SOAKAGE GUIDELINES PREPARATION – EASY OR NOT?

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ABSTRACT (200 WORDS MAXIMUM)

Matamata Piako District Council have placed into statute a District specific Stormwater Policy to provide clear guidance and performance standards for stormwater control associated with all forms of development and land use changes.

The preparation of a District specific Soakage Design Procedure and Guideline Manual as a design tool was an important step in completing the supporting documents for this policy and providing a clear guideline to those developing lots and subdivisions. This is particularly so in locations like Matamata where growth pressure is in tension with a flat landscape with no immediately adjacent watercourses for stormwater disposal.

It shouldn't be too hard to get together a few standards and other examples, and everyone knows how to design for soakage? But when we started to undertake this the different soakage assessment methods, design procedure techniques, preferences and standards, created a inconsistent palette to start from, and everyone has an opinion, seldom the same.

Is E1 /VM1 a suitable guideline for soakage disposal to prevent off site effects, not just to protect your own floor?

This paper will look at the challenges in preparing this guideline, some of the inconsistencies of existing guidelines and standards, and discusses what can be learnt.

KEYWORDS

Soakage guidelines, Matamata, E1/VM1

PRESENTER PROFILE

Neill Raynor is a "regular" engineer, for 26 years so far, and his current role is Aurecon's Portfolio Manager for New Zealand Water Projects. Neill has lived and worked exclusively in New Zealand and has been with Aurecon for the last 16 years. Neill's 6 children keep him firmly grounded (and knowing his place).

Since trialing fluid and hydraulics papers at Auckland University Neill has been drawn to the three waters with a special interest in stormwater.

Neill has been involved in private and public infrastructure development as a consultant for many years, but also briefly spent time with the Waikato Regional Council on the Waihou Valley Flood Protection Scheme.

1 INTRODUCTION

Matamata Piako District Council have placed into statue a District specific Stormwater Policy to provide clear guidance and performance standards for stormwater control associated with all forms of development and land use changes.

Due to a combination of topography, ground conditions and existing infrastructure the Stormwater Policy recommends or requires stormwater runoff to be discharged to ground.

The availability of a District specific Soakage Design Procedure and Guideline Manual as a design tool was an important next step.

2 KEY COMPONENTS

In developing a manual or guideline of any type it is necessary to determine who it is aimed for and what specific information is to be gained by those using the guideline.

For this soakage guideline, the target audience will range from the house designer architectural draftsman or educated individuals who are used to using NZS3604, to the civil engineer designing specific stormwater disposal systems for large developments and subdivisions.

The guidelines therefore needed to contain:

- Quick and easy 'paint by numbers' tables and charts and standardised procedures for soakage determination testing for those wishing to gain consent without any detailed technical input.

- More detailed "report" elements providing background to the procedure and the performance standards required for engineers or others wishing to undertake specific design.

3 THE CHALLENGES

Although there are some specific characteristics of the Matamata Piako area, it was considered important to provide some consistency with other soakage guidelines. Other guidelines from Auckland City and Hamilton City Councils were reviewed as well as the NZ Building Code E1/VM1 document that includes guidance to soakage rate determination.

Challenges in preparing this guideline included:

- Determining suitable design criteria (eg rainfall depth / duration) - especially given the unique Matamata environment.
- Differing soakage determination procedures and which one to adopt
- Allowance for longevity of the soakage design
- Producing Quick and easy 'paint by numbers' tables and charts but which have a sound technical basis and do not resort to either overly simplistic or conservative assumptions.

