Quality for Life

greater WELLINGTON REGIONAL COUNCIL | Water

TECHNICAL INFORMATION

Wainuiomata Water Treatment Plant

Key statistics

Plant flow: 16 ML/d to 60 ML/d, daily average flow 30 ML/d

Main treatment processes:

- Coarse Screening
- Coagulation/Flocculation
- Dissolved Air Flotation over Filters
- Chlorination
- pH adjustment
- Fluoridation

Treatment chemicals:

- Raw Water Dosing
  - Carbon Dioxide (CO_2)
  - Lime ($Ca(OH)_2$)
  - Polyaluminium Chloride (PACL)
  - Polyelectrolyte
- Treated Water Dosing
  - Lime ($Ca(OH)_2$)
  - Chlorine (Cl_2)
  - Fluoride (Na_2SiF_6)

Typical operating costs:

- Power: 0.8 cents/cubic metre
- Chemical: 3.5 cents/cubic metre
- Sludge disposal: 0.6 cents/cubic metre

20% of the Wellington urban region's treated water supply comes from Wainuiomata Water Treatment Plant

Raw water sources

Water for the treatment plant comes from the 7,600 ha Wainuiomata/Orongorongo Water Collection Area in the Rimutaka Ranges. The water is taken from five different rivers or streams. These are the:

- Wainuiomata River
- George Creek
- Orongorongo River
- Big Huia Creek
- Little Huia Creek

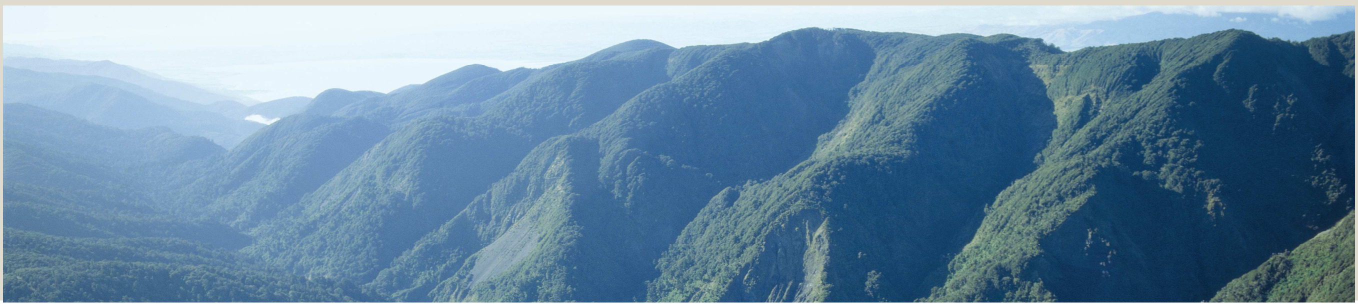
At each site the water flows over a weir, through bar screens measuring 15-20 mm (to remove large objects such as leaves and twigs), and into an intake pipe. From the Orongorongo catchment the water flows by gravity through a 5.6 km long pipeline to the treatment plant, and through a 1.4 km pipeline from the Wainuiomata River.

The Wainuiomata River and George Creek provide about 15% of the annual water supply for Wellington. The Orongorongo River, Big Huia Creek, and Little Huia Creek provide about another 5% of the supply.

As there is no means of storing raw river water at Wainuiomata, the treatment plant must be switched off temporarily if the water quality at the intakes deteriorates. Extra water is sourced from the artesian supply in the Hutt Valley to make up the shortfall.

Typical raw water quality

Colour:	5-50°Hazen, average 12°Hazen
DOC:	0.5-10 mg/L, average 2.5 mg/L
Turbidity:	0.1-5.0 NTU, average 1.0 NTU
pH:	7.2-7.6, average 7.3
E.coli:	0-250 cfu/100 mL, average 19 cfu/100 mL
Cryptosporidium:	0.7-5.9 oocysts/100 L, average 1.2 oocysts/100L
Giardia:	0.6-5.9 cysts/100 L, average 1.2 cysts/100L
Alkalinity:	10-30 mg/L as $CaCO_3$, average 16 mg/L as $CaCO_3$
Temperature:	3-18°C, average 9°C



Plant inlet

As water enters the plant, carbon dioxide (CO_2) and lime ($Ca(OH)_2$) are added to the raw water to achieve optimum pH and alkalinity for coagulation and flocculation. They also reduce the corrosiveness of the water.

Carbon dioxide gas is added at a rate proportional to the flow to give an optimum concentration set by the plant operators. The amount of lime added is also proportional to the flow. The lime is used to achieve a water pH of 6.7, with the pH being measured three times to ensure an accurate reading.

Typical dose:
CO_2: 5-30 mg/L, average 15 mg/L
($Ca(OH)_2$): 5-30 mg/L, average 15 mg/L

Inlet mixing chamber

The water then flows into the inlet mixing chamber where polyaluminium chloride (PACL) is added at the tip of the mixing blades inside the chamber. The PACL acts as a coagulant, causing small particles in the water to clump together forming flocs. Polyelectrolyte, which increases the strength of the flocs, is added after a delay of at least 13 minutes in a second mixing chamber.

