Folder [Proposed DrainMOD modified drainage and recharge stormwater system for Whangam

Proposed Stormwater Drainage System:

Based on DrainMOD gravity dewatering system.

Summary by Ian Holyoake 22 November 2023

For discussion with stakeholder and stormwater action groups.

This proposal describes a modified DrainMOD dewatering system to act as the stormwater management and aquifer recharge system.

Opus and other engineers support the use of the sand base to store stormwater. This saves the costs of pipes and stormwater discharge into CMA is filtered within the aquifer. The Holocene sand base can store about 50% of its sand volume as water. The underlying principal required is to provide a balanced drain off system so longer duration rain events that oversupply what the sand base can absorb and high intensity rain events that exceed the natural soakage rate. Both scenarios results in surface ponding and flooding to low lying properties and depressions that is required to be managed.

Post settlement large areas of land have been developed into impervious surfaces which means less permeable surfaces left to soak up rainwater. Post settlement we have created organic layers which reduce soakage rates. What this means is more surface ponding and flooding, longer periods of surface ponding, greater requirement for overland flow paths and more damage and nuisance value.

Opus groundwater monitoring 2008-2012 established that the water table is between 1.7m to 3.0m down (Achilles Rd Bore 3). At 50% by volume this means rainfall between 850mm (winter) and 1500mm (summer) can be absorbed into the sand without surface ponding or flooding. Naturally there would be some low lying ground below Bore 3 ground level where the water table would break into.

As the water table fills more rain eventually overwhelms the storage capacity of the sand culminating in surface water ponding in low lying land and depressions for extended periods. Surface water depth increases sufficiently to become trespass water property to property eventually flooding floors built below overland flow paths levels. Normally roads are built low to manage overland flow paths to waterways and CMA. Whangamata sand belt has already been developed with roads relying on soakage as the stormwater management system. The flat ground provides little opportunity to create overland flow paths between the roading network. Whangamata is flat with little fall for pipes or hydraulic benefit. Pipes need to be overly large as velocity is slow.

Whangamata is built on what could be described as a river delta surrounded by a lengthy circumference of waterways. This starts along the Wentworth river, through Moana Anu Anu, the Harbour, around both beaches and up Otahu Estuary. The circumference could be as long as 5-6km meaning the water table has a good seepage to waterways ratio. In dry weather the water table can drop 200-300mm in a month (Opus

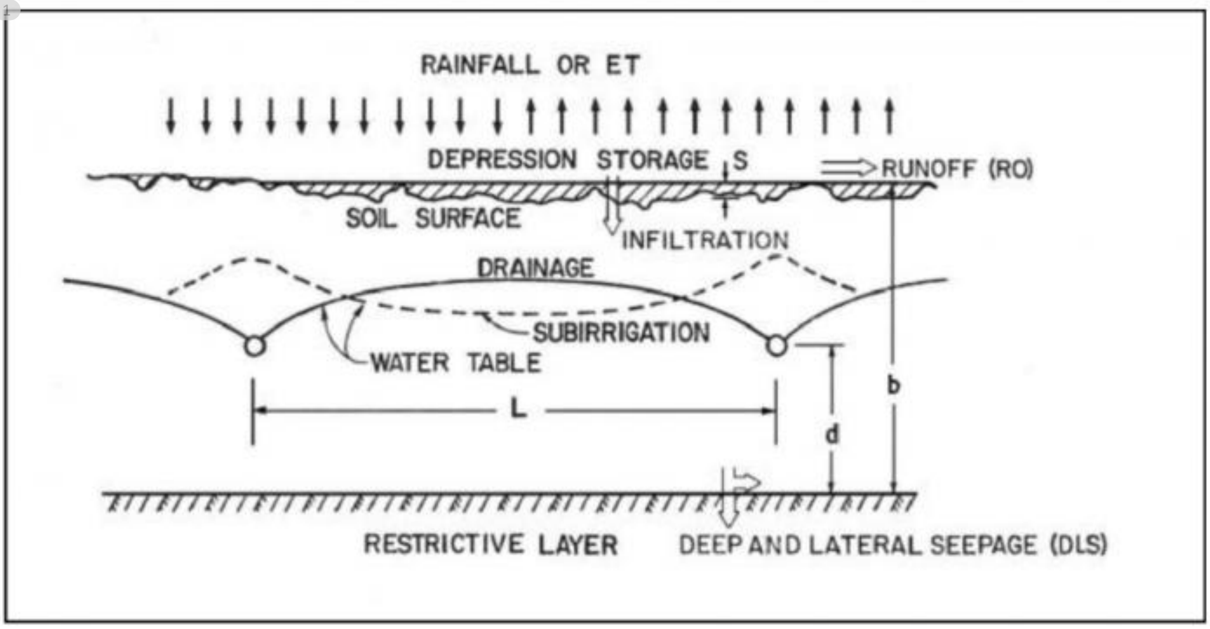
Normal stormwater systems use pipes to remove water to waterways as directly and quickly as possible. This is predominately because these systems are built on clay where aquifers do not drain efficiently. Rain water cannot be absorbed in time so must be piped away. Whangamata sand is used as a large underground detention device which takes time for the aquifer to discharge into the waterways. During that time surface ponding and flooding can remain in low lying land and depressions. If more rain comes before the water table falls surface ponding and flooding returns.

