



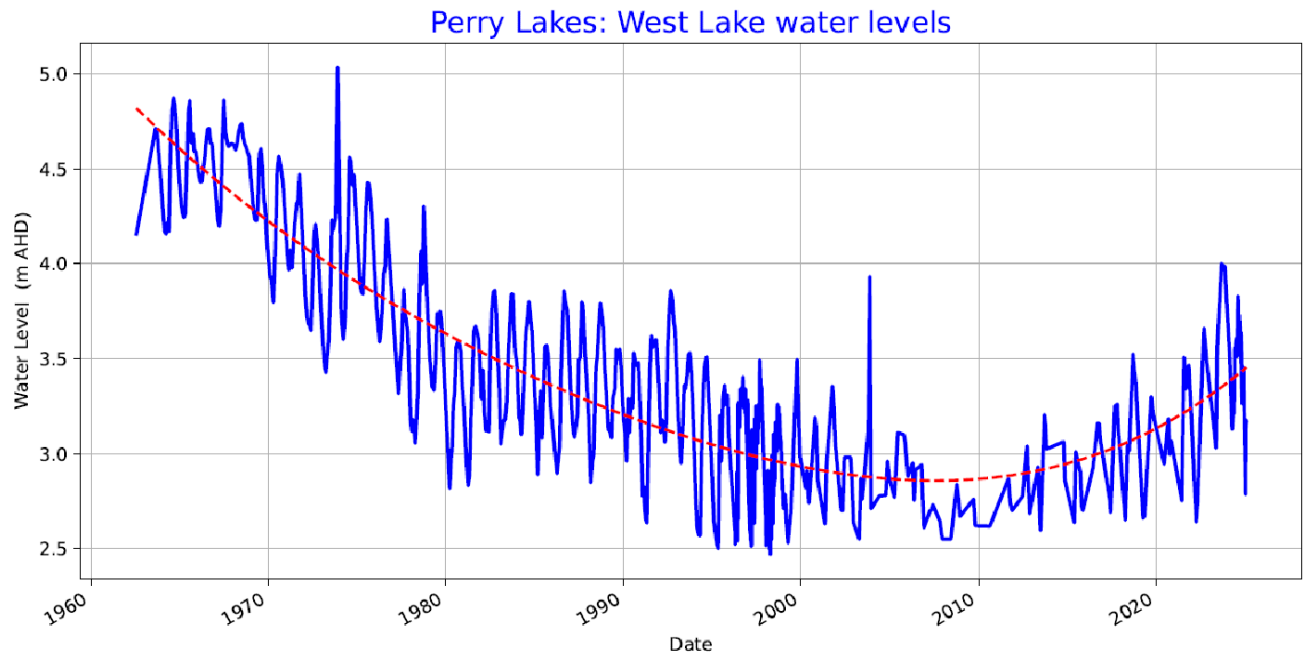
Management of water levels and quality in Perry Lakes
Last revised: 17th February 2025

