorandum. 20\textsuperscript{th} March 1872. p 35
Government, could not go against the Government resolution. Awaiting the settlement of these differences, it was decided to provisionally execute those portions of the Tulsi water works, with which both the Municipality and the Government agreed. The remaining was left for further consideration. For this, the Government awaited the detailed report of Captain Tulloch. Consequently, the construction at Tulsi came to a standstill for some years.

In the intervening time, the deadlock between the Government and the Municipality was exploited by a London Syndicate, in 1875 to propose the establishment of a private water supply company. The English capitalists were eager to make use of this opportunity. The scheme looked tempting for the city and the promoters were prepared to raise a capital of pound 2,000,000; and get to work at once. However, the resistance engineered by the Municipality, under the leadership of Dr. Blaney, forced the promoters of the syndicate to retire gracefully while Bombay kept her water administration in her own hands.153

In December 1875, the deadlock regarding Tulsi came to an end when the Government of India, gave formal approval to Mr. Walton’s designs, as sanctioned by the Municipal Corporation, and authorized the grant of loan for the works of Rs 36, 00, 000.154 The Tulsi was finally to be brought into the city as an independent supply.

But this did not spell the end of troubles at Tulsi. The delivery of water was postponed, on account of delayed and heavy rains which impacted the pipe laying activity and also caused a landslip which posed an imminent threat to the earthen dams, but which was timely reverted by measures adopted by Mr. Walton.155 Men could not be induced to work at the Tulsi site, as it had won notoriety for fever. Hence, nothing but a high wage rate could persuade men to work and even these

152 Ibid. Extract from the Bench Proceedings, 9th October 1872, pp 41-42
154 GAR. op. cit. 1875-76: p114
155 MCR. op. cit. 1878. p 25
failed very often. The contractors were therefore forced to adopt the only alternative in such cases, which was to permit men to live at Coorla or Marole, which were at a distance of 4-8 miles from the place of work. Pipe laying activity, at Tulsi too, was affected due to the non arrival of pipes in time.\textsuperscript{156}

Tulsi dam also received much criticism. It was considered too bold, and in need of more masonry and rubble. Russell Aitken too, found the masonry to be in a state of tension. Others described the design as amateurish. It was also felt that the dam had shown signs of movement when filled, but this was reported as due to thermal movement.\textsuperscript{157} At Tulsi too, as at Vihar, a great number of cement joints gave way when water was first led into the main.\textsuperscript{158} Even at the time that Tulsi water was formally let into Bombay, on the 15\textsuperscript{th} of March 1879, by Governor, Sir Richard Temple Bart, Vihar continued to wolf down money. A sum of Rs. 50000 had to be spent on its annual maintenance.\textsuperscript{159} But so poorly had the works been executed, that maintenance was a constant source of problems. The leakage from the Lake was estimated at 1, 25,000 gallons per day. Added to this, were the frequent bursts of pipes, which, especially on the railway track, caused great inconvenience and damage to the railways. Even the reconstruction of the Vihar outlet works proved to be particularly difficult as many divers died in consequence of the unhealthiness of the climate. Hence, it became difficult to get the services of these divers.\textsuperscript{160}

\textbf{Service Reservoirs}

This phase, of water management, was also marked by the emergence of service reservoirs which were introduced to prevent the breakage of pipes which, due to the

\textsuperscript{156} Ibid. pp 284-89
\textsuperscript{157} Mike Chrimes, op. cit, p 366.
\textsuperscript{158} MCR op. cit, 1879, p 258
\textsuperscript{160} MCR op. cit, 1879, pp 260-261
intermittent system of supply were exposed alternately to moisture and air leading to their breakage. The service reservoirs were expected to solve the problem by keeping the pipes constantly charged with water. These would have also expedited the new underground system of drainage. In the case of Tulsi, the water was to be passed to such a reservoir on the Malabar hill, for the convenience of distribution to the higher levels. The latter, reservoir was to contain one day's supply to 6, 50,000 people at 17 gallons a head.\(^{161}\)