4 DESIGN CRITERIA

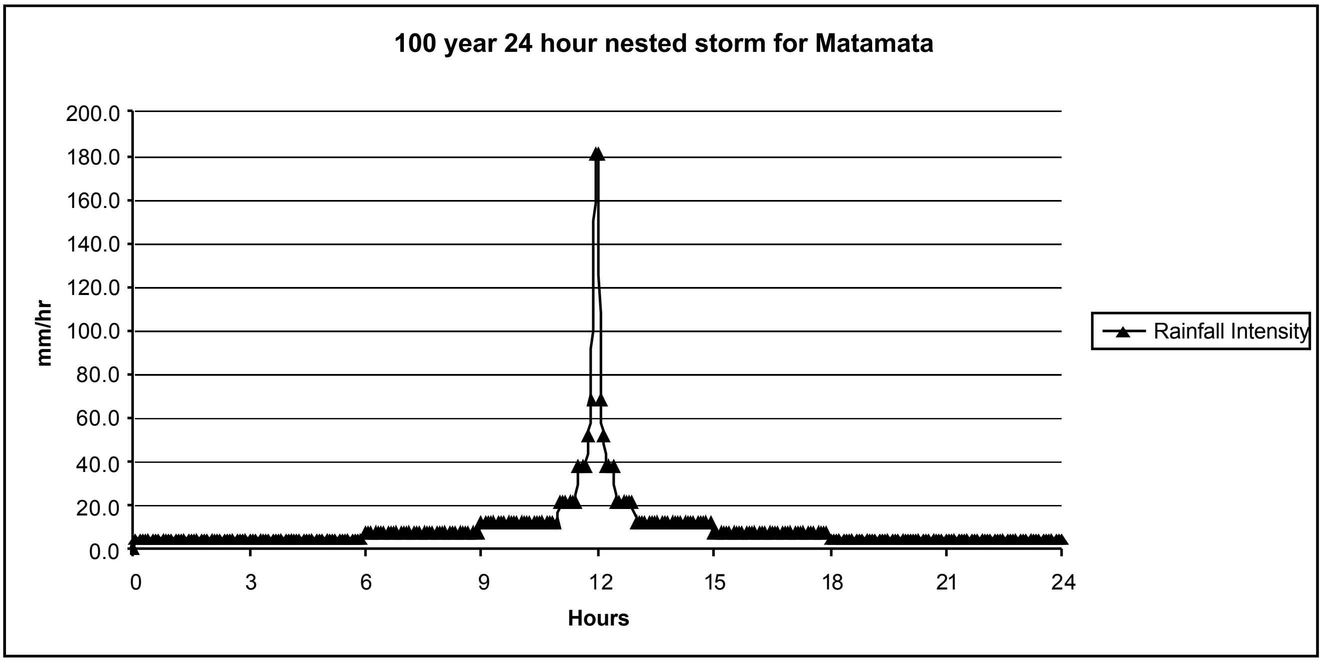
The standard E1 / VM1 design standard is to provide positive disposal of rainfall runoff for a 10% AEP design storm of up to 1 hour duration, as long as the floor level is protected against inundation for up to a 2% AEP flood level. This is consistent with many stormwater design requirements of a 10% AEP primary reticulation capacity with controlled overland flows in the 2% AEP storm event. This is a runoff control based criteria rather than runoff mitigation based criteria.

This standard assumes that overland flow is available for rainfall greater than the 10% AEP event however Matamata is a very flat town with few, if any, overland flow paths available. The nearest natural watercourses are the Mangawhero Stream 2km southeast of Matamata and the Waitoa River 2km west of Matamata.

The booming dairy industry of the Waikato region is leading to development pressures around the fringes of Matamata. The town's existing reticulation can generally only cope with the 1 in 2 or 1 in 5 year event and has no spare capacity. As such, any new developments are required to provide full on-site mitigation for up to the 2% AEP (with consideration also given to the 1 % AEP event).

If on site mitigation is to be provided by soakage then the soakage disposal capacity for events larger than the 10% AEP 1 hour storm need to be considered and a full storm analysis consistent with attenuation design needs to be used. It is therefore important that the correct rainfall depth and intensity is used. Soakage system characteristics are more storage hungry in shorter, more intense storms, but the availability of storage is often varied depending on the intensity and duration of the preceding rain in conjunction with the soakage rates. Once again there are a variety of design storms used throughout the country, including the ARC TP108 distribution, and the nested storm was used for this manual. This assumes that a specific AEP event, the shorter duration rainfall depths occur midway within longer duration depths for the same AEP, creating a bell shape curve for intensity vs. duration, or an ‘S’ curve for depth vs. duration.

Figure 1 – Design Storm temporal pattern



This allows for preceding rain prior to a shorter intense storm, and allows variability of intensity over longer duration events, which better approximate reality than a uniform rainfall rate. Rainfalls were extracted from NIWA’s HIRDS database and included an allowance for climate change to 2080 (i.e. +2.1°C).

5 SOAKAGE DETERMINATION

Falling head percolation tests are most suitable for medium to low permeability areas such as Matamata where as constant head percolation tests are more suitable for high permeability areas. Prior to deciding on the method to adopt for the guidelines for MPDC different existing methods for soakage determination by falling head percolation tests were reviewed:

- E1 / VM1 – This method is a falling head test method that is quite broad and open to interpretation. For example it says that the minimum slope of the curve should be used as the design soakage rate. However this method also states that the lower rates may be disregarded where there is a marked decrease in soakage as the hole becomes nearly empty and a value closer to the average can be adopted. It also says that the hole should be presoaked for 4 hours prior to the test (unless the soakage is so great that the hole completely drains in a short time). Test measurements continue till the hole is empty or stops after 4hrs. In determining the soakage rate in mm / hr the surface area of test hole includes the sides and base.