If Whangamata adopted pipes as the stormwater disposal system the aquifer would drop, vegetation would die, animals and birds would suffer and land would become arid. Clay soils drain slowly if at all, so is not so reliant on repeated rainfall. In respect sand drains quickly so Whangamata must get repeated rain. It is important to not remove rainwater which would upset the natural balance of the environment. The obvious answer to this is to manage the water table in a way that promotes absorbency in heavy rain and recharges the aquifer in droughts and periods of low rainfall.

This report describes a system designed to manage the discharge of the water table in times of excess rainfall and promote recharging of the water table in lesser rain periods so the precious rainwater needed for the aquifer health is not lost to waterways.

I have used the DrainMOD dewatering system as the model and added a recharge mechanism to it.

My design is essentially a network of soakage cells connected with pipes fitted with drain off switching to open to pre-drain the water table in preparation of predicted storms, provide peak drainage during storm events to remove water from overfilling the aquifer and when the switching is turned off normal rain recharges the aquifer through the soakage cells. In this way the water table would be partially managed to an accepted level to sustain vegetation, animals, birds and our well-being. The soakage cells need to be located close to the low lying land and within depressions where surface water ponding forms and can be removed via the underground flow path pipes switched on to drain. The pipe sizes do not need to mirror clay based system sizing because the sand is acting as the temporary detention storage device. The pipe removal sizing only needs to deal with surface ponding volumes that if not removed becomes trespass water that cannot be drained away, accumulates, becomes deeper, overloads the network and causes nuisance and damage .



Principal hydrologic components of subsurface drainage and water table management system (Skaggs, 1978)

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This figure is from a Skaggs DrainMOD system to drain soils by gravity. I call this dewatering of mashlands. There are variations to this model.

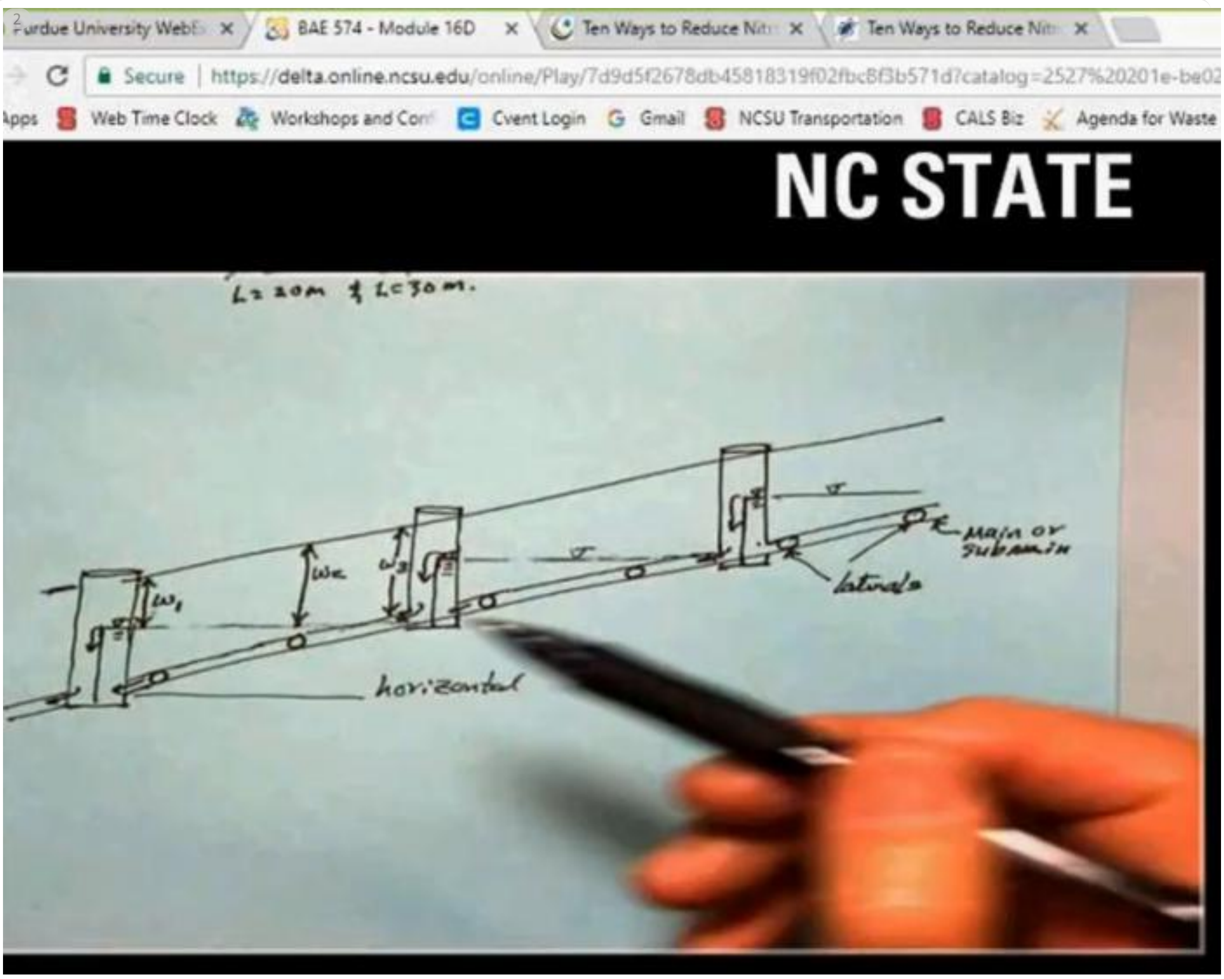
1. Pumps can supplement removal on land with insufficient fall for gravity discharge
2. Deep wells can be used to provide access below semi impervious layers into subterrain aquifers

