IPENZ ENGINEERS NEW ZEALAND

ENGINEERING HERITAGE NEW ZEALAND

IPENZ Engineering Heritage Register Report

Karori Water Supply Dams and Reservoirs

Written by: Karen Astwood and Georgina Fell
Date: 12 September 2012

Aerial view of Karori Reservoir, Wellington, 10 February 1985. Dominion Post (Newspaper): Photographic negatives and prints of the Evening Post and Dominion newspapers, Alexander Turnbull Library (ATL), Wellington, New Zealand, ID: EP/1984/0621.

The Lower Karori Dam and Reservoir is in the foreground and the Upper Karori Dam and Reservoir is towards the top of the image.

Contents

A. General information

Name: Karori Water Supply Dams and Reservoirs

Alternative names: Kaiwarra Dam; Kaiwharawhara Stream Valley Dam; Karori Dam; Karori Reservoir; Karori Pump Station; Karori Waterworks; Lower Karori Dam and Reservoir; Upper Karori Dam and Reservoir

Location:

Waiapu Road

Karori

Wellington

Wellington Region

Geo-reference:

Lower Karori Dam (taken at the valve tower) - Latitude: -41.291, Longitude: 174.753

Upper Karori Dam (taken northwest end of dam) - Latitude: -41.298, Longitude: 174.744

Legal description:

Lower Karori Dam and Reservoir - Lot 1 DP 313319 (CT WN 52413), part Legal Road (made public by T 72086), Wellington Land District, Pt Sec 1 Upper Kaiwharawhara District marked A on SO 32281 (*NZ Gazette* 1982, p. 714), Pt Sec 10 Owhiro District marked A on SO 32922 (*NZ Gazette* 1982, p. 1390)

Upper Karori Dam and Reservoir - Lot 1 DP 313319 (CT 52413), Wellington Land District

Access information: The Lower and Upper Karori dams and reservoirs are within the fenced boundary of the Karori Wildlife Sanctuary. The Lower Karori Dam is accessed most directly from the Waiapu Road entrance. The Upper Karori Dam is located further into the Sanctuary and can be reached via various walking tracks.

City/District Council: Wellington City Council

Location map courtesy of Google Maps

IPENZ category: Engineering work

IPENZ subcategory: Infrastructure

IPENZ Engineering Heritage number: Lower Karori Dam – 104

Date registered: 28 August 2012

Other IPENZ recognition: Lower Karori Dam heritage recognition plaque (installed 2004)

Other heritage recognition:

- *New Zealand Historic Places Trust*: Lower Karori Dam - Category 1 historic place (Register no. 7750); Upper Karori Dam – Category 2 historic place (Register no. 7749)
- *Local Authority District Plan*: Not listed in Wellington City District Plan
- *Other*: Lower Karori Dam and associated features – New Zealand Archaeological Site Recording Scheme, R27/276

B. Description

Summary

The Karori Water Supply Dams and Reservoirs captured the water resources of the Kaiwharawhara Stream in the west Wellington hill suburb of Karori, and are now within the Karori Wildlife Sanctuary. The Lower and Upper Karori Dams were completed in 1878 and 1908 respectively, and continued to contribute to the New Zealand capital city's water supply until the late 20th century.

A good water supply is essential to human existence. The population of Wellington rose rapidly in the 1860s and 1870s, with residents and industry putting severe pressure on streams and wells. Public health was at risk and this motivated local government to investigate establishing a public waterworks system, with various proposals put forward. However, it was not until the passing of the *Wellington Waterworks Act* in 1871 that earnest planning could commence, and with the completion of the Lower Karori Dam in 1878 Wellington became the first municipality in New Zealand to construct a public water supply dam. From that time progressive development of the water resources at Karori, and around the Wellington region, struggled to keep up with demand. Another early addition to the water supply system was the Upper Karori Dam, constructed between 1906 and 1908.

The Lower Karori dam was designed by Nicholas Marchant (1836-1907) and is an earth dam with a puddled clay core. Availability of materials meant that this structure was innovative in its use of concrete, rather than stone, for its wave protection lining and culverts. It was the use of concrete which also made the Upper Karori Dam a pioneering structure; it being one of the earliest New Zealand examples of a large scale concrete gravity dam. This structure was designed by another notable Wellington City Engineer, William Hobbard Morton (1866-1923).

The Karori Water Supply Dams and Reservoirs have outstanding engineering heritage value because the dams both represent early large scale examples of their respective dam types. Located on the Wellington fault, these dams were decommissioned in the 1990s due to earthquake safety concerns. However, for over a century the Karori waterworks was heart of the wider system in Wellington and, as a result, had considerable social impact.

Historical narrative

In 1865 the seat of New Zealand's Government shifted south from Auckland to Wellington. This was a contributing factor in Wellington's rapid population increase by the end of the century, from 7,460 in 1867 to 49,344. This boost in people led to overcrowding which, along with poor hygiene and a lack of adequate public water supply and sewerage facilities, resulted in a high rate of disease and infant mortality.[1] In 1871, Government scientist James Hector referred to the "misery and suffering entailed especially of the children from the presence of intestinal worms" and concluded that "no water collected from within the crowded part of the city either from wells or housetops, is safe or proper for human consumption."[2] At the time, water reticulation in Wellington was limited to a few pipes laid by the Government to supply their own buildings and the naval vessels in port. Residential water was "collected from house-tops into barrels and iron tanks, and also shallow wells."[3]

Even in 1867 it was recognised that the city's water supply was inadequate. Various plans had been formulated, but nothing came of them because they were "more or less grand in design, and expensive in character."[4] The chief difficulty was a financial one. Wellington's first town surveyor/engineer, Robert Skeet (1832-1894), developed a scheme to supply the southern wards of the town with water from the Te Aro (or Waimapihi) Stream in Polhill's Gully (upper Aro Valley), with the Thorndon ward being supplied from the Kaiwharawhara Stream (or Kaiwarra Stream as it was known by early European settlers) tapped near Baker's cutting. However, the estimated cost was over £41,000, which was a huge sum and beyond local government financial capacity. Other engineers generally agreed with the scheme, George Aickin (1822-1882) added that a reasonably deep four acre reservoir would contain enough water to adequately supply double Wellington's population at the time.[5]

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[1] C. Maclean, 'Wellington region - From town to city: 1865–1899', Te Ara - the Encyclopedia of New Zealand, URL: http://www.TeAra.govt.nz/en/wellington-region/8 (updated 24 November 2009); S. Morrison, *History of Water Supply in the Wellington Region*, 1872-1985, Wellington, 1986, p.1

[2] A. Mulgan, *The City and its Strait: Wellington and its Province*, Wellington, 1939, p.211

[3] 'Report of the Select Committee on the Wellington Waterworks Bill,' *Appendix to the Journals of the House of Representatives*, 1871, Session I, H-03, p.3. URL: http://www.atojs.natlib.govt.nz/cgi-bin/atojs?a=d&cl=search&d=AJHR1871-I.2.2.5.3&srpos=1&e=-----1871--10--1------2wellington+waterworks-- (accessed 26 March 2012). This was stated by Nicholas Marchant, Wellington City Engineer, when he was before the Select Committee.