Both the PACL and the polyelectrolyte are dispersed using mechanical mixers.

Polyaluminium chloride

The amount of PACL coagulant needed to treat the water depends on the raw water organic content and turbidity.

The pH and alkalinity of the raw water is adjusted prior to the addition of PACL so that the predominant mechanism of coagulation is charge neutralisation.

Typical dose:
Polyaluminium chloride (as PACL):
8-40 mg/L, average 12 mg/L
Polyaluminium chloride (as Al^{3+}):
1.3-6.0 mg/L, average 1.9 mg/L

Polyelectrolyte

The polyelectrolyte used is a cationic polymer which increases the strength of the flocs created during coagulation and flocculation. This increased strength prevents the flocs from breaking up during the flotation process and within the filter bed.

The amount of polyelectrolyte needed depends on the flow rate of raw water and the amount of PACL that has been added. The exact amount added is managed by the plant computer control system.

Typical dose:
Polyelectrolyte (as product):
0.05-0.15 mg/L, average 0.10 mg/L

Flocculation tanks

From the inlet mixing chamber the water is split into (up to) five different process streams via weirs in the inlet channel. There are two flocculation tanks in each process stream. Energy for flocculation is applied using paddle flocculators. The flocculation tank operating parameters are:

- Flocculator 1 Gt*: 22,000/s
- Flocculator 2 Gt*: 18,000/s
- Total Gt* for flocculation: 40,000/s

* The intensity of mixing required for optimal flocculation is measured by the "G" value. Combining the G value with flocculation time provides a Gt value.

Flocculation tanks

Float layer over filter

Dissolved Air Flotation over Filters (DAFF)

No. DAFF modules:	5
No. of saturators:	2
Recycle:	10-12%
Float-off mechanism:	Hydraulic or mechanical
Flotation area:	54.3 m^2
Hydraulic loading on flotation area:	10.1 m/hr at max plant flow (including recycle)
Typical float sludge solids concentration:	0.05% Hydraulic 0.3% Mechanical
Filter Area:	44 m^2
Media Type:	Mono media sand Sand depth: 1.6 m, 1.2-2.4 mm media size
Hydraulic loading of filter area:	12.5 m/hr max plant flow (including recycle)
Typical filter run time:	8-12 hours
Backwash regime:	Combined air and water backwash
▪ Air scour rate:	30 m/hr
▪ Backwash water rate:	950 m^3/hr, 34 m/hr
▪ Backwash duration:	18 minutes
▪ Backwash water volume:	3.6 bed volumes, 250 m^3

There are five Dissolved Air Flotation filters at the Wainuiomata Water Treatment Plant. Flotation and filtration occur in the same vessel.

Around 10-12% of the filtered water is recycled to the two saturators, where air is dissolved into the water at a pressure of around 550 kPa.

Water, now containing the flocs created from particles in the water reacting to the chemicals which have been added, enters the first section of the filter. The recycled water, saturated with air, is released through a manifold across the width of the tank. At this point, the air comes out of solution in the form of microbubbles, which attach to the flocs. The water-floc-microbubble mixture floats to the surface, guided by an inclined baffle, and into the second section of the filter. This DAFF process removes approx 90% of the floc particles.

The float layer (flocculated particles brought to the surface by the air bubbles) which forms on top of the filters is removed either hydraulically, by flooding the filter with discharge over a weir; or mechanically, by a tilting tray. The operator can choose which mechanism to use.

When either method is used, the interval between each float-off decreases as the amount of coagulant used increases. This is because more flocs are formed. During a hydraulic float-off operation the whole float is removed. The float-off interval can range between 2 and 4 hours. When the mechanical mechanism is used, the float removal is a more continuous process ranging from 1 to 4 minutes. Float from all of the filters is sent to the float balance tank.

Filter gallery

The subnatant (clean) water from the DAFF process flows downwards through the 1.6 m deep filter of mono media coarse sand (1.2-2.4 mm) into the underdrains.

The turbidity of each individual filter is monitored continuously and maintained below 0.1NTU to ensure they are operating effectively to remove protozoa. If the turbidity of an individual filter exceeds the limits which have been set, the filter becomes 'out of service' until it can be backwashed.

Backwashing

Because the filters remove flocculated particles, over time they become clogged and less effective. At this stage they must be backwashed to remove the flocs and 'clean' the sand.

Backwashing of the filters starts automatically if any of the following three events occurs:

- Turbidity spikes in the treated water
- Excessive run time or
- High bed headloss

The operators can also manually start a backwash of the filters.

When a filter backwash is required, the filter is taken offline until there is sufficient water in the washwater reservoir (backwash tank) and there is capacity in the washwater recovery plant for the dirty backwash water. Filters are washed on a first in/first out basis, however the operators can change the order in the queue.

