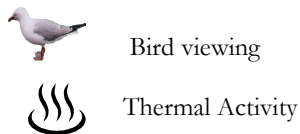
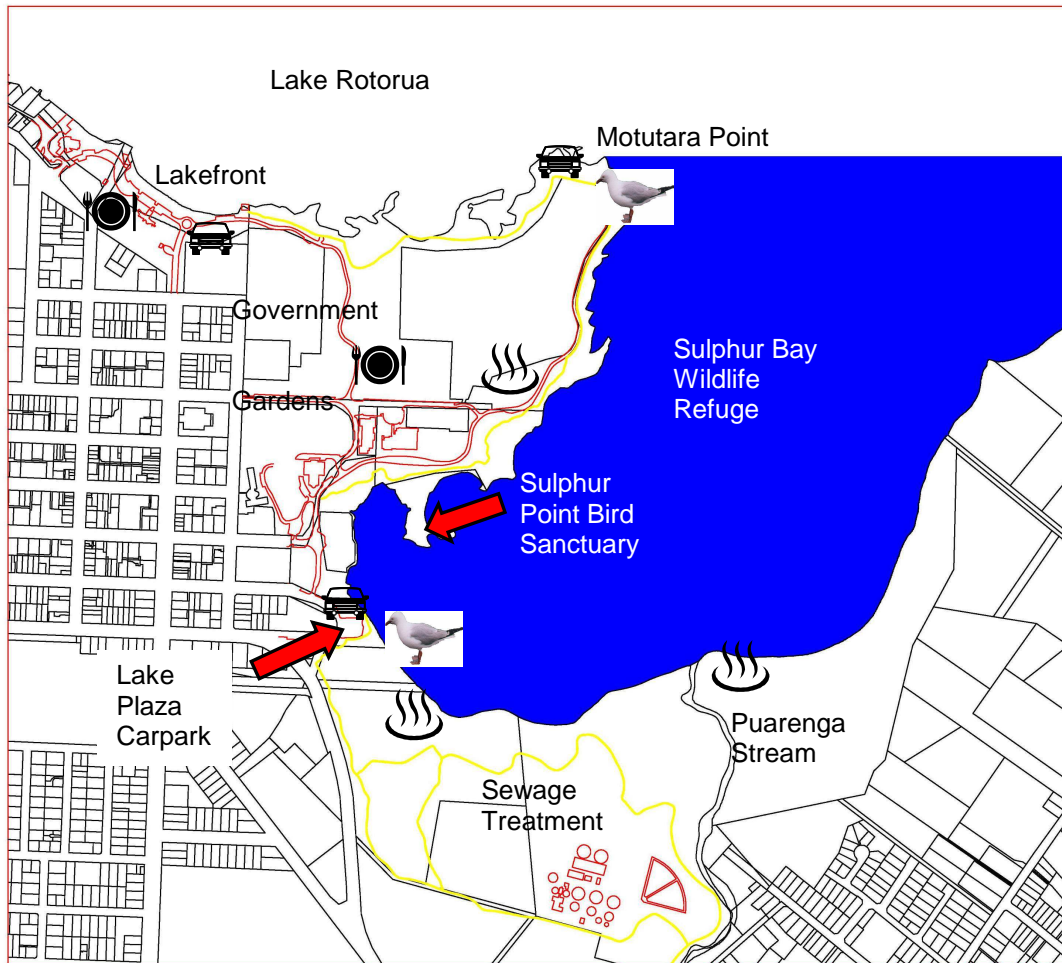


## 2. SULPHUR BAY



Sulphur Bay is situated in the south-eastern corner of Lake Rotorua which is a volcanically formed, 'eutrophic' lake. The Bay stretches from Motutara Point across to Ngapuna. Puarenga Stream flows into the Bay and features geothermal activity at its mouth. This activity is the origin of the warmth and murky sulphurous suspensions in the water, which is low in oxygen and quite acidic (pH3.5).

Past geothermal activity and mining for sulphur has left behind sulphur/silica flats and sinter terraces. There are still many active fumaroles and mudpools. The shore features manuka-kanuka scrubland and other plants specialised to living in these conditions. The sediments range from fine mud to fine quartz sand. Midge larvae are found in the quartz sand and are the only abundant insect group.