Here too, disputes in the Corporation and the Town Council about whether the whole, part, or any of the reservoir, should be covered, led to delays in construction. The discoloured and apparently impure state of water, distributed from the Tulsi, also gave rise to the question of filtration and it was finally determined to rearrange the reservoir in such a way as to include a Settling Tanks, Filtration Beds and Storage Tanks under one roof.\(^{162}\)

Apart from the Malabar Hill reservoir, a new one, the John Hay Grant Reservoir was constructed at Bhandarwada. The water here would be passed through filter beds, to improve its quality and regulate the quantity. This was expected to aid in the distribution of water at higher pressure, during those hours when it was greatest in demand.

Negligent supervision at Bhandarwada was yet again responsible for leakages in the reservoir.\(^{163}\) Even here, scientific calculations, on recognized theoretical formula, did not work. The 32 inch main, which was supposed to deliver water into it, failed since its interior was found incrusted. Hence, an additional main of 24 inches was required to deliver the required quantity of water.\(^{164}\) Furthermore, the whole

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\(^{161}\) L Michael op. cit., pp 82

\(^{162}\) MCR. op. cit. 1879, p 262

\(^{163}\) Proceedings of the Town Council. 1888-89. Vol. XII. p 245-246: Hereafter. Procs. TC. This reservoir, with its 6 filter beds for Vihar water was commenced in Mazgaon on the 10\(^{th}\) May 1880 and the water from the Vihar Lake was diverted into the reservoir on the 7\(^{th}\) April 1884- Gazetteer of Bombay City and Island. Vol. III. SM Edwardes. pp 34- 35

\(^{164}\) MCR. op. cit.. 1884-85, p iii
reservoir was not constructed in conformity with the original specifications. R Walton, the engineer in charge of the works, was accused of carelessness and from a pecuniary point of view, neglect of the interests of the Municipality. Blind faith in the contractors and carelessness displayed by the Municipal Commissioner and the Corporation, apparently, were responsible for what was described as a ‘grave’ failure. Thus, a work which cost Rs. 6, 14, 166, within 4 years of its completion, required remedial measures costing Rs. 2, 41,000. The storage basin intended to hold 30 feet of water, leaked so much that, in practice it could hold only 25 ½ feet of water in it. Despite this, the work was pronounced satisfactory from time to time by the municipal engineers. This state of affairs brought discredit to the Commissioner and the Municipal officers, without a doubt. Besides this, leakages at both the reservoirs in the city proved to be a fruitful source of malarial fevers in the city. The usual round of accusations followed.

In the meanwhile, the introduction of the water carriage system after 1877 and the resulting insufficiency of water and the expansion of the city as a trade centre, prompted the Corporation into initiating, in 1885, the much larger Tansa scheme on the basis of Tulloch’s Report. Engineer W.W.I.B. Clerke, an officer of the PWD, was appointed on this duty, on account of his considerable experience and having been in charge of the work at Lake Fife, near Poona, which was similar in character.

THE UNSUCCESSFUL WATER INSURANCE- POWAI (1889)

But, even before the Tansa water could be brought into the city, Powai had to be considered in 1889, as a water famine stared the city in the face. Insufficient rainfall at the Vihar catchment area lowered the level of the Lake to an undesirable point. So grim was the water scenario in 1890, that the Municipality, among other problems.

also anticipated a loss of revenue from the meter supplies. Powai was the expected knee jerk response to overcome the crisis.