A report by Dr Don McFarlane

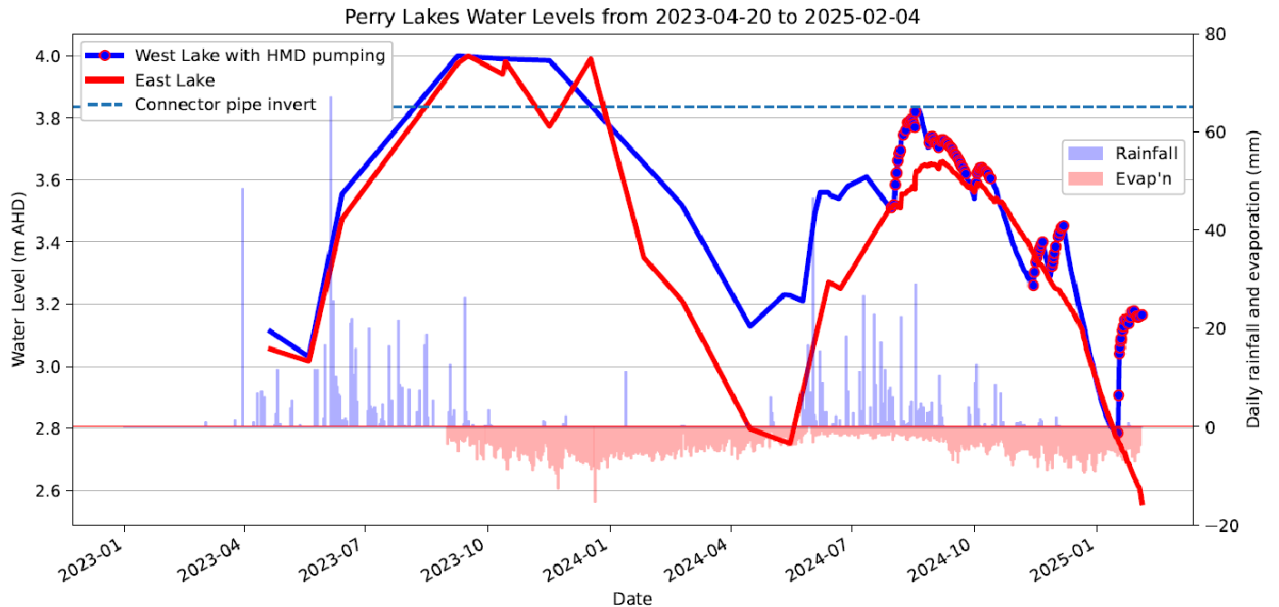


Background – water levels

- The lakes are surface expressions of an aquifer contained in wind-blown sands and limestone. Groundwater flows through the lakes from the north-east to south-west.
- Water levels in West Lake were high in the 1960s and early 1970s (see figure). At this time, water flowed from West onto East Lake via a connecting pipe when levels were over 4m. Excess water in East Lake was then pumped into the Subiaco Main Drain.



- Since the 1970s, rainfall has reduced by about 15%, and temperatures, evaporative demand and groundwater extraction have increased. Increased roads and roofs in surrounding areas will have increased aquifer recharge and road runoff that discharges into the lakes.
- The net effect of those changes has been a reduction in lake levels with a slight recovery in the last 15 years (see figure), possibly because of a reduction in groundwater extraction in the Perry Lakes Reserve and surrounding houses.
- When filled to the top of its banks at 5 m AHD (Australian Height Datum), West Lake covers 7.3 ha and holds 126 megalitres (ML) of water, with an average depth of about 1.7 m. In the last 7 decades West Lake was close to full or full in 1956, 1957, 1958, 1964, 1965, 1967 and 1973.
- East Lake is slightly larger than West Lake, with a maximum area of 8.4 ha and a capacity of 135 ML. When it fills, it is drained to Swanbourne Beach.
- Seepage losses to the aquifer are greater in West Lake than in East Lake, possibly because groundwater levels are lower near West Lake. The aquifer may also be more permeable in the west.
- East Lake levels were low in the 1990s, which prompted the Town of Cambridge to add water from the nearby aquifer. This ceased in 2023.
- Pumping water from the Herdsman Main Drain has raised levels in West Lake since May 2023. It can also raise or help maintain East Lake's levels. This impact is mainly through the aquifer but when East Lake is above 3.85 m, water will flow through a new lower connector pipe with East Lake. Flow occurred between August and November in 2023, but not in 2024 when levels were lower (see figure below).



- The pumps can theoretically transfer up to about 6ML/d but usually operate at 2 to 3.5 ML/d.
- Under dry autumn conditions with moderate evaporation, a pumped flow of 1 ML/d from the Herdsman Main Drain should maintain level in West Lake. Every additional 1 ML/day can raise West Lake by about 15 mm per day. In summer, higher evaporation rates and lower groundwater levels mean that larger volumes are needed to maintain water levels.
- Monitoring over the 2024 autumn and early summer has shown that on days with no rain and no augmentation from the Herdsman Main Drain, the average daily fall of water level in West Lake is 15.5 mm and 7.5 mm in East Lake.