The backwash involves both a combined air scour and water wash. Once the backwash is completed, the filter is half-filled with washwater and ready for operation again.

Clean wash water is pumped to the filters from the washwater reservoir.

Washwater Recovery

Washwater settling tank:	1 x 250 m^3
Float balance tank:	1 x 21 m^3
Thickener:	1 x 420 m^3
Supernatant tank:	1 x 250 m^3
Centrifuge:	1

Typical dried solids concentration:

Float:	Hydraulic 0.05% dried solids
	Mechanical 0.3% dried solids
Unsettled washwater:	0.05% dried solids
Settled washwater:	0.5% dried solids
Thickened sludge:	2.5% dried solids
Centrifuge sludge:	18% dried solids

Backwash water from the filters flows by gravity to the washwater settling tank where it is left to settle for an hour. Settled washwater sludge together with float from the float balance tank are transferred to the thickener where polymer is added to speed up the sedimentation process.

Settled sludge from the thickener is pumped to the centrifuge. More polymer is added to the sludge to strengthen the flocs so that they do not break apart in the centrifuge.

Centrifuge sludge is taken to the landfill, while the centrate is discharged into a dedicated sewer.

Supernatant from the washwater settling tank and the thickener, is stored in the supernatant tank before either being pumped back to the head of the plant or discharged to the river (under controlled conditions).

Treated water

Lime and chlorine are added to the filtered water in the outlet mixing chamber.

Lime

Lime is added to raise the water's pH and to reduce its corrosiveness. The water leaving the treatment plant generally has a slight tendency to dissolve calcium carbonate.

The amount of lime added is controlled by the flow and desired pH of the treated water. This is set by the operators but is usually around 7.8.

Typical Dose:
Lime: 2-10 mg/L, average 5.0 mg/L

The lime used at the plant contains some impurities which do not dissolve in the water. These could accumulate in the treatment plant and the water reticulation system. Therefore a grit chamber is provided after the outlet mixing chamber to collect the majority of these impurities before the water is sent to the treated water reservoir.

Chlorine

Chlorine gas is used to disinfect the filtered water.

The flow of chlorine is adjusted in proportion to the flow of treated water to achieve the required chlorine concentration when the water leaves the treated water reservoir. The chlorine dose is adjusted to produce a final concentration of approximately 0.6 mg/L.

The amount of chlorine in the water is monitored continuously. If the concentration exceeds predetermined limits the plant is 'slam shut' to protect the treated water supply.

Typical Dose:
Chlorine: 0.5-2.0 mg/L, average 0.8 mg/L

Fluoride

Fluoride is dosed after water leaves the treated water reservoir.

Fluoride is added to the water to provide dental health benefits to the consumer. The natural level of fluoride in the river water around Wellington is 0.1 mg/L. Following treatment this is increased to 0.7-1.0 mg/L as recommended by the Ministry of Health.

Sodium silicofluoride (Na_2SiF_6) is made into a slurry and added to the treated water. The fluoride is added at a rate proportional to the flow of treated water.

The concentration of fluoride is monitored to ensure that the required dosing range is maintained.

From the treated water reservoir, water flows by gravity to the water supply system.

Typical treated water quality

The quality of treated water from the Wainuiomata water treatment plant is very high, and exceeds all the standards set out by the Ministry of Health in the Drinking Water Standards for New Zealand 2005. This is reflected in the plant's attainment of the Ministry's A1 grading for the source and treatment management. The quality management system is certified to ISO 9001: 2000 while the environmental management system holds ISO 14001:2004 certification.

Treated water is monitored for turbidity, pH, and residual chlorine to ensure the standards are met. In addition, treated water is monitored continuously for organics, aluminium and alkalinity.

Typical characteristics:

Colour:	0.5-5°Hazen, average 2°Hazen
DOC:	0.1-1.0 mg/L, average 0.4 mg/L
Turbidity:	0.02-0.5 NTU, average 0.06 NTU
pH:	7.0-8.5, average 7.7
Chlorine Residual	0.5-1.0 mg/L, average 0.6 mg/L

Comparing typical mean values with popular brands of bottled water

Parameter	Pump*	Kiwi Blue*	Wainuiomata
Calcium (total), mg/L	2.7	2.2	**20**
Chloride, mg/L	5.0	6.4	**21**
Magnesium (total), mg/L	1.0	1.3	**2.0**
pH	6.5	5-7	**7.7**
Sodium (total), mg/L	7.8	8.3	**12**
Solids (total dissolved), mg/L	110	110	**115**

* Mean values derived from Nutritional Information supplied on product

Wainuiomata Water Treatment Plant

For more information, contact Greater Wellington:

Wainuiomata Treatment Plant
PO Box 43160
Wainuiomata 5048

T 04 564 8599
F 04 564 8943

Wellington office
PO Box 11646
Manners Street
Wellington 6142

T 04 384 5708
F 04 385 6960

www.gw.govt.nz

Publication date: January 2008
Publication No: GW/WS-G-08/07