It was also distinctly suggestive of the divide between the Commissioner and the Corporation at this juncture; a problem that had been acerbated with the provisions of the Municipal Act of 1888 which concentrated authority in the hands of the Municipal Commissioner, who was given the charge of sanitation of the city and in case of epidemics was alone charged with the taking of proper measures while not communicating to the Corporation. In this particular instance, though it was known that Tansa water would not reach the city before June 1892, no measures had been taken to deal with the dismal picture; a problem which, according to the Corporation, should have been foreseen by the Commissioner. Angry with the Commissioner, for not recommending sufficient means to deal with the impending water crisis, the Corporation was obliged to hurriedly sanction the Powai scheme, at a cost of at least 6 lakhs of rupees, not because it was the best, but because the matter was brought forward very late by the Executive and time did not permit of any other scheme being undertaken. It also demanded that the Kanheri and Yeoor schemes be carefully examined once again.\footnote{Proceedings of the Corporation. 1889-90. Vol. XIII. p 271. Hereafter, Procs. Corporation}

The wisdom of the scheme was disputed right from the beginning. Unplanned in nature and undertaken with an immediate objective of tiding over the crisis till 1892,
the Corporation at this juncture, had not even decided about the future of Powai Lake. Yet, land was acquired for the gathering ground; a move opposed by the Commissioner, who cautioned against the acquisition only for the sake of the two years in question.  

More surprisingly, despite its obvious drawbacks, this short-sighted scheme was projected, by the municipal engineer Tomlinson, as a permanent auxiliary to all the water works of the city. Tomlinson’s convincing arguments about the cheapness of the water from the Powai scheme; as well his confidence, that it would serve to replenish Vihar or assist Tansa, temporarily, in case of accidents along the line of duct or its use as an independent supply for Kurla, or for irrigation, enticed the Corporation into hurriedly completing the work before the monsoon of 1890. The new water works supplied about 7 ½ to 8 million gallons to the city daily, from the 11th July to 30th November 1890, its total supply being 1056 million of gallons. But, on account of the lower level of the Pawai works and small storage capacity, they could not efficiently supply the whole city by gravitation. Therefore, the works were temporarily abandoned, only to be revived a little later, with the development of the suburbs, and finally dumped unceremoniously for which the suburbs had to pay the cost.  

TOWARDS MAGNIFICENCE: THE TANSA WATER WORKS  

“There would be no completion of the works of water-supply to Bombay”  

In the intervening time, the Tansa dam, the construction of which commenced in 1886, was completed in 1892. It comprised the largest masonry dam in the world. Tansa was noticeably influenced with the new engineering trends worldwide. Of relevance is the fact, that the 1880s witnessed the increasing trend towards designing huge water supply systems, which from now on began to be equated with modernity.

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170 MCR. op. cit. 1890-91. pp 228-230
This also set the trend for searching deeper into the hinterland, for ‘perfect sources’, needed for creating reservoirs at a considerable height. Yet another visible trend, that drove this change, was that of rejection of sources near the city. Thus, the modern engineering vision of water supply system came include the idea that water had to arrive from a distance. In England, the other ideas that guided this decision, were that the intermittent system was a ‘social defect’, since it prevented the poor from obtaining water when they required the most and that this defect needed to be overcome via the constant supply system. In this ‘age of progress’ which rejected the limits of deficiency and distance, water supply engineering now came to be predominated by the new vision that water must flow from regions of plenty to regions of scarcity. Tansa stood for all of these.

Naturally, it came to be regarded as a truly ‘magnificent’ municipal achievement of Bombay as the Lake was expected to provide an ‘inexhaustible supply of water’ to the city. Situated at a distance of 55 miles from the city, this Lake became the main source of supply to the city. The dam, 9800 ft in length and 135 ft. in height, in the deepest portion, was capable of being raised to an ultimate height of 13 ½ ft. A proud Government once more optimistically expressed that the ‘scheme when carried out will afford another splendid proof of the public spirit of the citizens of Bombay and the skill of the English Engineers’.