[4] *Wellington Independent*, 19 February 1867, p.3

[5] *Wellington Independent*, 16 May 1867, p.5

In April 1868, consulting engineer Robert Mudge Marchant (1820-1902) prepared another scheme which he promoted through a pamphlet with lithographed drawings. Robert Marchant was related to famous British engineer, Isambard Kingdom Brunel (1806-1859), and early in his career he had worked as an assistant to Brunel.[6] Robert suggested piping water down the Kaiwharawhara Valley and then tunnelling through Northland Hill to Tinakori Road. Including plans for a dam and a 136 million-litre reservoir, according to Nicholas Marchant (1836-1907) this was the first feasible proposal submitted to the Town Board.[7] Nicholas (no relation of Robert) had emigrated from England in 1864 and within a few years had become Wellington's Waterworks Engineer. Between 1875 and 1878 he was the City Engineer, before resigning to go into private practice after the Lower Karori Dam was completed.[8]

In order to pay for Robert's scheme, it was proposed that Wellington should follow Dunedin's example in passing the *Dunedin Waterworks Act 1864.* This assigned responsibility for building waterworks, and rating users, to the Dunedin Waterworks Company Limited. Their two dams on Ross Creek were privately built between 1865 and 1867.[9] The decision by Wellington's Town Board to accept Robert's scheme led to a well-publicised furore with ratepayers angered at the heavy water rates they would be obliged to pay to fund the expensive proposal.[10] Therefore, when the Wellington Water Works Company was established its shares were issued secretly. However, in the end this company played no part in Wellington's first public waterworks system.[11]

When the Wellington City Council formed in 1870, Nicholas was asked to develop yet another waterworks scheme for the city. He combined elements of many of the previous proposals, recommending that water be taken from the elevated Kaiwharawhara Stream catchment. The stream was clean and its altitude meant a gravitational water supply system could be created. Nicholas suggested that the water be tapped near Baker's Hill, 130 metres above the sea-level, before passing

[6] Peter Cross-Rudkin and Mike Chrimes (ed.), *Biographical Dictionary of Civil engineering, Volume 2 – 1830 to 1890*, London, 2008, p.521. The working relationship between Brunel and Marchant seems to have been consistently acrimonious. Brunel was involved in the 'battle of Mickleton Hill' incident which virtually bankrupted Marchant, and it was after this that he immigrated to Brazil and then onto Australia and New Zealand.

[7] P. Cooke, *Our water history – on tap: Water supply in the Wellington region 1867-2006*, Wellington, 2007, pp.6, 36. URL - http://www.gw.govt.nz/assets/Our-Environment/Water-Supply/PDFs/Covers-foreword-introduction-water-history.pdf (accessed 2 April 2012)

[8] Furkert, p.219

[9] Ibid.

[10] S. Morrison, *History of Water Supply in the Wellington Region, 1872-1985*, Wellington, 1986, p.1; Cooke, 2007, p.6; *Wellington Independent*, 20 August 1968, p.4

[11] Cooke, p.6

through a tunnel and collecting in a distributing basin.[12] A water main would run down the gully near Aro Street, to Willis Street, where it diverged in two. These mains would convey water along Willis Street and Lambton Quay, while the other travelled down Ingestre and Vivian Streets to Cambridge Terrace. The estimated cost of the works was £17,358.[13]

The *Wellington Waterworks Act* (1871) defined an area of 92 hectares to be purchased by the Council from land owners, which included two gold mining companies.[14] After many years of trying the project was effectively underway on 12 December 1871 when the Council created a permanent waterworks committee. The Act stated that the Council was not allowed to construct a dam on the land until 1873 at the earliest. However, they could progress the first stage for the water supply system. John Blackett (1818-1893) acted as a consulting engineer and the initial works involved creating the Baker's Hill tunnel, which was completed on 24 October 1872.[15] Tenders were received in early 1873 for the Aro Valley distributing basin (on what is now the corner of Raroa and Mount Pleasant roads), to receive water from the tunnel. This contract was awarded to Saunders and O'Malley.[16] However, a shortage of money meant that the construction of the proposed dam across the Kaiwharawhara Stream had to be postponed. Instead it was decided to increase the capacity of the reservoir in Pollhill's Gully, from 2.3 million litres to over 4.5 million litres. This basin became the source of Wellington's first public water supply, not the Lower Karori Reservoir as is commonly believed.[17]

On Saturday 2 May 1874 it was reported that "all difficulty or apprehension in regard to the water mains" was finally at an end when "the full force from the [Pollhill's Gully] reservoir was flushed through the mains to their extreme range as far as the lower end of Tinakori Road, and the pipes with one exception, proved equal to the pressure."[18] Because of this success the Council wanted to push forward with further works and spending despite the increased cost of iron and labour meaning the estimate for the first stage work had been exceeded. Therefore, in August 1874 a

[12] Ibid.; Morrison, pp.1-2

[13] *Evening Post*, 29 March 1871, p.2

[14] Cooke, 2007, p.6

[15] 'Wellington Waterworks Act, 1871 - Powers of the Council in connection with the undertaking,' New Zealand Legislation: Acts, URL: http://www.legislation.govt.nz/act/private/1871/0003/latest/DLM89257.html (accessed 26 March 2012); Cooke, 2007, p.7; 'Wellington Waterworks Act, 1871 - Schedule,' New Zealand Legislation: Acts, URL: http://www.legislation.govt.nz/act/private/1871/0003/latest/DLM89747.html (accessed 26 March 2012)

[16] Cooke, 2007, p.7

[17] Cooke, 2007, pp.7, 21. This distribution basin was filled in during 1964.

[18] *Wellington Independent*, 4 May 1874, p.2

new Act was passed authorising an extra £25,000 in borrowings to extend the scheme, including building the Lower Karori Dam.[19]

Figure 1: Karori Reservoir, Wellington, ca 1874. Zoe Martin -Carter Collection, ATL, Reference Number: PA1-F-171-75. Please note that the date for this image is inaccurate. Research has shown that the dam would not have been in this state of completion until *circa* 1878

The Lower Karori Dam was the first dam in New Zealand to be built by a municipality for the purpose of public water supply.[20] Construction tenders for the dam were called in 1875, but the contract with J. Saunders was not entered into until October 1876.[21] Nicholas Marchant designed the earth dam with a puddled clay core.[22] This feature was typical of British best practice at the time, and was similar to the Ross Creek Dam in Dunedin. However, a difference was that the Lower Karori Dam's upstream protection from wave action was through a concrete facing instead of the traditional hand placed riprap, which is a layer stones.[23] Under Marchant's supervision the construction was completed in January 1878, and water storage commenced at daybreak on 25 January.[24] With some work remaining to be done the reservoir was