The spacing 'L' is to reduce the crown heights that form in the soils. The spacing for Whangamata sand is dependent on water filtration rates and gravity hydraulics. ie duration/intensity of rain forming crests that crown and break out into low lying ground and depressions. Ideally the pipes should be laid below road kerbs where rainwater is collected. By installing soakage cells along the pipes this increases soakage speed and volume.

The infiltration rate from surface ponding is determined by the soil material. Whangamata sand base would be a good medium.

This is the removal system.

Due to the permeability of our sand base I would like to propose 'reverse dual purpose' DrainMOD system that in low rainfall recharges the aquifer and not drain it.



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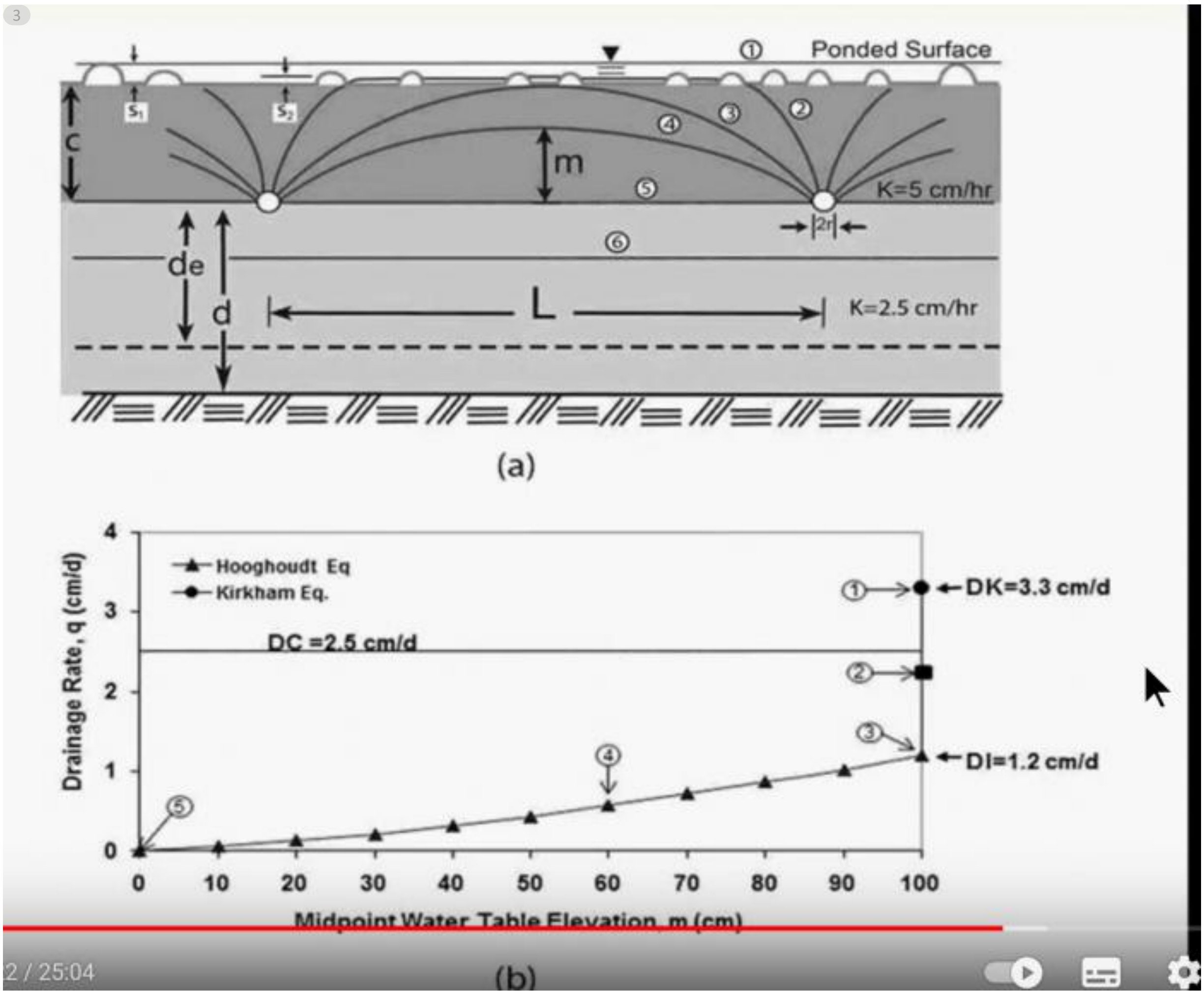
Skaggs clip of a training video showing connectivity of DrainMOD - note this site has good elevation which we do not have.