Management suggestions – water levels

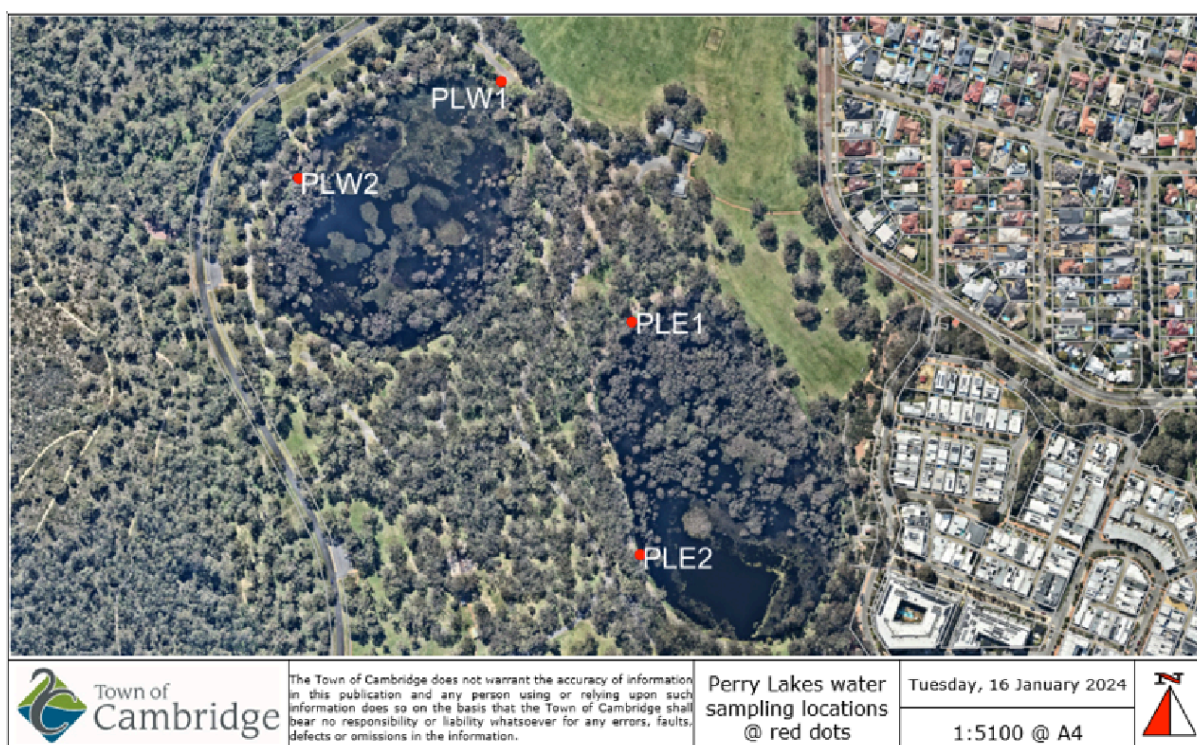
- There may not be an ideal water regime because of competing interests between various aquatic species and aesthetics.
- The ability to affect both lake levels by varying the inputs of water from the Herdsman Main Drain means that it should be possible to achieve lake water levels to meet defined objectives.
- Several species of birds, including ducks and swans, nest in the lakes. Their fledglings need time to grow strong enough to fly before December, when predators, such as foxes and dogs, might reach their nests. The water level needs to be about 75 cm deep around the nests to prevent predators from accessing them.
- Seasonal water level variations offer additional ecological benefits, such as providing inundation of low-lying areas to enable breeding of moaning frogs.
- Bulrush (*Typha orientalis; domingensis*) and Jointed twig-rush (*Machaerina articulata*) can invade the lake beds and reduce the area of open water. While this can exclude many birds, South-western snake-necked turtles (*Chelodina oblonga*) nest under these reeds when lakes dry. The Western or Purple Swampphen (*Porphyrio porphyrio*) can use Jointed twig-rush.
- Young reeds are killed if inundated by more than 30cm. They can also be cut and poisoned using glyphosate herbicide. Their harvesting removes nutrients (especially phosphorus) that is responsible for toxic algal blooms (see later).