## 2.1 HISTORY

There have been some notable battles between Maori tribes that occurred in this area. Utu was once a way of life and on one particular occasion in the early 1600s, a Tuwharetoa war party from Taupo was causing trouble in the area. As they journeyed back to Taupo, a small Ngati Whakaue war party from Mokoia Island pursued them. The Tuwharetoa turned back, bringing reinforcements with them. Te Roro-o-te-rangi, chief of the Ngati Whakaue stood his ground and roused his warriors to join him against the Tuwharetoa. In the battle that followed Te Roro-o-te-rangi's brother was killed and his other brother Tunohopu fought strongly against Kaipahu the chief of Tuwharetoa. Because Tunohopu was an equal match for Kaipahu, he was spared and left as the guardian of the lake.

Te Roro-o-te-rangi was captured and taken to Taupo to be paraded as a trophy until he was finally put to his death. Many Ngati Whakaue lost their lives in this battle.

The southern shoreline of this bay was once used as a rubbish dump and also for sulphur mining. The nearby sewage treatment plant discharged effluent into the lake until 1991.

## 2.2 FACILITIES

There is a walkway from the Lakefront, to Motutara Point, around the Government Gardens, past the Polynesian Pools and Lake Plaza Hotel, and then on past the sewage treatment plant to Sala St along the Puarenga streamside. There are a number of excellent interpretation panels along the way.

Access is easy from many places, but you **must** stay on the tracks due to the danger from thermal activity and sanctuary reserve status. Sinter terraces may look solid but often are not – **don't walk on them**.

Public toilet facilities can be found at the Lakefront and the Sportsdrome. If visiting the Rotorua Museum of Art and History there are toilets there also. There are playgrounds and picnic areas with big shade trees in the Government Gardens and at the Lakefront.

