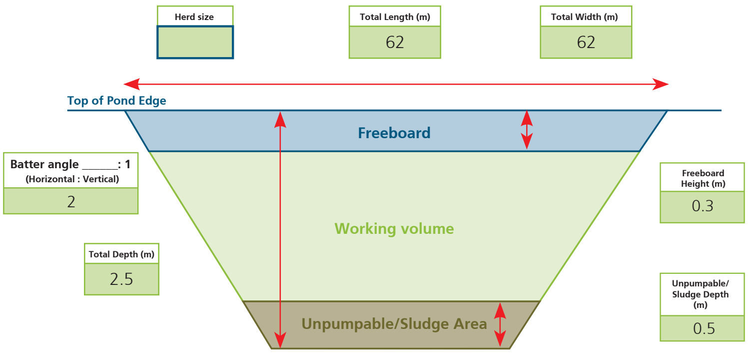
# Hauraki Plains clay pond case study

## Can I build a pond in Hauraki marine clay without a liner?

The answer is yes, but with some caveats, mainly related to the depth and the construction properties of the clay which vary across the district. For more technical information on this subject, please read IPENZ Practice Note 21 Pond Design and Construction (see Appendix on Hauraki marine clay).

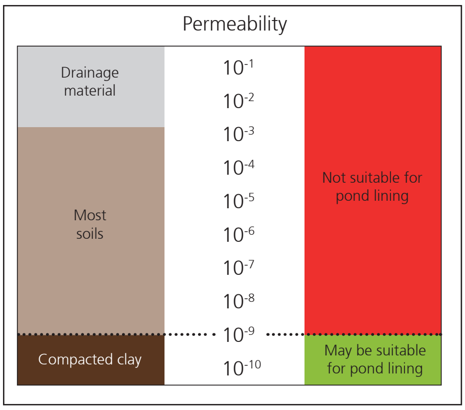
This case study illustrates a successful example of a pond dug without a lining at a farm near Ngatea. To determine storage needs, the pond was sized using the Dairy Effluent Storage Calculator. The volume required was 7.5 million litres. This gave pond dimensions of 62m by 62m and 2.5m deep (including a 1m high above-ground bund) with 2:1 batters. The pond cost between $46,000 - $53,000.

Storage tanks and synthetically lined ponds were investigated as alternatives. An unlined marine clay pond offered substantial cost savings over these options. A comparably sized, synthetically lined pond was more than double the cost, and above ground tank estimates were nearly six times the cost, due to the very large storage volume required. For smaller storage requirements, the differences between options may be less extreme.




## Site investigation and design

With any pond construction, it is essential to start with ground investigation and soil testing. Trial pits were dug across the planned pond area and revealed 1.4m of firm to stiff brown clay on top of soft to firm bluish grey clay. This is a common soil profile across the Hauraki Plains. Samples of the clay were tested in the Opus soil testing laboratory and gave a permeability of 1.5 x $10^{-10}$m/s, almost 10 times more impermeable than the required value. The final step was to check that the excavated clay could be rolled and compacted to a point where it met the permeability criteria and was strong enough to form a stable base, sides, and above-ground bund. In this case, Opus set a target of 95 percent of the clay's maximum dry density, with less than 10 percent air voids.




**Some key things to avoid are:**

- excavating below the groundwater table
- excavating into very soft materials as construction equipment can struggle in these conditions
- jeopardising the stability of the sides of the excavation and surrounding bund, and
- not having the surrounding bunds settle excessively.

## *Limitations of working with 'blue' marine clay*

As the deeper 'blue clay' is very soft and wet, there are risks with construction. When attempting to compact blue clay, it tends to form a 'bow wave' in front of rollers and be pushed along rather than compacted. To ensure that these risks were avoided at this pond, an excavation limit for the base of the pond was set just above the brown-blue clay boundary. The depth to the blue clay and the strength of the brown clay was monitored during construction.

## *Construction method and monitoring*

The pond construction was essentially a 'cut to fill' operation with set compaction criteria to be met for the bund fill. In this case the farmer had many pieces of the plant required for the job and only had to hire a sheepsfoot roller to compact the clay. The following plant was used:

- 1 x 16 tonne excavator with ditch bucket
- 2 x tractors with trailers
- 1 x 8 tonne sheepsfoot roller
- 1 x 12 tonne tractor with spreader bar.

After stripping topsoil to a stockpile, a compaction trial was carried out. The results of this set the compaction method for the rest of the earthworks. Soil density and air voids were measured using a nuclear densometer. A shear vane was also used and calibrated to the soil's moisture content, density and shear strength, as well as checking the change in soil shear strength with increasing compaction effort. The excavator dug the material and placed it into the trailers. The tractors then carried the fill around the footprint of the bunds and placed it in the bunds' location.

The tractor with a spreader bar graded the fill into 200mm layers before the sheepsfoot roller compacted the fill. The engineer and the farmer conferred when layers of clay had been placed and compacted. All layers were inspected visually for consistency of clay material, and shear vane readings made. Similarly, the sides and base of the excavation were monitored for unacceptable layers of sand, shells, or peat. To finish the pond, the bund slopes were trimmed to the design gradient and the topsoil re-spread in a 200-300mm layer over the bunds. It took 70 hours to complete construction.

## *Project costs*

The table below shows the process, the associated costs, and the timeframe from start to finish.

| *Project Stage* | *Fees/Cost* | *Time* |
|---|---|---|
| Investigation and laboratory testing | $1,200 | 1 week |
| Design | $2,250 | 2 weeks |
| Construction- physical works | ~$10,000 | 1 week |
| Construction- on-site testing | $3,150 | During construction |
| Total Design and Testing | ~$16,600 | |
| Equipment hire and labour | | |
| Total Pond costs | ~$43,000 to $53,000 | |

## *Health and safety*

When a pond is constructed, regardless of location, the pond becomes a construction site and is controlled by the Health and Safety at Work Act (2016). This means that all physical construction works must be risk assessed and managed to ensure a safe site for everyone involved in the project. There may be maintenance requirements throughout the life of the pond, such as de-sludging and pump maintenance, and these must be factored in at the design stage.

## *Lessons learnt*

The time of year is key for planning earthworks and for this case study, the pond was constructed in April and May 2016. Planning in advance is crucial to successful pond construction. Early morning dew meant that to prevent skidding, wet surfaces had to be stripped or allowed to dry out before more material was placed.

We recommend completing earthworks before late autumn and using compaction plant that has a sheepsfoot roller on the front and rear axles to ensure continual traction, and completing earthworks earlier than late autumn. An early wet spell could result in a partially constructed pond lying idle for months over winter.

## *Paperwork provided to the farmer*

Once the effluent pond was completed, the farmer was provided with records of the permeability lab test results, the design drawings, and a summary of the construction methodology should the Waikato Regional Council raise any queries. The supervising engineer would have also submitted a Producer Statement.