- Dry parts of the lakes promote the oxidation of organic matter, which can then be leached into the aquifer after inundation.
- Observations by Birdlife WA show that bird diversity in Perry Lakes is highest in summer. Many bird species prefer shallow waters, such as waders and mud feeders. The lakes' varied depths cater to many species' needs¹. In addition, elevated water levels in summer may be a benefit if surrounding lakes have dried (e.g. Claremont) or are affected by toxic cyanobacteria (Monger) and/or avian botulism (Jualbup).
- Allowing water to flow between West and East Lake through the balance pipe will allow carp, pearl cichlids and nutrients that have entered from the Herdsman Main Drain to contaminate East Lake.
- It is **recommended** to raise West and East Lake levels in winter – spring high enough to ensure at least a 75cm depth around bird nesting sites in December. Thereafter levels should gradually drop to mimic the seasonal water cycle and encourage summer waterbirds, and the oxidation and leaching of nutrients in sediments. Reduced pumping in autumn may be necessitated by low flows in the Herdsman Main Drain.
- Water flow into West Lake from the Herdsman Main Drain needs to be monitored regularly with early intervention if suboptimal flow is observed.
- We also need to monitor the response of waterbirds, frogs, turtles, reed invasions and algal blooms to various water regimes to further refine these rules.

Background – water quality

- Nutrient enrichment, referred to as eutrophication, has the potential to cause cyanobacteria (blue-green algae) blooms. Their growth and subsequent decay greatly impact aquatic animals and waterbirds through the disruption of food cycles and a lack of oxygen. Low oxygen levels promote the growth of the toxin-producing *Clostridium botulinum* which causes avian botulism. Eutrophic lakes also have associated odour, midges and mosquito problems. Once cyanobacteria cysts are present in a lake the blooms are much easier to trigger so it is best to avoid any blooms.
- Phosphorus (P) is the main concern for water quality in freshwater lakes because it can trigger these blooms. Cyanobacteria fix their own nitrogen (N), so N is not as important as other factors such as water temperature, light and salinity. Cyanobacteria produce powerful toxins that can affect the nervous system and liver and can be fatal if ingested.
- Other water quality factors of concern are heavy metals (mobile under acidic conditions) and bacteria, especially *Escherichia coli* or Total coliforms, an indicator of contamination by animal or human faeces. The Herdsman Main Drain contains groundwater from a light industrial area and from the Herdsman Lake which has been exposed to insecticides and herbicides.
- The quality of water in West and East Lakes has been recorded at two sites in each lake up to nine times between June 2019 and May 2024 (see figure below). Water quality in the Herdman Main Drain was sampled ten times during this same period.

¹ A detailed report on this, authored by Viv Read, is available on the Friends of Perry Lakes (FoPL) website and may provide valuable guidance for lake water management.



- Pollutants likely to be found in industrial areas and Herdsman Lake have been measured but none have exceeded guidelines. Most are below levels of detection.
- The Total Dissolved Solids (salinity) of the main drain waters are like those in both lakes.
- The Total Phosphorus levels in the **main drain** are comparable with those in the lakes. Concentrations of P have exceeded the trigger levels² for eutrophication half of the time. However, five of the last six measurements have been above the trigger level of 0.06 mg/L, indicating an increasing trend since 2019.
- The average Total P in the drain is about 0.06mg/L. Pumping 3 ML/d throughout the year will add 65 kg P per annum. Pumping rates are not monitored but are likely to be less than 3 ML/d.
- Nutrients are also introduced in road runoff, a major component of lake water. Their sources are fertilisers in lawn runoff, and lawn clippings and leaves which accumulate in gully traps. Street sweeping and adduction of gully traps can reduce nutrient loads. The Friends of Perry Lakes plan to measure the contribution of street runoff to nutrient loads in the lakes.
- Total Phosphorus in water samples from **West Lake** have exceeded trigger levels three-quarters of the time since 2019 with no obvious trend.
- Total Phosphorus in **East Lake** has exceeded trigger levels 55% of the time with the northern site being most affected.
- Analyses of **lake sediments** in June 2019 showed that Total P ranged between 557 and 1,110 mg/kg in East Lake and 222 and 584 mg/kg in West Lake indicating substantial stores of P.