Because we do not have the elevation we can use the pipe system that connects the cesspits to not drain in light rain. In this Skagg system all water entering the pipes is drained off and lost to the environment. This is intentional because marshlands have underground spring water that replenishes the wet ground.

I envisage the pipe system to either have a switching system to open a value or a head system that can be raised or lowered to certain drain off levels.

The pipes can be quite shallow if they are located underneath or beside the low lying ground and depressions.



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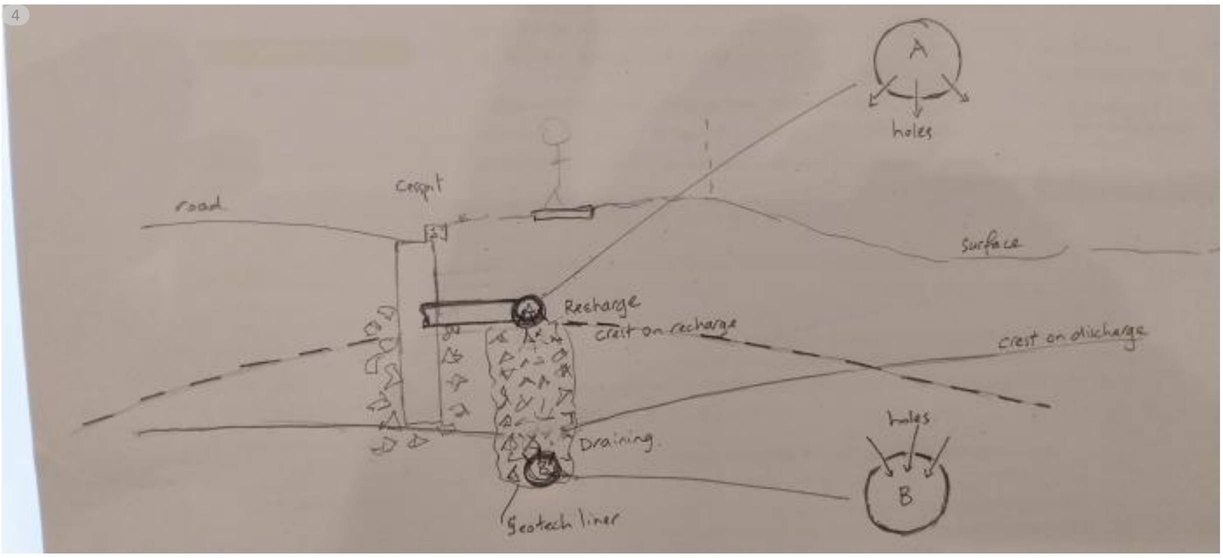
Skaggs about version 6 showing calculations for engineers with different equations from other engineers.