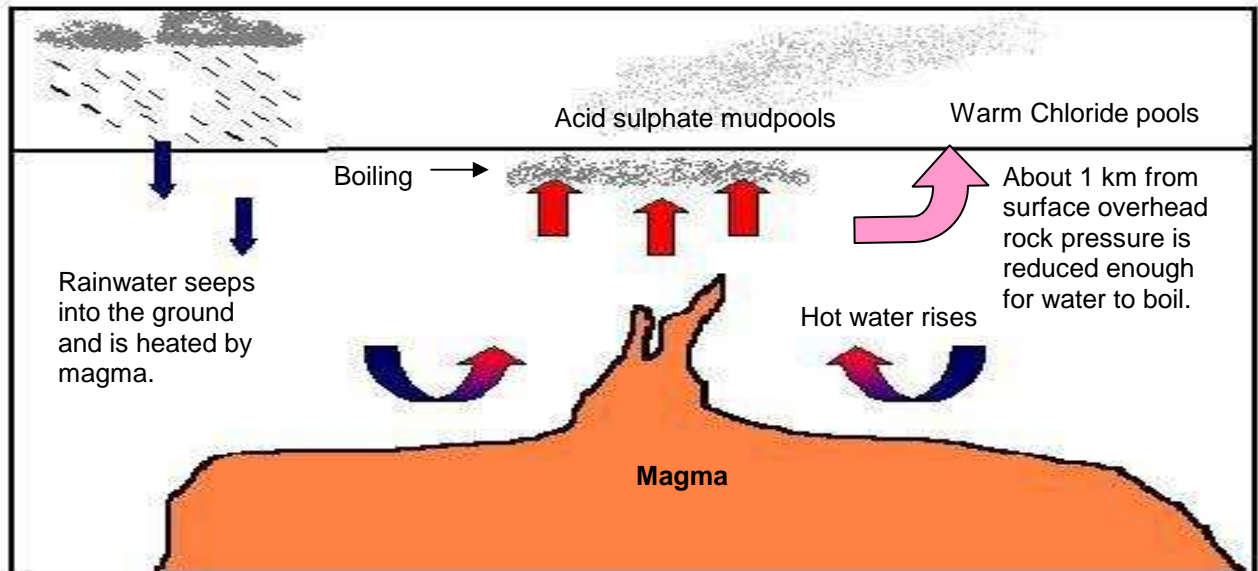
## 2.3 VOLCANIC BEGINNINGS

Lake Rotorua was formed approximately 220,000 years ago, following an ignimbrite eruption. This was a large, explosive ash eruption whose eruption column collapsed sending the ash in a fast-moving, gas-buoyed cloud across the landscape creating Mamaku Plateau. The roof of the emptied magma chamber collapsed, forming the circular caldera we see today. This subsequently filled with water, forming the lake. The lake level has risen and fallen over time as a result of other eruptions damming the outlet, then subsequently breaching that dam. Evidence of this is seen in the lake terraces on the surrounding hills, depicting the past lake levels. The outlet is now at Ohau Channel which feeds into Lake Rotoiti, then into Kaituna River which flows out to the Bay of Plenty. At one stage, water flowed from the Lake through Hemo Gorge and into the Waikato River. Mokoia Island, Kawaha Point, Mt Ngongotaha, Owhatiura, Hinemoa Point and Pukeroa are rhyolite domes. Rhyolite is formed from very viscous lava high in silica. This lava

was pushed up through faults rather like toothpaste after the initial explosive ignimbrite-producing eruption.

The rocks found around Rotorua result from these ignimbrite and rhyolitic eruptions. They are all high in silica but take on various forms due to the ways they were erupted, the gas content of the lava and the way they cooled. Ignimbrite, rhyolite, obsidian and pumice can be found.

## 2.4 THE HOT SPOTS



Rainwater and lake water, seep down into the ground and the water is heated by magma. The water dissolves elements from the surrounding rock. The heat causes the fluid to rise and about a kilometre from the surface, boiling occurs as the pressure from the overlying rock is reduced. At various levels, different mineral ores are deposited in fractures caused by the boiling. These mineral ores contain gold, silver, copper, zinc, iron, lead and others. The Waihi mine deposits were formed in the same way.

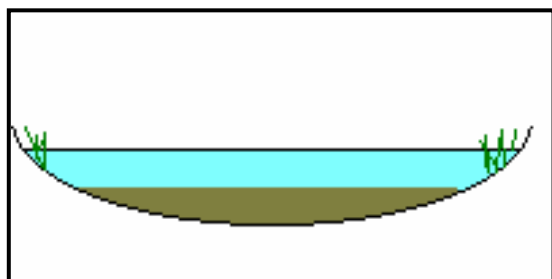
Acid sulphate features include steaming ground, sulphur domes, mudpools and pools of dirty water. They are produced by steam and gases released by boiling of rising hot fluid. The steam contains water, carbon dioxide and hydrogen sulphide. Hydrogen sulphide is responsible for the rotten egg smell and is toxic. It is a dense gas that accumulates near the ground. When mixed with groundwater and air it changes to sulphur dioxide, which dissolves to make sulphuric acid. This acid reacts with the surrounding rocks and produces colourful clays, sunken features and turbid water.

Chloride features include sinter terraces and flats, springs and geysers. The water comes from deep in the ground, is clear and rich in silica and chloride and has a soapy feel when cool. The silica precipitates to form deposits called sinter. Sinter terraces seen around the lake were formed at a time when the lake level was higher. Chloride pools can be anything from alkaline to acid. The 'Rachel Pool' behind Blue Baths in Government Gardens is the only alkaline chloride pool near to Sulphur Bay.

## 2.5 LAKES

After a period of stabilising, volcanically formed lakes begin as clean, deep lakes with low sediment and low nutrient concentration - (oligotrophic ) and slowly change to become less clear (turbid) with higher amounts of sediment and nutrient through a process called 'eutrophication'. Eutrophication is a natural process often sped up by human activity in the surrounding catchment such as the disturbance of soil and vegetation and the addition of fertilisers and animal wastes. These activities influence the quality and quantity of water and type of sediment and nutrients reaching the lake. Discharges into the lake via waterways also feature as a source of nutrients. Too much nutrient, especially nitrogen and phosphorus can fuel the growth of undesirable aquatic plants and promote problematic 'algal blooms'.

Lake Rotorua is a eutrophic lake that was rapidly becoming worse, but the Rotorua District Council has done much to reverse this trend. They have stopped discharging effluent from the sewage treatment plant into the lake and now spray it on the Whakarewarewa Forest. They have installed sediment traps to reduce the amount of sediment from stormwater reaching the lake. You can see one of these at the beginning of the Lakefront walk and another near the Lake Plaza Hotel. The change from lakeside septic tanks to sewerage is another move towards improvement. They have also worked on education of the public to eliminate discharge of pollutants into streams and down stormwater drains. Retirement of stream margins by Environment Bay of Plenty is another excellent move towards reduction of nutrients entering the lake.