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173 Edwardes Bombay op. cit. p 317
When the Tansa works were undertaken, engineers like Clerke expressed confidently that the gathering ground of the Tansa was far in excess of any demands Bombay was likely to make on it. Many however felt that the words “completion” could not be used in the context of water works as there was no end to the amount of water communities could use. proved true 174 As early as 1888, when the Tansa was still under construction, Deputy Executive Engineer Tomlinson had calculated, that it would be necessary to enlarge the supply system in 1899.175

Coincidentally in 1899, while pointing out the defects of the water supply system of the city, Santo Crimp, an eminent sanitary engineer invited by the Corporation, attributed the water problem of the city to its piecemeal and inharmonious development. Crimp conclusively suggested the duplication of the Tansa main and the formation of reservoirs and filters for the northern and central parts of the island, instead of the

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175 Mumbai’s Water, op. cit. p 90
then practice of taking water south first and then north again, to supply that part of the city; the removal of the pernicious system of drawing from the supply mains and directing the water to balancing reservoirs instead.176

Predictably, demands for water increased in no time and very soon the Tansa had to be duplicated and triplicated. One of the major reasons being, the increasing population which nullified the effects of the increased water supply from Tansa. Reclamations and natural calamities in the past, such as the famine of 1877, attracted migrants to the city. Paradoxically, the expansion of water works in the city such as the Malabar hill reservoir, the Vihar outlet and the Tulsi reservoir had also prompted these migrations. Thus, each wave of water works brought with it prosperity in the form of increased industrial activity, and thence an increased population. In the process, the capacity of the city was stretched and more and more people were marginalized in terms of water supply. The city’s population, by the census of 1931, stood at 1,161,383.177 Tremendous industrial development added to the water woes. The chart subjoined is indicative of this.

By the beginning of the second decade of the 20th century the daily consumption in Bombay increased to 31 million gallons, of which 18 million gallons was from

Tansa, the balance being from Vihar and Tulsi. The rate of consumption among the highest classes was over 100 gallons per head.\textsuperscript{178} Calculations by municipal engineers, in 1911 showed, that water requirements for municipal purposes alone would be 4,585,000 gallons per day in 1935 as against the then requirements of 4215800. For trade purposes it would increase from 4,077,859 to a whopping 7,000,000 during the same period. Curiously however, while determining the needs for domestic consumption in the city, the engineers assumed that 80\% of the population would continue to live in the chawls and would be satisfied with 25 gallons per day, since they were housed in one room tenements only. On the other hand, since the remaining 20\% population used bathing arrangements, replete with sanitary fittings, and had gardens and ornamental fountains, their needs were deemed higher and the calculations were made on the basis of 50 gallons per head per day.\textsuperscript{179}

**THE LEGACY**

Tansa too followed the established trend in the water works engineering of the city. It proved to be more expensive than Government works of the same category. In its first phase transportation of materials from considerable distances and the unfavourable situation of the site, added to the cost\textsuperscript{180} There were further add-ons due to the extravagant claims made by the contractors Messrs. Glover and Co., who were sanctioned the contract by the Standing Committee along with the Commissioner, without consulting the Corporation.\textsuperscript{181} Therefore the scheme instead of costing 123 lakhs cost the Corporation almost a crore.\textsuperscript{182}

\textsuperscript{178} GD Compilations: 1916-18: file no. 680-Scheme for The Supply Of Water To Salsette Letter from Messrs. Tata and Sons to EG Turner, 19\textsuperscript{th} February 1912, p 7
\textsuperscript{179} Mumbai’s Water, op. cit. pp 88-95
\textsuperscript{180} Clerke Tansa, op. cit., pp 15-16
\textsuperscript{181} Record, Procs. Corporation, op. cit. 1891-92 (Pt. I) Vol. XV. Minute by Abdalla M. Dharamsi and Javerilal U Yajnik. 24\textsuperscript{th} March 1892. pp 602-603
\textsuperscript{182} Ibid. Speech of Mr. Acworth, Municipal Commissioner. 31\textsuperscript{st} March 1892. p 617
Corporation, therefore, alleged that the Tansa scheme had not been considered important enough to be perused by the Standing Committee.\(^{183}\)