[19] New Zealand Parliament, *Parliamentary Debates*, Wellington, 1874, Vol XVI, pp.305, 546; Cooke, 2007, p.8

[20] P. Cooke, 'Registration Report for a Historic Place: Lower Karori Dam,' New Zealand Historic Places Trust , 2008 (Register no.7750), p.3

[21] Cooke, 2007, p.8

[22] See the Physical Narrative section of this report for a definition of a puddled clay core dam

[23] R. E. Offer, 'Heritage Assessment Programme: IPENZ National Heritage Committee, Lower Karori Dam', 24 June 2002, URL: http://www.ipenz.org.nz/heritage/documents/Lwr%20Karori%20dam%20submsn1.pdf (accessed 2 April 2012); R. E. Offer, *Walls for Water: Pioneer dam building in New Zealand*, Wellington, 1997, p.203

[24] Cooke, 2007, p.8

only allowed to partially fill. In March 1878 it was reported that little remained to be done aside from cleaning up the site and grassing the slopes of the dam.[25]

By February 1878 water supply from the Lower Karori Reservoir had begun and Wellingtonians were able to "at last congratulate ourselves upon an abundant supply."[26] However, the greatly increased water supply was soon viewed by the Council as insufficient. The reasons for the shortfalls were varied. Firstly, there were consecutively dry summers in the late 1870s, and, the city's population continued to rise rapidly. Furthermore, the waterworks also became a victim of its own success, because the increased availability led to residents and industry, in particular, consuming more than expected.[27] The need for a consistent supply of water at a reasonable pressure became a pressing matter with fire a significant threat for the city's closely packed timber buildings.[28] Therefore, in 1884 a supply from Wainuiomata was completed, with this becoming the main source and the Karori supply augmenting it in order to maintain a reasonable amount of water pressure for customers.[29] This situation remained for years even when additional dams at Karori and Wainuiomata were constructed in the early twentieth century.[30]

The creation of these dams reflects the continued growth of Wellington's population and commercial operations. History repeated itself, because additions to the existing supply through extensions to the Karori and Wainuiomata catchments only came after several years and many proposals. It was not until 1904, with the appointment of City Engineer, William Hobbard Morton (1866-1923), that a proposal was accepted which included Morton's plans for a curved concrete gravity dam at Karori and a buttress dam at Wainuiomata, which became known as the Morton Dam (1911).[31] Morton had been a public works engineer prior to emigrating from Australia. Later Morton was a foundation member of the New Zealand Society of Civil Engineers, as well its Secretary and a Council member for many years.[32]

Morton's Upper Karori Dam was one of the earliest concrete gravity dams constructed in New Zealand, following one built at Korokoro, Lower Hutt (1903), and

[25] 'City Council,' *Evening Post*, 8 March 1878, p.2

[26] *Evening Post*, 23 February 1878, p.2

[27] Morrison, p.2; Cooke, 2007, p.8

[28] Cooke, 2007, p.9

[29] Cyclopedia Company Limited, 'Water Supply,' *The Cyclopedia of New Zealand [Wellington Provincial District]*, Wellington, 1897, p.274

[30] 'The New Reservoir,' *Evening Post*, 13 March 1908, p.3

[31] Offer, 1997, pp.63-64

[32] New Zealand Society of Civil Engineers, *Proceedings of the New Zealand Society of Civil Engineers*, Vol. X (1923-24), Wellington, 1924, pp.234-35

at the Okehu Stream in Wanganui and the Brook Dam, Nelson, both in 1904.[33] The construction of the Upper Karori Dam was undertaken by Mitchell and King and included the construction of a tramway and temporary weir. Mitchell and King seem to have been a Sydney construction firm which opened a Wellington branch in the early 20th century. Although they tendered for other engineering structures, this company mostly constructed buildings, such as the Union Steam Ship Company Offices (1909). In particular, they are noted for the remodelling of the James Smith Building façade in 1932, and the construction of the Waterloo Hotel opposite Wellington Railway Station.[34]

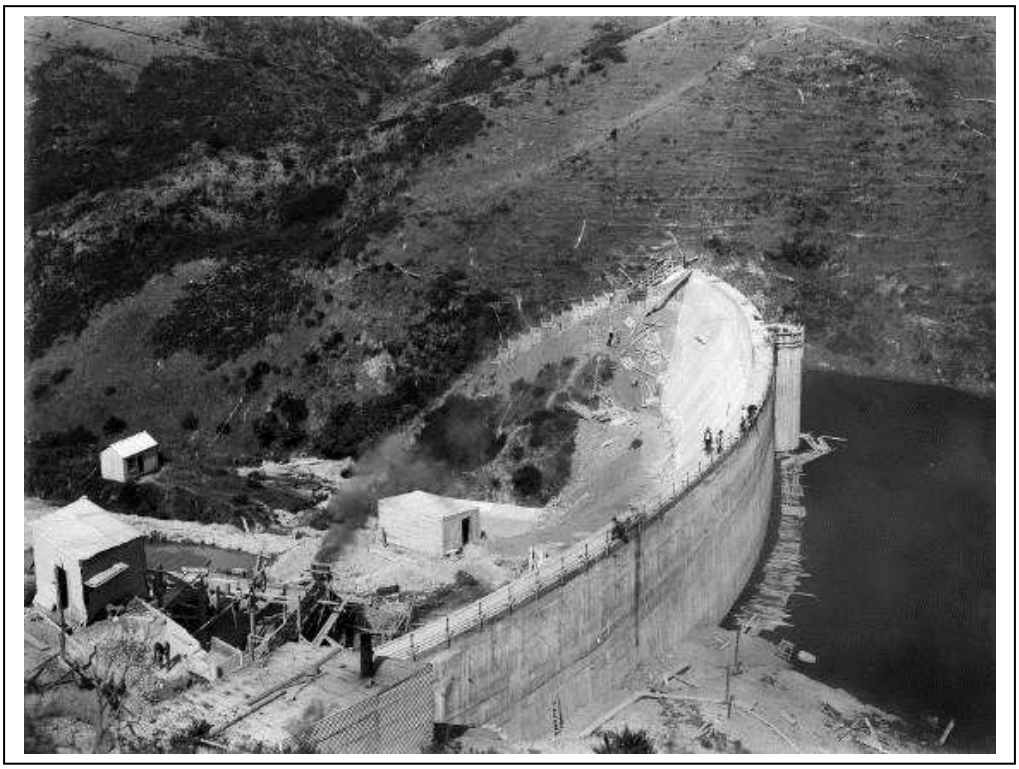

Figure 2: Dam under construction in the Karori Reservoir valley, Wellington, 1907. ATL, ID: 1/1-019829-G

Site work for the Upper Karori Dam began in late 1906, with the workforce of 55 men beginning to dig out the dam's foundations by early 1907.[35] There were stipulations in place to protect the integrity of the catchment while construction was taking place. For example, horses were not stabled near the water and workers were prohibited from camping too close. Also, during excavation explosives were not used, only picks and