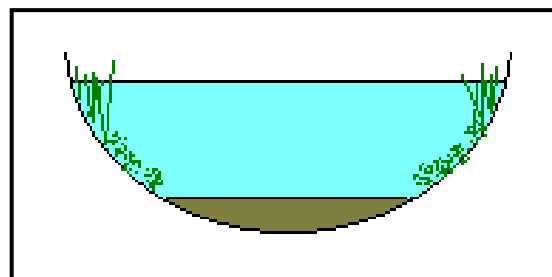
**Eutrophic Lake (Generalised)**

**Less than 15 metres deep**

**Clarity poor**

**Lots of sediment**

**Tends to stratify in summer, leaving little oxygen for bottom-dwelling fish**



**Oligotrophic Lake (Generalised)**

**More than 25 metres deep**

**Clarity excellent**

**Little sediment**

**Lots of oxygen available at all depths**

## 2.6 BIRDS

Sulphur Bay is a Wildlife Refuge of 145 hectares administered by Department of Conservation, which covers the water only part of the bay. All water bird species are protected here during the hunting season and the use of boats is prohibited throughout the year. Sulphur Point, a small headland protruding into the bay, has Wildlife Sanctuary Reserve status, the highest status of wildlife protection, thus access is not allowed except by permit.

There are 63 bird species found in the area – 45 are native and 24 are water dependent – very few of them actually feed in the Bay (few insect larvae and fish would tolerate water of this quality). Warmth, refuge and the proximity of much food in the rest of the lake are likely reasons for birds to be here in such large numbers. Birds have fast metabolic rates and need much energy to fuel flight – geothermal warmth would help conserve energy usually used to keep their bodies warm.

Some 9300 waterbirds were counted on Lake Rotorua in 1991, and in the Year 2000 over 4500 birds were counted in and around Sulphur Bay.

Birds found included: - black-billed gulls, red-billed gulls, Southern black-backed gulls, pied stilts, spur-winged plovers, N.Z. dabchick, N.Z. scaup, grey teal, mallard, black swan, pied shag, little shag, little black shag, Caspian tern, pukeko, feral domestic geese, welcome swallow, white-faced heron, N.Z. shoveler, and banded dotterel. The banded dotterel is a threatened species in gradual decline and the dabchick is classified as sparse.

Sulphur Bay is generally used for roosting and breeding but often not for feeding. Insect larvae found in the sediments of the lake, bullies, smelt, inanga and lakeweed are part of the waterbird diet. Dragonflies, midges and beetles are also consumed. Midge larvae are the only abundant insect group found in the Sulphur Bay sediments. Clouds of midges around the lake margin are testament to this. No lakeweed grows in the Bay with the exception of raupo and rushes on the margins. It is believed that smelt are rendered groggy by the sulphurous and acidic water in Sulphur Bay. The Bay is so acidic that gulls can be seen with feet that have the webs eaten away and they are often seen feeding at the mouth of the Bay along the margin between the sulphurous and cleaner water of the lake. Red-billed and black-backed gulls also make use of the landfill to the South of the city. The black-billed gulls, don't scavenge to the extent that the other gulls do, but they can be seen feeding on insects and worms on agricultural land in the catchment.

## 2.7 PLANTS

Sulphur Bay is a harsh environment for plants, so there is not a great diversity of plants as not many would tolerate the heat, unusual concentrations of minerals and elements and acidity. Geothermal soils are infertile with unusually high levels of sulphur and iron. Not only do the plants have to tolerate poor soil but also they are exposed to steam and toxic gases. Due to the past land uses and disturbances at Sulphur

Bay, it supports a number of weed species. Native vegetation consists of plants with needle-like leaves, slow growth and irregular flowering habits. These include manuka, kanuka, mingimingi and prostrate kanuka. In geothermally heated soils, roots can only grow down a few centimetres into the soil creating a widespread flattened root system. In prostrate kanuka, branches that spread out to form a low-growing shrub mirror this.



Manuka



Kanuka

The kanuka looks very similar to the manuka but can be distinguished in a number of ways: - manuka is aromatic, kanuka is not; manuka has harsher leaves; manuka has bigger flowers (12mm) than kanuka (5mm); kanuka capsules are smaller but more elongated than manuka.

Turutu (blueberry) grows along the edges of the paths in clumps and raupo (bullrush) and rushes can be seen growing in the water at the lake's edge in some places.