Planning and execution still continued to be disordered. More chaos followed in the 3\(^{rd}\) phase of expansion. These works were delayed due to the engineers strike in England. In the same way plans of a balancing reservoir at Sion, in 1922,\(^{184}\) had to be abandoned temporarily though the process for the acquisition of the Sion hill, for the same purpose, was initiated by 1926. Another reservoir at Golanji Hill could not be executed as the hill, on which it was proposed to be executed, was completely cut up for the purpose of quarrying. Pipe laying operations continued to create considerable nuisance and traffic difficulties to the people of the localities concerned in Bombay.\(^{185}\)

Slack supervision, yet again, on the part of the Resident Engineer and disobedience of the Assistant Engineer, resulted in the washing away of one of the piers of the Kasheli Bridge then under construction, in connection with the third phase of Tansa expansion in 1925.\(^{186}\) In 1934, due to the extreme variation in temperature two of the mains carrying 86 % of the city’s supplies were torn asunder.\(^{187}\)

Other Measures

Even after its 3\(^{rd}\) phase of development in 1925 when water was delivered at full pressure, the higher storeys of the buildings and higher districts could not obtain water. Pumping could not be recourse to, due to its prohibitive costs. House owners were therefore expected to bring about rearrangements of the water service within

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\(^{183}\) Ibid, p 606

\(^{184}\) MCR. op. cit. 1922-23. pp 198-199

\(^{185}\) Ibid. 1926-27. AW Stonebridge. Special Engineer. Tansa Completion Works. p 205

\(^{186}\) Procs. SC. July to December 1925. First Report of the Sub-Committee regarding the washing away of one of the piers of the north Kasheli Bridge. Bombay 23\(^{rd}\) July 1925. pp 785-787

\(^{187}\) MCR. p. cit. 1933-34. p 239.
their premises at their own expenses. Only the ground floors could expect a good flow of water.\textsuperscript{188}

Not surprisingly, with its insatiable water demands, the city was forced to explore other measures from time to time. Despite Tansa, at the beginning of the 20\textsuperscript{th} century, boring operations seemed to excite much interest. Having proved successful in Sholapur, people of Bombay felt that the same could be emulated before the extension of the water works. It was strongly felt that if such experiments were carried out, industries such as bleaching, dye works or paper works would benefit and the value of the land too would increase. It would have further encouraged search for such water as well.\textsuperscript{189}

Desperation to augment the water supplies in the mid 1920s, forced the Government, in spite of its tendency to regard the people of the east as superstitious and unscientific, to regard water divining as an art, as a mysterious faculty, and it even sought the services of water diviners. This work was entrusted to one Major Pogson who charged a fee of Rs. 200 a day for private work. There was also a move to train indigenous people under him. Considering his huge charges some Indian members of the Bombay Legislative Council felt that the same work could be given to Indian water diviners at no charge.\textsuperscript{190}

Further, during the 2\textsuperscript{nd} World War, it was decided to open the wells in the city. In 1941 therefore, the Government of Bombay issued orders to reopen 200 wells in order to meet the emergency. There were about 1650 closed wells in the city at this time. Alternative sources of underground water supply were also explored and as an experimental measure 12 tube wells were sunk in the city.\textsuperscript{191} But improvements in

\begin{footnotesize}
\begin{enumerate}
\item Procs Corporation, Jan to March 1926, Letter from the Commissioner. No. C 329 of 16\textsuperscript{th} January 1926, pp 2585-86
\item IMJ, op. cit, February 3\textsuperscript{rd} 1901. Artesian Wells in Bombay. p 74
\item MCR. op. cit. 1941-42. p 278
\end{enumerate}
\end{footnotesize}
the war situation brought about a hermetic sealing of all wells once again. During these years however, despite the scarcity, the supply of water was restricted in most of the areas of the city except the Port Trust.

**Municipal Centralization**

Any discussion on the city’s water supply would be incomplete without looking at the municipal development, with which it is intimately related. The new water supply technology, besides instituting a legal relationship with water, also made the latter an important factor in the process of municipal development of the city. As early as 1861, the bye laws of the fledgling Bombay Municipality vested the control of all public tanks and wells in the Municipal Commissioners and provided for stringent application of the nuisance laws. They also empowered officers of the Bombay Water Works to enter into any house or building, to which water was laid on from the mains, for the purpose of inspecting water pipes or cisterns, meters, and other things connected with water supply, at a 12 hours notice to the occupier. Alterations to pipes etc. was not allowed without the permission of the Commissioners and these could be effected only by ‘authorised plumbers’.