[33] Offer, 1997, pp.25-26

[34] 'Kelburn Viaduct,' *Evening Post*, 4 December 1929, p.12; 'Union Company Offices,' *Taranaki Herald*, 18 March 1909, p.5; 'Alterations to Business Premises,' *Evening Post*, 3 September 1932, p.15; 'Hotel Waterloo,' *Evening Post*, 27 February 1936, p.10

[35] *Colonist*, 24 September 1906, p.1; 'Building a Reservoir,' *Evening Post*, 27 February 1907, p.2

shovels. It seems that this digging was a greater task than anticipated, with poor quality rock forcing the men to go deeper to find a good foundation for the dam.[36]

Morton was happy with the way the dam turned out upon its completion in March 1908. Morton stated that:

> Water was looked upon by engineers and contractors as an insidious enemy, still there were thirty-five feet of water already in the new reservoir, and he had not been able to trace the slightest degree of soakage. He believed that the work would prove perfectly satisfactory.[37]

The dam was formally opened on 29 November 1908.[38] Like the Waitakere Dam completed two years later, the Upper Karori Dam was lauded as a major New Zealand engineering feat of the time.[39]

Dry summers during World War One soon put pressure on the Council to again expand its water supply infrastructure. Therefore, Morton looked to the Orongorongo catchment, further northeast of the Wainuiomata reservoir. Rather than create a dam and reservoir, a weir was built and the water was piped to the Lower Karori reservoir and distributed from there.[40]

In the 1930s there seems to a have been a constant effort by Wellington's heavily in debt Water Supply Board to locate and tap into good water sources around the region for central Wellington and its expanding suburbs. The Hutt River was a likely source, although the water quality was variable. A further Wainuiomata dam was also proposed, as was exploitation of the Hutt aquifer. Much negotiating with the Petone and Hutt Borough Councils eventually led to the Water Supply Board building a pumping station at Gear Island, Petone, completed in 1935. This drew water from the Waiwhetu aquifer and linked into the Orongorongo to Karori water main. In the meantime a chlorination plant and pump station were built at Karori. However, the

[36] Emma Meyer, 'Registration Report for a Historic Place: Upper Karori Dam,' New Zealand Historic Places Trust, 1 May 2008, pp.7-9

[37] 'The New Reservoir'

[38] Meyer, p.17

[39] Offer, 1997, p.64

[40] Cooke, 2007, p.16

search for more water continued and by 1938 there were 19 service reservoirs feeding into Wellington's mains through the Karori catchment.[41]

Intensive Government housing schemes at Porirua motivated the beginning of the Hutt River scheme in the mid-1940s, with water being piped south over and through the hills to the Karori catchment. The headworks for this gravitational scheme were at Kaitoke, north of Upper Hutt. The pipeline had a capacity of 11 million gallons of water (41.6 million litres) per day and the scheme was eventually completed in 1957. Part of this pipeline project was the building of a pump station at Karori, so that in the event that Kaitoke's water quality was adversely affected by storms or floods, then the Karori reservoirs' water could be pumped back along the line to supply users when the Kaitoke supply was shut down.[42] Further reservoirs were gradually added into the network and in 1968 this back-pumping capacity at Karori was increased to 40 million litres per day.[43]

Wellington water engineer, John Morrison, notes that the operational significance of the Karori waterworks was huge. The Lower Karori reservoir was the terminus for water from Kaitoke and Orongorongo, with pumps to deliver water to the Onslow and Kelburn reservoirs, as well as surplus water up the valley to the Upper Karori reservoir. During the day the Karori system supplied additional water to the lower areas of Wellington, and replenished overnight. To ensure the best outcomes water balancing was almost a fulltime job, and the daily figures of flows and levels were studied carefully. These statistics influenced decisions on pumping up to, and releasing water down from, the Upper Karori Dam. In the 1980s there were further additions to Wellington's water supply, including the creation of the Stuart Macaskill storage lakes at Te Marua, north of Upper Hutt. The main reason for their construction was to add yet more storage capacity in an area not as vulnerable to pollution as the open water catchment at Karori.[44]

Engineering advice in the late 1970s suggested the decommissioning of the Karori waterworks. This eventually took place in 1997, although the reservoirs still retain water.[45] Despite the dams being in reasonably sound condition, their location across

[41] Ibid., pp.20-21; 'Water treatment – Gear Island,' Greater Wellington, URL: http://www.gw.govt.nz/Gear-Island-2/ (accessed 21 March 2012); I. A. Williamson, 'Karori Pumping Station,' New Zealand Engineering, Vol. 14:6 (July 1959), p.172

[42] E. E. Henriksen, 'Wellington Metropolitan Water Supply: Hutt River Scheme,' *New Zealand Engineering*, Vol. 11:1 (January 1956), pp.2-15; Williamson, p.172

[43] Cooke, 2007, p.25

[44] Pers Comm, John Morrison to Karen Astwood, 9 April 2012

[45] Ibid., pp. 29-31, 34

the Wellington fault line was identified as a significant argument in favour of their decommissioning. The presence of the fault was unknown to engineers when the dams were built.[46] Another factor not considered as part of standard engineering practice at the time of the Upper Karori Dam's construction was the effect of water pressure from underneath the structure, which in its case posed a risk to stability during an earthquake. The main concern of engineers was if the Upper Karori Dam failed during an earthquake this would have a domino effect, causing the failure of the Lower Karori Dam through overtopping due to insufficient spillway capacity.[47]

By the late 20th century the Wellington Regional Council no longer required the Karori dams and reservoirs for water supply and the land was transferred back to the Wellington City Council in 2004.[48] Because the Karori waterworks was the heart of the regional system it took a significant amount of work to circumvent, including major pipeline disconnections and realignments, as well as building yet more reservoir and pumping capacity at Ngauranga. Although the Karori waterworks are now out of service, a lot of water still passes through the site. [49]

The former Karori water supply dams and reservoirs are now features within the Karori Wildlife Sanctuary, whose predator-proof fence was finished just a few years after the dams were decommissioned.[50] In the future the former reservoirs will provide the Sanctuary with the opportunity to develop its native aquatic species programmes.[51] In particular, the attractive valve tower turret of the Lower Karori Dam has become a focal point of the Sanctuary. However, this is not a new phenomenon, with the dam and reservoir's picturesque qualities being recognised and publicised through photographs and postcards since the late 19th century.[52] Interpretation panels for the dams and reservoirs, as well as other remnants of their construction and operation, have been installed to help explain them to the Sanctuary's visitors.[53]

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[46] Meyer, p.12. This reference applies specifically to the Upper Karori Dam. However, it is also assumed that this was the case with the Lower Karori Dam considering it has been retained as a reservoir lake with no significant structural change.