- Auckland City Council – This method is based on E1/VM1 but is a lot more prescriptive. Pre-soaking of the hole is for 17 hours. The slope of the curve should be taken from the lowest 2 points on the curve and negates the bottom 250mm of the hole. Test measurements continue till the hole is empty or stops after 4hrs. It should be noted that the formula given in the manual divides the volume soakage rate l/min by the surface area of the side wall only and does not include the base area. While this assumption is conservative for the sizing of soakage systems it is unconservative for the derivation of the design soakage rate. For small diameter holes it is not significant (about 11% for a 150mm diameter bore hole of 0.3m) but is important for larger ones – for a 600mm diameter borehole the neglected base contributes 33% of the wetted surface area.

- Hamilton City Council – Their 'Soak up Your Stormwater' manual refers users to E1 / VM1.

For the Matamata Piako District Council Soakage Guidelines a soakage test procedure based on E1 / VMI was developed but included more prescription on the exact methodology to be used (similar to the Auckland City Council manual). It also included additional elements such as repeating the test to gain a better understanding of the percolation response over a longer rainstorm duration. The big question however was whether to adopt the minimum slope or average slope as the design soakage rate.

As the groundwater around some areas of the Matamata / Piako District is quite low, common practice is to install approx 4m deep soakholes. For deeper soakholes in the order of 4 m during the large, more intense, design storms the soakholes are expected to be operating somewhere between half and full height. The "average" rate method would be consistent with this through the critical period of rainfall as the area of the soakhole wall through which percolation occurs is greater, and the driving head for the deeper areas of the soakhole is greater. Also the sizing of the soakhole is based on it coping with a full 24 hour nested storm as discussed earlier in this paper and is therefore likely to be operating near to full during the peak part of the storm.

For these reasons the average soakage rate during the falling head percolation test was used as the base for the design soakage rate. However as a factor of safety to allow for a long term reduction in soakage of the life of the asset this design rate was calculated as the average rate divided by two.

For more unique soakage systems, designed for multi lot developments, specific design is required and different testing methods should be undertaken that better approximates the actual operation proposed.

6 PAINT BY NUMBER CHARTS

In determining the number of soakholes required we used a spreadsheet model to calculate the roof runoff into the soakhole at minute timesteps. The runoff was based on the appropriate design storm an example of which is shown in Figure 1. The change in volume (depth) of water in the soakhole at the end of each timestep depended on the difference between this inflow rate and the outflow rate. The outflow rate was approximated by the design soakage rate multiplied by the wetted area during that time step.

It was decided that to more accurately model reality the base area was excluded from the wetted area as this is the first part of a soakhole that is likely to silt up. A soakhole was considered to have sufficient capacity if it did not surcharge during the 24 hour nested rainfall event.