Starting from 1865, on account of the policy of decentralisation, successive acts of the Legislature began placing increasing responsibility of the sanitary services on the Municipality. The Bombay Municipal Act of 1865, passed mainly to establish a strong and efficient administration for the purpose of carrying out sanitary improvements, and for reducing the death rate of the city, however proved to be very unsatisfactory. The first Municipal Commissioner under this Act, Arthur Crawford’s policy of favouring the sanitary needs of the Europeans and ignoring the native quarters left people highly dissatisfied.

Over and above this, the gross misuse of Vihar water, the insufficiency of its supply, despite its modern technology and the sense of betrayal caused by the poor status of

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192 MCR. op. cit. 1943-44, p 154
193 MCR op. cit. 1944-45, p 186
194 Bombay Gazette. 16th November 1861. p 1099
195 NNP. op. cit. Jam E Jamshed. 2nd June. 1868. p12
the Vihar dams, apart from the high water rates, ruffled the public which now clamoured for representation in the municipal affairs. Consequently, when the Tulsi scheme was introduced, it insisted on the rectification of the defects in the older scheme, rather than investing in new 'gigantic expensive and therefore impractical' schemes, and also urged that rate payers be satisfied first. Otherwise, they felt it would be impossible to finance the next scheme.196

Financing Tulsi meant additional taxation which was not possible without representation. But even while introducing the elective principle, the Municipal Act of 1872 further strengthened the sanitary control of the Municipality. From now, in matters of sanitation, especially water supply and drainage, the Commissioner emerged supreme with almost tyrannical powers. He had the power to raise or sink or otherwise alter any new gas or water pipe; supply water on conditions he deemed best; make owners ventilate all drain and, their cesspools; make employers construct any or all privies: open and examine all drains to see if they had been built as per their directions and so on.197

With the expansion of the city in 1880s, the Municipal Act of 1872 was again recast in 1888 with a view to advancing the interests of the city of Bombay. Several provisions of this Act such as construction of drains, facilities for drinking water and so on were shaped by educated Indian Corporators such as Mr. K.T. Telang. Despite this, the Act once again, vested tremendous powers in the hands of the Municipal Commissioner. The new Act, therefore, with its exclusive regard for the improvement of the city, completely overlooked the rights of private individuals.198

During the same period, the failure of the Bhandarwada Reservoir brought out the need for an additional executive authority, in the form of a Deputy Municipal Commissioner. This was a post which had been resisted by Indians such as Telang

196 Times of India, 8th May 1871. p 2
and Pherozshah Mehta. However, since the Act of 1872 threw the entire responsibility and executive power on the Municipal Commissioner, even engineers were inclined to neglect their duty. Further, with the increase in the number of the major and minor sanitary works, in the city, Government now insisted on the creation of a post of a Deputy to assist the over burdened Municipal Commissioner. The Act of 1888 provided for this post. This Act also made it obligatory for the Corporation to provide for the execution and maintenance of drainage and water works, the provisions for which were admittedly very severe. For example, Section 274 (2) of the Municipal Act of 1888 prescribed the exact size material, quality and description of the pipes, taps, and other fittings to be employed for the purpose of any connection with or communication from any Municipal Water Work.

By the end of the century a more organised, efficient and independent Water Department, under SM Edwardes as an acting Municipal Commissioner came into existence with a view to improving the water supply of the city. The increased duties of the Water Department and the increased obligation of the Corporation, of keeping that Department in a high state of efficiency necessitated the appointment of a trained expert, in the form of a Hydraulic Engineer, whose position was analogous to that of the other two officers viz. the Executive Engineer and the Health Officer. On the eve of independence, this department had transformed into a large one with various branches, including those of distribution, waste prevention, meter, maintenance, construction, survey and design.