[47] Offer, 1997, p.65. Pers Comm. John Morrison

[48] Cooke, 2007, p.34

[49] Pers Comm. John Morrison

[50] 'Trust Timeline,' Karori Sanctuary Trust, URL: http://www.sanctuary.org.nz/Site/About_us/Key_achievements_and_wildlife_releases.aspx (accessed 26 March 2012)

[51] 'Wetland fauna restoration,' Karori Sanctuary Trust, URL: http://www.sanctuary.org.nz/Site/Conservation_and_Research/Restoration/Wetland_flora_and_fauna/Wetland_fauna_restoration.aspx (accessed 26 March 2012)

[52] Cooke, 2008, p.15

[53] Meyer, p.10

The heritage values of the two dams, and associated structures, were recognised by the New Zealand Historic Places Trust in 2008. This was through individual registrations for each place: the Lower Karori Dam as a Category 1 historic place (Register no. 7750) and the Upper Karori Dam as a Category 2 historic place (Register no. 7749).[54] IPENZ had recognised the engineering heritage importance of the Lower Karori Dam with a plaque in August 2004.

[54] Lower Karori Dam, New Zealand Historic Places Trust Category 1 historic place (Register no. 7750), URL - http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7750 (accessed 27 March 2012); Upper Karori Dam, New Zealand Historic Places Trust Category 2 historic place (Register no. 7749), URL - http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7749 (accessed 27 March 2012)

Social narrative

Dams were constructed in New Zealand from early in the history of earnest European settlement. There were a number of uses in the early period for this type of human intervention to control water, such as in gold extraction or providing water supplies for the populous. These, usually small, structures were prolific, numbering in the thousands nationally. It was not until the early 20th century that the public infrastructure functions of dams expanded to include large scale structures for hydro-electric power generation. These became possible because of technological developments and greater understanding of how concrete could be utilised, which in New Zealand began with structures like the Upper Karori Dam.[55]

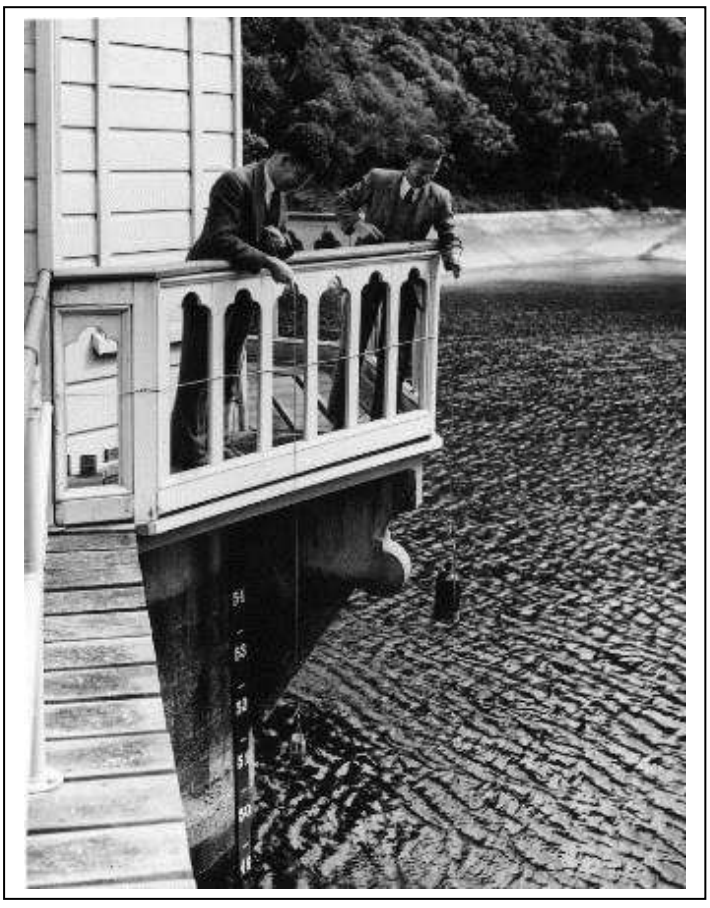

Figure 3: Water testing at Karori reservoir, Wellington, ca 3 December 1952. ATL, ID: PACOll-6203-06

As a basic societal necessity, pressures on the existing early water supply grew as the population of New Zealand did. Rapid growth in urban centres in the mid to late 19th century meant that springs and wells were soon unable to meet the needs of the population, which caused public health and safety problems. Therefore, water supply

[55] Offer, 1997, pp.13, 16

schemes were soon being developed in Wellington and other main centres.[56] In New Zealand water supply became the responsibility of local authorities relatively early on, along with other essential services, such as sewage and refuse disposal.[57] Aside from being important personally because of the provision for drinking water, adequate water supply systems were especially important to industry, as well as for activities like fire fighting.[58]

The creation of the Lower Karori Dam in 1878 was beneficial to the community because it was the first major water supply dam in the region and promised an increased and more certain public water supply.[59] Population growth meant that a few years later residential and industrial consumption had increased to the point where the supply "failed deplorably."[60] Built in the early 20th century, the Upper Karori Dam was the third major undertaking to augment that public supply.

[56] Ibid., p.38

[57] Bush, 1991, p.70

[58] Offer, 1997, p.16

[59] Offer, 2002

[60] Cyclopedia Company Limited, p.274

Physical narrative

The Lower and Upper Karori Dams and Reservoirs stretch across the upper Kaiwharawhara Valley. These form the main components of engineering importance of the Karori Water Supply Dams and Reservoirs, which were the heart of Wellington's regional water supply system until the late 20th century.

The dams are each recognised for their engineering significance as early New Zealand large scale examples of their respective dam types: the Lower Karori Dam being a puddled clay core earth dam and the Upper Karori Dam is a concrete gravity dam. The dams and reservoirs are individually discussed below.

While buildings and the networks of bridges, aqueducts, tunnels and pipeline are only discussed briefly in this section, these are acknowledged as being intrinsic parts of the Karori waterworks' former operational effectiveness. For example, generations of Wellington water engineers modified the functionality at Karori as necessity dictated and needs changed, from the late nineteenth century until recently. As a result, an aspect of the system which is of engineering note was that there were some extremely complicated pipe intersections, many of which were in tunnels, to allow for a series of different operational conditions.[61]

Lower Karori Dam and Reservoir

The Lower Karori Reservoir is high in Wellington's western hills, with a top water level 141 metres (m) above sea level, and an original water capacity of 207 million litres.[62]

The Lower Karori Dam, completed in 1878, "deserves to be described as a landmark in New Zealand's dam-building history."[63] This earth dam has a central core of puddled clay, similar to the Ross Creek Dam in Dunedin (1867), and rises to a height of 21.6 m. A puddled clay core dam is one where water was added to the clay and then it was compacted into place by ramming.[64]

The shoulder material on the upstream side of the puddle clay core was treated differently to its counterpart in Dunedin. It was graded from fine to coarse as recommended for British dams after 1852 as the result of the failure of the Bilberry