I am not doing these calculations. My feeling is that putting the DrainMOD variant along Tui, Kiwi, Bellona, Sylvia and Mary would show us whether 'L' can be approximately 80m apart and work.



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DrainMOD variation.

Normally ALL Road stormwater needs to be drained away safely up to 10%AEP. Then overland flow paths are required. Normally the 10%AEP is high intensity short duration rain which means large pipe systems especially on ground with little fall. The obvious solution to keep pipe sizes down is to have lots of detention storage devices that can manage short high intensity rain. This requires a lot of land. The Cleveland Reservoir being constructed now is an example being tried. We can use the sand base as the reservior and only need to drain off the surface ponding water before it becomes trespass water.

In this example I use the rock trench (pit) size for traffic-able areas but Cirtex would work for low traffic ground. Each would be the detention storage device with a calculated volume. Rocks are not the favoured medium as these hold less water than the sand itself and half what Cirtex would store. During the 10%AEP water will drain into the soakage cells and begin soaking into the sand. At the beginning of each rain event, the loading 'flush' period, the cells will accept more than its own volume of water because the sand will absorb and act as a secondary reservoir. Pipe A is only a feeder pipe into the rock trench - not required for Cirtex.

Pipe B is the drainaway pipe. It has holes to allow water in and to allow water to soak out into drier nearby sand which increases the size of the reservoir. For pipe B to function the water table level must be at this height. Once the water table is above this level Pipe B can de-water the aquifer. Pipe B needs a switching value or header system to turn drainage on or off. This switch is independent of the 10%AEP. It can be turned to drain to prepare the sand for heavy rains otherwise it is shut off. What this means is smaller rainfall discharging from pipe A will enter the rock soakage cells and recharge the water table. The dotted recharge line represents the crest of water rise across the water table. The lower line crest on discharge is if pipe B valve was deliberately opened to drain off the water table prior to a major or long term predicted rain. This would create depressions in the water table where surface ponding is likely and where impermeable areas are collected and drained to eg cesspits. By lowering the water table prior to rain events this increases the overall ability of the sand to receive and store larger and longer duration rain events.

Modifying existing pipe systems to DrainMOD variation.

The existing piped system is the Pipe B. Install a series of soakage cells along each existing pipe. These may need to be at 50m-100m spacings. More can be fitted at a later date. Water from high water tables would soak into the soakage cells and into pipe B and flow to nearby drier sand and soak into it. This makes Pipe B 'shifting' the water table from wet areas to dry areas before any discharge occurred. Moving the excess water in the water table by gravity pipes progressively moves it closer to the CMA where filtration rates into the CMA are greater and the crests lower.

This has relevance for Island View and Williamson areas. The last soakage cell should be close to the sand dunes for maximum filtration rate. Pipe B could be Tee'd and run parallel to the Ocean to provide the best filtration rates to the CMA. Noted that Pipe B is not intentionally discharging water during the storm event so won't be contributing to erosion as it currently does. Pipe B would be swtiched on 7-10 days before a major storm and drain the water table down in preparation and then drain slowly again after the storm this reducing peak outflows.

Modifying existing soakage systems to DrainMOD variation.

The existing soakage pits get connected with Pipe B's to other Pipe B's to form the network.

Benefits of DrainMOD variation.

1. The 'narrow soakage cells' means the system is ideal along roads and through walkways.

2. The deeper the trench the more water table can be drained prior to storm events and the more sand volume to absorb water into the water table.

3. The soakage cells could almost be continuous in sections along Pipe B as part of the pipe laying process.

4. Pipe B can be PVC of smaller diameter which would be easy to lay and cheaper.

5. To disperse road stormwater catchment more Cesspits and soakage cells can be installed. This would lower the discharge obstructions and even out soakage rates in variable soils.

6. Pipe A height and soakage cell height should be no higher than any low lying nearby property. This would reduce the chance of tresspass water breaching the surface of properties below the road crown. Ideally the soakage cells could be extended into private property with low lying ground or depressions.

7. The system can be retrofitted to any road, piped or not. Pipe B may not always need to go to a waterway. It could be that sufficient water can be absorbed into the water table without discharge. It could mean these areas may not have the water table managed pre storm events.

Disadvantages of DrainMOD variation.

The sand base may make it difficult to retain the sides of trenches especially when the sand is overly dry or already saturated and liquefied.

Pipe B may not be able to be installed at depth to drain much of the water table the further the system is from a waterway and to low lying properties.