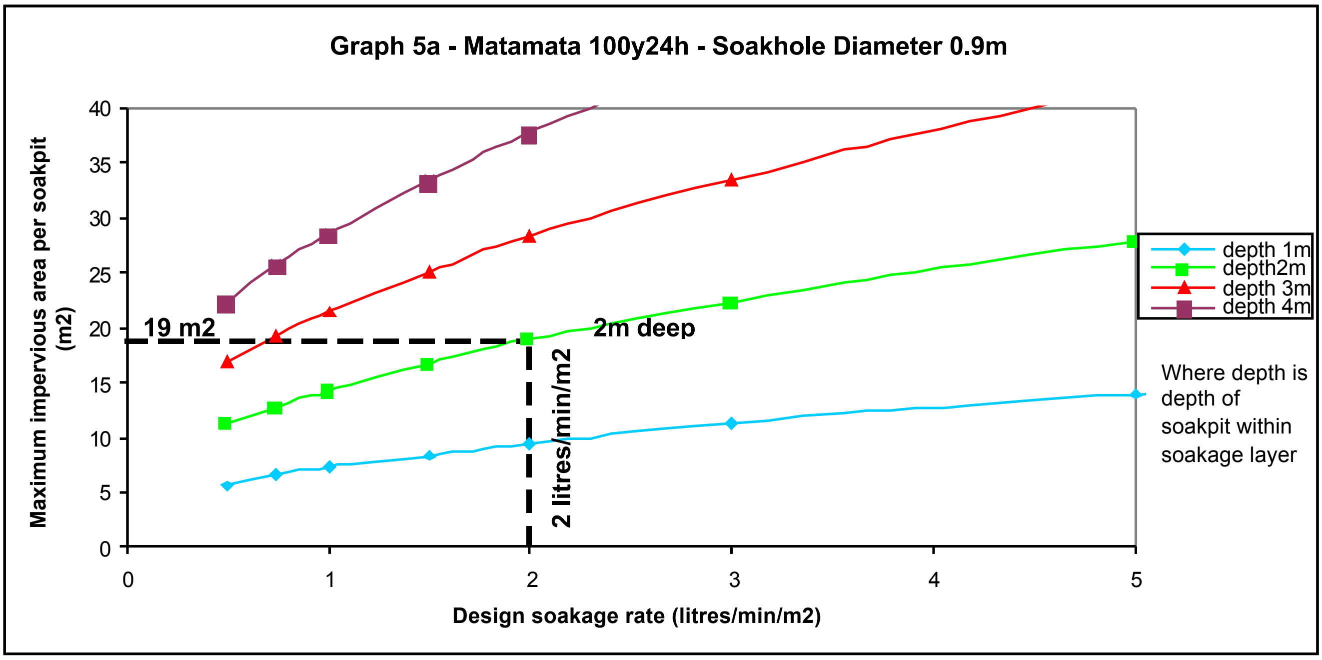
The number of soakholes required to provide full on site mitigation depends on a number of factors.

- The size storm to be mitigated for (which depends if overland flow is available or not)

- The depth of the soakhole
- The diameter of the soakhole
- The design soakage rate (as discussed in the preceding section)
- The roof area or overall catchment to be mitigated

These factors were combined on a number of quick and easy 'paint by numbers' charts for those wishing to gain consent without any detailed technical input. A schematic example is shown in Figure 2 below.

Figure 2 – Example of chart produced for guidelines



Proforma tables for soakage testing have also been included in the guidelines with an excel format version able to be downloaded from Councils website to undertake the calculations for the designer.

7 OTHER FACTORS TO CONSIDER

Other factors to consider include longevity of operation, runoff volume calculations and how to get the water into soakholes in larger design storms.

Longevity

To prepare the operational ability of soakholes for their life, pre-treatment of runoff is incorporated into the guidelines requirements. This was intentionally kept simple to encourage home owners to maintain these pre-treatment devices and based around the more domestic sized applications.

An additional allowance for longevity was to ignore the soakage through the base of the device as this will be reduced by any sediment or organic matter that may enter the device. Provision for access to the device to enable maintenance is also required.

Runoff Volume

The volume of runoff calculation is an important element in the design of a soakage device.

For many the Rational Formula has been used over many years to calculate runoff volumes as well as peak runoff rates.

For smaller areas from single downpipes through to a few lots the Rational method is considered applicable enough considering the degree of accuracy of soakage rate determination and applicability to the whole area.

When larger catchment and development blocks are disposing of stormwater through soakage, specific design is more appropriate.

Other methods of runoff volume calculation such as TP108's SCS method is considered to be a better assessment tool for volume calculations in these scenarios.

With the bigger systems in particular, where storage and longer term soakage occurs the duration and depth of the storage needs to be assessed and taken account of. As an example a road is potentially a good storage area where the depth and duration are significant.

Downpipe sizing

For the soakage system to be effective to mitigate runoff effects in up to 100 yr storm events it is necessary for the collection and conveyance system to not be exceeded during such events. For most residential lot developments the pre-dominant source of runoff is from the roof and the NZ Building Code design charts gutter and downpipe sizes are based on 100mm / hr rainfall intensity. The increase in intensity that relates to the design storm for full attenuation was applied to the E1 / ASI Figures 15 and 16 for gutter and downpipe capacity design to accommodate these larger events.

8 CONCLUSIONS

In conclusion, there are many different ways of approaching soakage designs. The development of these guidelines required us to think beyond the usual 10% AEP 1 hour storm, which also required to reconsider other items such as downpipe sizing. A key to any good guidelines is that are easy to use and required development a series of easy to read charts.

ACKNOWLEDGEMENTS

Matamata Piako District Council for commissioning the work.

Barr and Harris Surveyors and Alan Leahy (MWH) for review of the guidelines

REFERENCES

Soak Up Your Stormwater – Hamilton City Council

Soakage Design Manual – Auckland City Council

E1/VM1 – New Zealand Building Code