[61] Pers Comm. John Morrison to Karen Astwood, 9 April 2012

[62] Cooke, 2008, p.22; Offer, 1997, p.35

[63] Offer, 1997, p.37

[64] Ibid., p.203

Dam, which killed 80 people. Wave protection on the upstream face was in the form of a concrete skin, instead of the hand-placed stone (or riprap) which had been shown in the original drawings and was the usual Victorian practice (Figure 4).[65] This innovation was probably born out of necessity due to the "difficulty of finding durable stone in the vicinity of the dam without large scale quarrying."[66] By the 1870s concrete was becoming more widespread in construction in New Zealand, although it was not until the 1880s that the first small scale concrete weirs and dams were constructed.[67]

During construction, the engineer "altered the relative positions of the front [upstream] wall and the puddle wall in the centre of the dam, bringing them about 29 feet (nine metres) nearer together…to suit the ground."[68] Other modifications included: reducing the height of the dam; shortening the front slope to 3:1, which reduced the earthworks and length of the pipe culvert underneath; changing the outlet to a culvert type; and launching the valve tower bridge from the side rather than the crest of the dam.[69]

The culvert was used to pipe water out of the reservoir and is another difference between the Lower Karori Dam and Ross Creek Dams. This culvert passes through a tunnel in the rock ridge on the right abutment. This was considered best practice in British engineering of the time and was used to minimise the chance of leakage that could occur along the outside of the culvert. Such leakage was dangerous since it could cause internal erosion, therein undermining the dam.[70]

The Lower Karori Dam's valve tower has been described by Geoffrey Thornton as a "visual delight."[71] Beneath the surface of the lake, this is a simple concrete shaft which is about 3 m in diameter.[72] However, the column terminates with decorative corbels and has a Gothic inspired turret on top, which is a focal point of the Karori Wildlife Sanctuary. It was from the valve tower that Council staff monitored and controlled the outflow of water (see Figure 3). The current bridge between the valve tower and the reservoir's shore was constructed in late 1990s.[73]

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[65] Ibid., p.34

[66] Offer, 2002

[67] G. Thornton, *Cast in Concrete: Concrete construction in New Zealand 1850-1939*, Auckland, 1996, p.26; Offer, 1997, p.40

[68] Cooke, 2007, p.8

[69] Ibid.

[70] Offer, 1997, p.36

[71] Thornton, p.31

[72] Cooke, 2008, p.23

[73] Ibid.

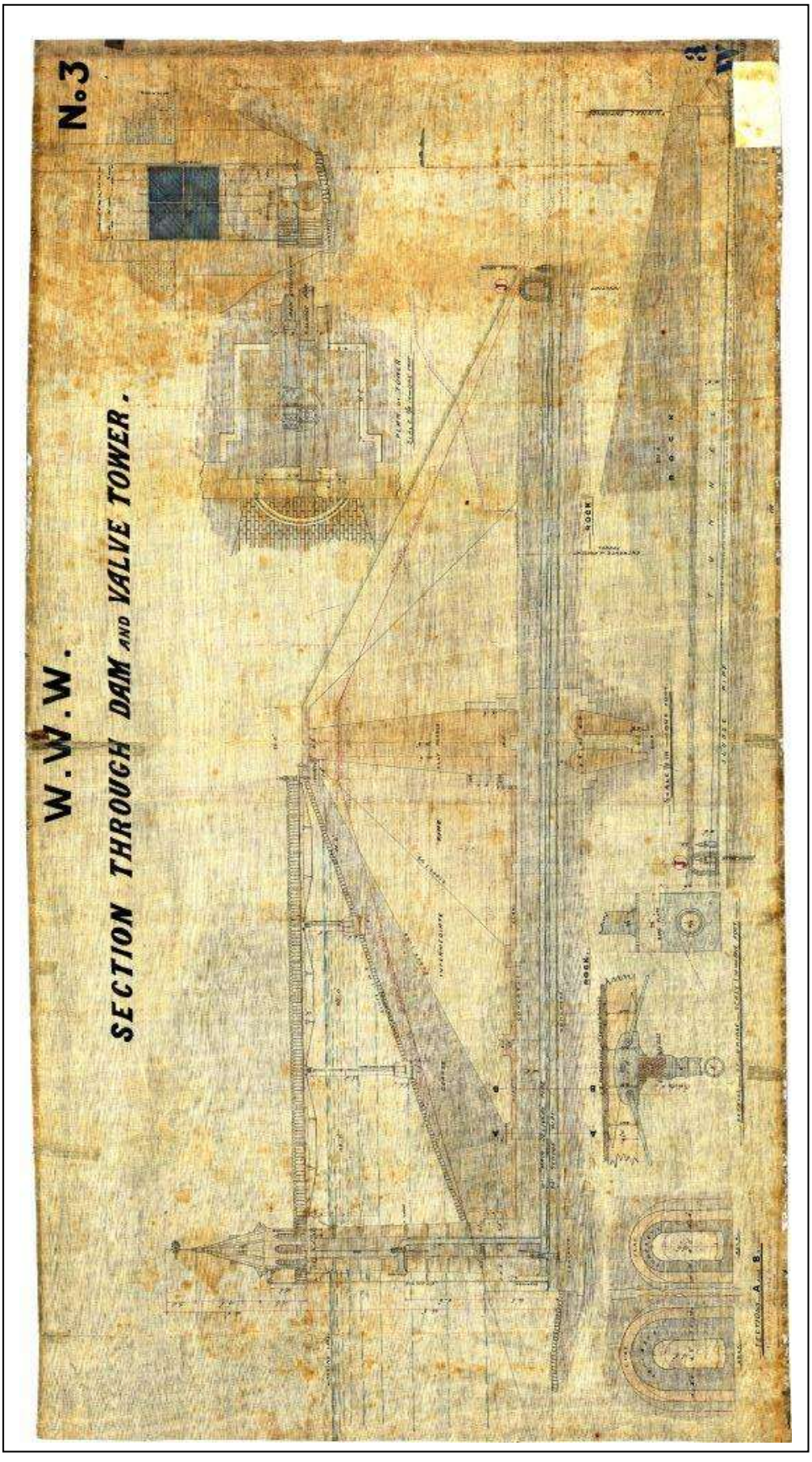

Figure 4: Karori Dam, Section Through Lower Dam and Valve Tower, Sheet 3, circa 1874. Wellington City Archives (WCA), Reference: 00456:1:1

The Lower Karori Dam has an eastern spillway, or bywash channel, which at various points is an open ditch, concrete lined, or carried using timber flume structures. This spillway is no longer used. The opposite (western) spillway, was originally very similar in materials. However, aside from the first few metres, this spillway was subsequently changed, with the water being carried through a pipe. The western spillway still carries overflow from the reservoir to the stream below.[74]

Lower Karori Dam and Reservoir associated features

The tunnels associated with the Karori waterworks connecting to the reservoir date from 1872 and are important extant parts of the scheme. There are also many other features associated with the dam and reservoir which are close by, such as the break pressure tank, remaining buildings (some plant *in situ*) and the foundations of various pump houses, as well as the chlorine and valve houses.