The Act of 1888, amended in 1912, once again gave extensive powers to the Municipality and the Commissioner, in order to provide the city sufficient water

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200 BMC Acts, op. cit. Vol. II. p 421

201 MCR 1889-90. p 241

202 BLC Procs. op. cit. 1911. p 45

203 MCR 1945-46. p 165
supply. Far-reaching rules were framed for the conveyance of water to people. Hereafter, the water connections could only be executed by the municipal agency under the Commissioner’s order, while cost of making or removing the connections had to be paid for by the people concerned.204

After the end of the First World War, water connections began to be granted on the recommendation of the Health Officer. From now on, no connection could be allowed to new buildings until the latter had recommended the granting of the building completion certificate. This procedure was rendered necessary, as in many instances, buildings were occupied even before the standard sanitary works, such as proper access to cisterns or sufficient water closet accommodation, were carried out. Therefore, to ensure the sanitation of the buildings, water connections were not granted until the requirements of the Health Department were carried out. This procedure however entailed hardships on the landlords who therefore habitually evaded their responsibilities. Provision of waste water disposal also became mandatory before the sanctioning of new water connections.205 Pipes conveying water from the municipal mains were supplied by the Municipality to buildings in the city as far as the boundary of the premises. Beyond these, the house owner was responsible for the fittings and piping and for the proper distribution of water in his premises. By now cisterns on rooftops were a common spectacle in the city. The total cost of the Bombay Water Works amounted to nearly 10 crores and its maintenance cost was about Rs. 10 lakhs per annum.206

WATER DILEMMA

Yet, there was no solution to the city’s water problem. In the closing years of the Second World War, Bombay was again poised for further industrial and commercial
advancement which led to uncontrolled growth of the city. Millions migrated to the city during 1941-51. The communal disturbances additionally burdened the Water Works Department due to the number of fires. On some occasions there were as many as 29 during the day.\(^{207}\)

To solve the water problem, in 1945, the Corporation even consulted Sir M Viseswaraya and Sir Claude Inglis, about the next source of supply to be brought into use for the city. Their recommendation of utilizing the tail water of the Bhivpuri power house, as the next source of supply, could not however materialize, as the Bombay Government wanted an assurance from the Tatas that the Bhivpuri tailrace would provide 100 million gallons per day which the Tatas were unable to give. The negotiations also revealed that due to the vested interests of the industries in the Kalyan Bhiwandi areas and along the Ulhas River, free use of water by the Municipality was not possible. Instead, it was the industrialists who desired 15 million gallons of water, free of cost, every day from the Municipality, for the use of the villagers and riparian owners. Government water works at Badlapur and for the supply of water to Kalyan, Dombivali Thana etc.\(^{208}\)

By 1949, Bombay with an area of 26 sq. miles accommodated a population of 28 lakhs of people, instead of the 13 lakhs it could support.\(^{209}\) More were added with the addition of the suburbs between 1950 and 1957. This coupled with the failure of the Five Year Plans, after independence, to pay attention to urban development and an economic climate which favoured the expansion and concentration of economic activities in cities like Bombay, Calcutta and Delhi, resulted in urban chaos. A survey conducted in 1952 revealed that, middle class homes, with an income range between Rs. 50-200 per month, residing in the A-G wards of the island city, did not have taps at all or were provided with a single tap. Water supply in most of these

\(^{207}\) MCR. op. cit. 1946-47. p 177

\(^{208}\) Ibid. p182

\(^{209}\) GD Files 4837/33-I of 1946. Note from Health and Local Government Department. 27-2-49. p 275
tenements ranged from 1 to 4 hours from midnight to midday. By 1956, the water supply scenario was so lamentable, that the Corporation was accused of hatching, a conspiracy along with the Congress to ‘beguile the citizens and mislead them’. The 24 hour water supply scheme was declared a dream and the Commissioner was urged to accept his mistake.