² If the water quality does not meet the water quality guidelines, the waters may not be safe for those environmental values and management action could be triggered to either more accurately determine whether the water is safe for that use or to remedy the problem (ANZECC / ARMCANZ Guidelines 2000)

- A macroinvertebrate assessment in November 2023 showed that eutrophication may already be present in West Lake and recommended more investigation was needed. It was unlikely in East Lake at that time.
- N and P in groundwater is greatest immediately downgradient of West, East and Camel lakes indicating oxidation of organic-rich sediments on exposure and later leaching of these nutrients.
- While some P can be lost this way, harvesting of aquatic plants is needed to remove the P being introduced in the drain water.
- Three aquatic plants can cover the open water areas; Bulrush (*Typha domingensis*, *T. orientalis*), Jointed twig-rush (*Machaerina articulata*) and Water Fern (*Azolla pinata*). Their growth is stimulated by nutrients, and they can colonise new areas after flooding.
- The P content of *Typha* is greatest in early summer when it is growing (up to 0.6% dry weight) and less when it dies back after flowering in late summer. This releases P into the lake. It needs to be harvested so that it doesn't dominate the lake surface which reduces the area available for most waterbirds.
- The floating fern, *Azolla* accumulates P and contains up to three times more than *Typha*. On exposure to sunlight it turns red. *Azolla* is much easier to harvest compared with *Typha* and *Machaerina* so a smaller amount would need to be harvested to attain a P balance.
- *Azolla* forms a symbiosis with a cyanobacteria (*Anabaena azollae*) which allows it to fix its own nitrogen. In Asia it is grown to produce N-rich fertilisers and protein-rich animal feed. It can double in size every 14 days. It shades algae and macroinvertebrates which affects the food chain for turtles and birds. On decomposition it removes oxygen from the water.
- Carp are bottom feeders which increase turbidity and mobilise nutrients in bottom sediments. The turbidity affects light penetration which decreases food for birds and turtles; and increases the likelihood of toxic cyanobacteria blooms. When the blooms die, they remove oxygen from the water, affecting all wildlife.
- Carp eggs are contained in the drain water, so control needs to be on-going. Eggs were imported after February 2023. Carp become fertile after two years, so they are expected to lay eggs soon. Female carp contain 100,000 to 300,000 eggs per kg body weight
- The levels in East Lake could be maintained at a high level by pumping water from Herdman Main Drain into West Lake and allowing equilibration with East Lake through the aquifer, which would make use of the balance pipe unnecessary and avoid contamination risks.
- Pearl cichlids are small bottom feeding fish but have not yet been recorded in West Lake.

Management suggestions – water quality

- Block the balance pipe between the two lakes to prevent the introduction of nutrients, carp and pearl cichlids from West Lake. This depends on whether East Lake levels can be maintained at required levels by subsurface means.
- Remove defined areas of *Azolla*, *Typha* and/or *Machaerina* to reduce P levels and to maintain open water areas. All three are native plants and their removal requires prior approval from the Department of Water and Environmental Regulation.
- Another way to remove P is to add products that bind the nutrient. Products that are licensed for use include PhosLock™ (a WA invention), Aquaritin, Soilzyme and Simplot. These have been trialed by the City of Subiaco.

- Periodically remove >2 year-old carp through electrofishing or recreational fishing



Azolla infestation in Spring 2024 – fixing N and reducing light penetration western West Lake
Typha infestation in Summer 2025 – reducing open water areas. western West Lake