Upper Karori Dam and Reservoir

About one kilometre upstream of its counterpart, the Upper Karori Dam is one of New Zealand's earliest large concrete gravity dams. The outward curve of the dam has a 90 m radius, which means it has a crest length of 107 m, and the structure is 24 m tall at its highest point.[75] Originally the reservoir was designed to hold approximately 284 million litres of water, but this was lowered significantly in 1992 as a result of concerns over the earthquake safety of the structure.[76] The water level behind Upper dam was lowered by leaving open one of the outlet valves part way down. In heavy rain operational staff still have to go to the dam and manually open the main scour (drain) valve as the outlet valve has only limited flow capacity.[77]

The New Zealand Portland Cement Company provided nearly 4000 tons of cement for the Upper Karori Dam.[78] There are two different qualities of concrete used in the structure, with a coarse aggregate used for the core, and a "higher strength concrete made with clean river gravel aggregate" used for the outer shell of the dam. This was an unusual method at the time, but is akin to modern techniques.[79]

The plans for the Upper Karori Dam show that its valve tower adjoins the main mass of the structure, off-centre to the east (Figure 5). The planned spillway was located on

[74] Ibid., pp.23-24

[75] Offer, 1997, p.65

[76] Cooke, 2007, p.14; Meyer, p.12

[77] Pers Comm. John Morrison

[78] 'N.Z. Portland Cement,' *Observer*, 15 August 1908, p.37

[79] Offer, 1997, p.65

the west side of the structure. However it was eventually constructed on the east side.[80] The timber in the spillway had seriously degraded by 1980 which is when it was replaced in concrete.[81]

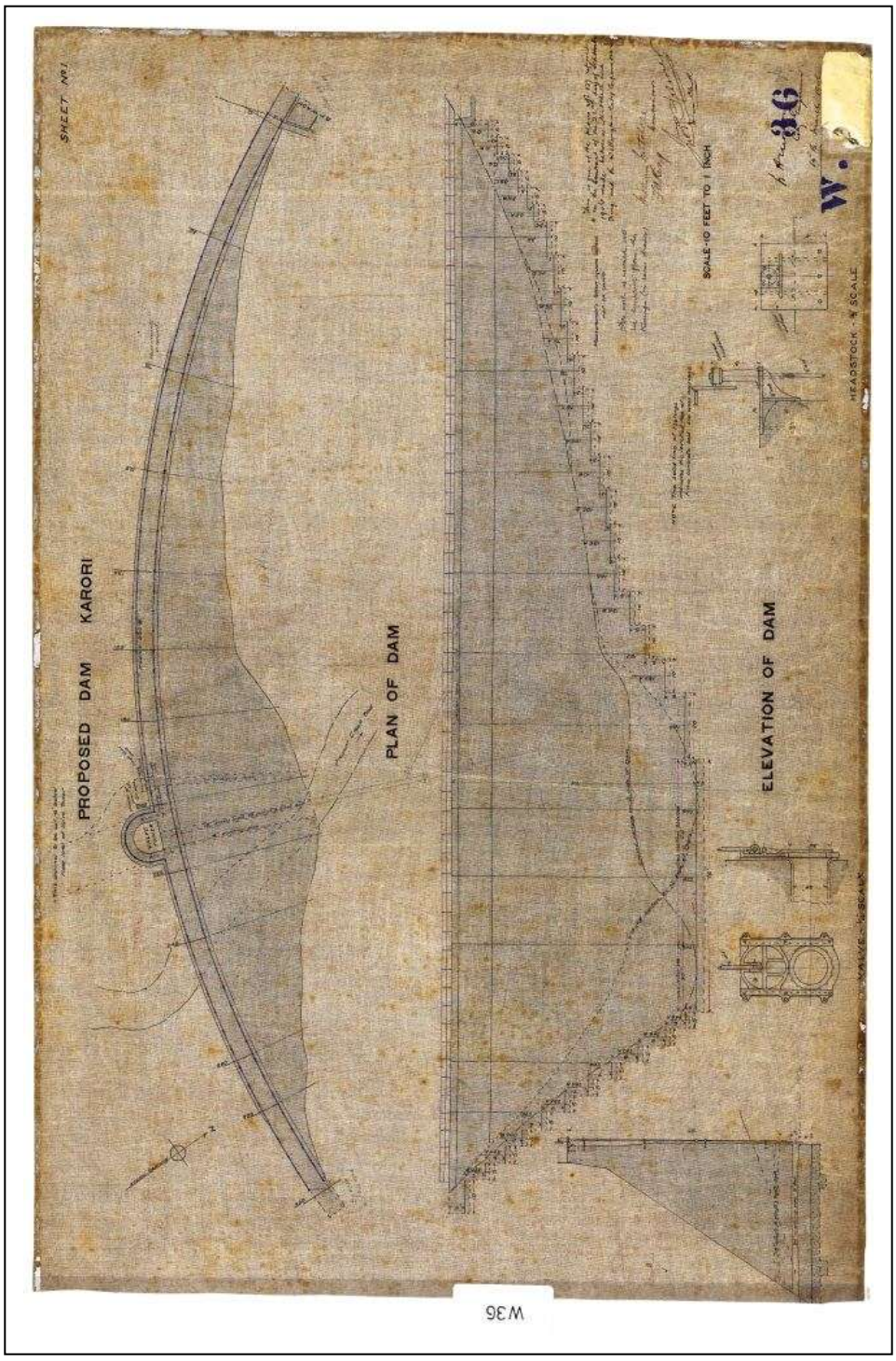

Figure 5: Proposed Dam, Karori. Sheet 1, Plan and Elevation, 1906. WCA, Reference: 00456:2:13

[80] Pers Comm. John Morrison

[81] Ibid.

Upper Karori Dam and Reservoir associated features

Sections of Lake Road, which leads to the dam, follow the line of the tramway used during construction of the Upper Karori Dam. Parts of the tramway lie beside the track at the junction of Lake Road and Swamp Track. Other remnants from the construction of the Upper Karori Dam include the quarry, which is near the top of the Campbell Street Track. Interpretation panels have been created for this and some nearby bogie wheels. The upper construction area, known as The Terrace, now features a reconstruction of the cable-way tower used during the building of the dam. There are also the foundations and other remains of buildings, such as storage huts, around the dam site. A replica hut has been built to house interpretation about the dam's construction and history.[82]

Key physical dates

1878	Lower Karori Dam completed
1906 - March 1908	Upper Karori Dam constructed
1930	Chlorination treatment plant added
1935	Pump house added (foundations remain) and distributing basin decommissioned (later filled in)
1957	Pumping station and valve house added for new Kaitoke scheme
1980	Upper Karori Dam timber spillway replacement
1990s	1924 bridge to Lower Karori Dam valve tower replaced
1992	Water level of Upper Karori Dam reduced
1997	Dams decommissioned for water supply, but reservoirs not drained

[82] Meyer, pp.16-17. A bogie is also known as a wheel truck and is typically the wheeled section of a tram or train which the carriage is then connected to.