Vaitarna cum Tansa Scheme: 1957

Hopes of solving the problem were revived in the year 1957 with the creation of an impounding reservoir on river Vaitarna, from which water was to be transferred to Tansa Lake. The work on this had started in 1948. This scheme was conceived, planned and constructed by a team of municipal engineers under the guidance and leadership of Mr. N V Modak, the city engineer, and was named in his memory as the Modaksagar. From the year 1957 the city started receiving additional 490 MLD. To ensure equitable distribution of the water to all parts of the Greater Bombay a Master Plan was prepared which included the construction of 11 balancing reservoirs in the different parts of Greater Bombay.

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211 Times of India, 17th July 1956, p 3
The Vaitarna cum Tansa scheme marked an epoch in the history of Bombay’s water supply, being the biggest scheme ever undertaken by the Corporation, in the field of augmentation of water supply. Undertaken at an unfavourable time in the post war period, because of the unsatisfactory finances of the Corporation and the scarcity of building material, its completion was doubted right from its inception. Thus, it was proposed to execute the work of the pipe in stages, depending upon the availability of funds. Fortunately, the Corporation received timely financial aid from the Central Government by way of loans which enabled it to lay the whole of the length of the pipeline.\textsuperscript{214}

But the progress of the dam was as usual, delayed due to poor planning on the part of contractors and the work having been undertaken during the monsoon. Once again, extension was granted without recovering the penalty.\textsuperscript{215} During the construction of the Vaitarna cum Tansa scheme, the Tansa dam too had to be strengthened to prevent its failure by uplift pressure. No provision had been made for this, when the dam was first constructed, as the theory of uplift pressure was not known then. Later on, it was also found that the provision made in its spillway capacity for passing heavy floods was not adequate and that it was quite likely that heavy floods, combined with uplift pressure, could affect its stability. Even this scheme, when completed, emerged completely different from the one that was envisaged in 1932-34. The latter design was only intended to divert a part of the Vaitarna waters into the Tansa Lake, to keep it filled at the end of the monsoon of each year, by building a small pick up weir on the Vaitarna River. But the changed scheme provided for an impounding reservoir on the Vaitarna instead.\textsuperscript{216}


\textsuperscript{214} Ibid. pp 2-4

\textsuperscript{215} BMC. Administration Report of the Municipal Chief Auditor for the year 1952-53. p 58

\textsuperscript{216} Modak. Vaitarna Report. pp 1-5 to 1-7
CONCLUSION

With the addition of the suburbs in 1950 and again in 1957, the water problem was intensified. The supply to the city, in the post 1957 period, was brought partly through the Service Reservoirs and partly by directly tapping the trunk mains. Even though the average per capita domestic consumption requirement was 29 gallons phpd, the actual consumption however, varied a great deal. The richer population of Malabar Hill, Marine Drive and such areas drew at a rate between 100 to 120 gallons per capita. Attempts to meter the supply, in order to put a check on the excessive use of water by the richer communities and avoid wastage, did not solve the problem. Although the city’s need was estimated at 50-60 gallons per capita, at this juncture, financial and other constraints forced the Corporation to adopt an allowance of 40 gallons instead. The suburbs did not receive even this much as they were only partly sewered. To meet its future requirements the city now looked ahead to colonize Dahisar, Upper Vaitarna, Bhat'sai and Upper Kalu Rivers.\(^{217}\)

As can be seen from the foregoing narrative water supply to the city was a future oriented engineering driven activity as the word scarcity was interpreted by engineers. This, therefore, set into motion a system of water supply that was self perpetuating in nature. Increased water supply augmented the growth of the city as a result of which more such projects had to be executed, at massive costs, at regular intervals. Unfortunately however, want of thoroughness in the process of execution and the rapid and unplanned spatial, demographic and industrial expansion of the city, during their long periods of gestation, nullified the effects of an increase in water supply. Thus, they failed to quench its water demands. Increased amounts of water also required appropriate drainage and sewerage facilities. The next chapter explores this theme.