C. Assessment of significance

The Kaiwharawhara Stream Valley, or Karori, water catchment was utilised for water supply for over a century, and became the heart of the Wellington region's system. As such, the Karori Water Supply Dams and Reservoirs were integral to the social and economic development of New Zealand's capital city. This gravitational public water supply system, with its impressive dams, also has importance because the structures are closely associated with noteworthy New Zealand engineers, Nicholas Marchant and William Hobbard Morton. This place is representative of their respective engineering skill, as well as the Wellington City Council's early innovative commitment to supporting large scale works in order to create a sustainable water supply.

In particular, Marchant's Lower Karori Dam, completed in 1878, has considerable engineering and social importance because it was the first water supply dam constructed in New Zealand by a municipality. This is a fine example of puddled clay core earth dam technology and best practice in dam construction at the time. Likewise, Morton's Upper Karori Dam, which augmented the waterworks system in 1908, is an engineering accomplishment because it is was one of the earliest large scale mass concrete gravity dams built in New Zealand.

Therefore, the Karori Water Supply Dams and Reservoirs have sufficient engineering heritage significance to merit inclusion on the IPENZ Engineering Heritage Register.

D. Supporting information

List of supporting information

Link to: Lower Karori Dam, New Zealand Historic Places Trust Category 1 historic place (Register no. 7750), URL - http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7750

Link to: Upper Karori Dam, New Zealand Historic Places Trust Category 2 historic place (Register no. 7749), URL - http://www.historic.org.nz/TheRegister/RegisterSearch/RegisterResults.aspx?RID=7749

Link to: 'Biographies: W. H. Morton,' IPENZ Engineering Heritage, URL: http://www.ipenz.org.nz/heritage/bio-detail.cfm?id=35

Link to: E. E. Henriksen, 'Wellington Metropolitan Water Supply: Hutt River Scheme,' New Zealand Engineering, Vol. 11:1 (January 1956), pp.2-15

Link to: I. A. Williamson, Karori Pumping Station,' New Zealand Engineering, Vol. 14:6 (July 1959), pp.172-79

Bibliography

Published sources

Brodie, J., *The Karori Gold-Rush, 1869-1873*, Wellington, 1997

Burch, J., *The Karori Reservoir Area: A Brief History*, Wellington, 1997

Cross-Rudkin, Peter, and Mike Chrimes (ed.), *Biographical Dictionary of Civil engineering, Volume 2 – 1830 to 1890*, London, 2008

Cyclopedia Company Limited, *The Cyclopedia of New Zealand [Wellington Provincial District]*, Wellington, 1897

Henriksen, E. E., 'Wellington Metropolitan Water Supply: Hutt River Scheme,' *New Zealand Engineering*, Vol. 11:1 (January 1956)

Morrison, S., *History of Water Supply in the Wellington Region, 1872-1985*, Wellington, 1986

Mulgan, A., The City and its Strait: Wellington and its Province, Wellington, 1939

New Zealand Parliament, *Appendix to the Journals of the House of Representatives*, Wellington, 1871, Session I, H-03

New Zealand Parliament, *Parliamentary Debates*, Wellington, 1874, Vol XVI

New Zealand Society of Civil Engineers, *Proceedings of the New Zealand Society of Civil Engineers*, Vol. X (1923-24), Wellington, 1924

Offer, R. E., *Walls for Water: Pioneer Dam Building in New Zealand*, Wellington, 1997

Thornton, G., *Cast in Concrete: Concrete construction in New Zealand 1850-1939*, Auckland, 1996

Ward, L. E., *Early Wellington*, Auckland, 1928

Williamson, I. A., 'Karori Pumping Station,' *New Zealand Engineering*, Vol. 14:6 (July 1959)

Archival and unpublished sources

Available from New Zealand Historic Places Trust, Central Region Office, Wellington:

Cooke, P., 'Registration Report for a Historic Place: Lower Karori Dam,' New Zealand Historic Places Trust, 2008 (Register no.7750)

Meyer, Emma, 'Registration Report for a Historic Place: Upper Karori Dam,' New Zealand Historic Places Trust, 1 May 2008

Electronic Sources

‘Trust Timeline,’ Karori Sanctuary Trust, URL: http://www.sanctuary.org.nz/Site/About_us/Key_achievements_and_wildlife_releases.aspx (accessed 26 March 2012)

‘Water treatment – Gear Island,’ Greater Wellington, URL: http://www.gw.govt.nz/Gear-Island-2/ (accessed 21 March 2012)

‘Wellington Waterworks Act, 1871 - Powers of the Council in connection with the undertaking,’ New Zealand Legislation: Acts, URL: http://www.legislation.govt.nz/act/private/1871/0003/latest/DLM89257.html (accessed 26 March 2012)

‘Wellington Waterworks Act, 1871 - Schedule,’ New Zealand Legislation: Acts, URL: http://www.legislation.govt.nz/act/private/1871/0003/latest/DLM89747.html (accessed 26 March 2012)

‘Wetland fauna restoration,’ Karori Sanctuary Trust, URL: http://www.sanctuary.org.nz/Site/Conservation_and_Research/Restoration/Wetland_flora_and_fauna/Wetland_fauna_restoration.aspx (accessed 26 March 2012)

Cook, P., *Our water history – on tap: Water supply in the Wellington region 1867-2006*, Wellington, 2007. URL - http://www.gw.govt.nz/assets/Our-Environment/Water-Supply/PDFs/Covers-foreword-introduction-water-history.pdf (accessed 2 April 2012) [also available in hardcopy]

Maclean, C., 'Wellington region - From town to city: 1865–1899', Te Ara - the Encyclopedia of New Zealand, URL: http://www.TeAra.govt.nz/en/wellington-region/8 (updated 24 November 2009)

Offer, R. E., ‘Heritage Assessment Programme: IPENZ National Heritage Committee, Lower Karori Dam’, 24 June 2002, URL: http://www.ipenz.org.nz/heritage/documents/Lwr%20Karori%20dam%20submsn1.pdf (accessed 2 April 2012)

Available from AtoJs Online, http://www.atojs.natlib.govt.nz

‘Report of the Select Committee on the Wellington Waterworks Bill, 1871, Session I, H-03

Available from Papers Past, http://paperspast.natlib.govt.nz/cgi-bin/paperspast

Colonist, 24 September 1906

Evening Post, 29 March 1871, 23 February 1878, 8 March 1878, 22 September 1879, 27 February 1907, 13 March 1908, 4 December 1929, 3 September 1932, 27 February 1936

Observer, 15 August 1908

Taranaki Herald, 18 March 1909

Wellington Independent, 4 May 1874, 19 February 1867, 16 May 1867, 20 August 1868, 15 October 1870, 19 April 1872, 4 May 1874