

IRRICALC GUIDANCE DOCUMENT

3rd June 2010

SECTION 1: CRITERIA

Consent protocols

Use of models to calculate seasonal irrigation volumes

BACKGROUND

The proposed NRRP allows consent applicants to use a model to estimate a seasonal volume that complies with the policies of

- 80% application efficiency
- Allocation for 80 percentile year

Any method used to demonstrate this must be verifiable, and where a modelled approach is used, there must be sufficient data available to calibrate for the specifics of the location.

This document sets out the criteria and requirements for a model and its application to estimate seasonal irrigation water use and to set seasonal irrigation water use limits.

PROPOSED SET OF REQUIREMENTS FOR A MODEL AND DATA

Model capability

1. The model must be able to predict irrigation water supply requirements for a specified:
 - Application efficiency (including 80%)
 - Water supply adequacy (including 4 years out of 5, or 80 percentile year)
 - Land cover (including pasture)
 - Soil type
 - Climate
2. The model must provide sufficient outputs to enable a third party to verify that the estimated irrigation water use and water use limit are based on policy-compliant inputs
3. The model's validation performance must meet or exceed an r^2 of 80%

Model documentation

4. Methods
 - a. Specify the assumptions, equations and time-steps used in the model
 - b. Specify the data inputs, parameters and data outputs
 - c. the sources of data, and the date range of all time-series data inputs used.
 - d. Model documentation must explain how the water supply adequacy (e.g 80%tile year) is determined.

5. Model Parameters and Testing
 - a. The model parameters must either be internationally accepted parameters (for example the FAO crop factors) or be calibrated and validated using Canterbury data.
 - b. Set out the calibration and verification procedure and results.
 - c. If parameters are developed from Canterbury data, the model documentation must comment on the applicability of the calibration across the whole of Canterbury and the applicability in years outside the calibration/verification period.
6. Input data
 - a. Describe the QA procedures used to verify that input data is fit for purpose.
 - b. If using standard input data or factors (as listed in Annex 1) then QA procedures are not required for the particular standard input or factor used.

Reporting of Model Application

1. Model application reporting must include the application efficiency used in the estimation of seasonal irrigation water use and the water supply adequacy used to determine the seasonal irrigation water use limit.
2. Model application reporting must outline the irrigation practices (management rules) and comment on their appropriateness for types of irrigation equipment.
3. Model application reporting must specify soil type, climate data and land-cover.
4. Model outputs must be reported or supplied in sufficient detail to enable a third party to verify that the modelled irrigation applications that the irrigation water use estimates are based on comply with Policy standards for application efficiency and water supply adequacy, are practical and result in soil moisture levels being maintained within best-practice limits.

ANNEX 1: APPROVED STANDARD INPUTS

Soils Data

1. Soil maps and plant available water for soils on a property can either be obtained from the most recent publically available version of the Landcare Soils Database or obtained from site specific measurements
2. If site specific maps/measurements, the documentation must outline the soil survey work, and include photos and a description the texture analysis undertaken.

Climate Data

1. Daily climate data from–
 - NIWA Tier 1 or Tier 2 climate station data or
 - Data from NIWA Virtual Climate Station Network or
 - Site specific data for rainfall in combination with climate data from the nearest climate station that meets or exceeds NIWA Tier 2 standards.
2. If data record is for less than 30 years, then a correlation with either the VCS or climate sites with 30 years must be carried out and used as part of determining the 80 percentile year.

Crop Data

1. Crop Factors in FAO 56

SECTION 2: How to calculate a farms seasonal irrigation water limit using the IrriCalc maps

This procedure is designed to provide seasonal irrigation water use limits that comply with Environment Canterbury's policy that such limits be based on the assumption that irrigation application efficiency is 80% and provide sufficient water volume to meet reasonable irrigation water use 4 years out of 5, on average.

This procedure is also designed to provide seasonal irrigation water use limits for arable farms, as well as for pasture-based farms. The seasonal irrigation water use limit for an arable farm is based on the seasonal irrigation water use limit for the farm if the farm was pasture-based. The seasonal irrigation water use limit for the farm is determined for pasture first and then this number is converted to the arable farm equivalent.

Step 1: Find out which soil water holding capacity class to use for your farm

Do this by locating where your farm is on the Soil Water Holding Capacity (SWHC) map for your area. See Appendix 1 in the map book covering your area.

Once you have located your farm on the SWHC map, use the colour at that location with the legend at the top left corner of the map to determine the SWHC for your farm.

For example, if your farm was located in the middle of the Burnham military camp (!) it would have a SWHC of 60mm.

If the soils information for a farm comes from a different source the following points need to be taken into account:

- Determining Soil Water Holding Capacity (mm) – The SWHC to be used with the Irricalc method is the soil water volume (mm) that is stored in the plant root zone between wilting point and field capacity. The depth of the plant root zone varies between crops/pasture/lucerne. For pasture a root zone depth of 600mm is recommended. Note that the Profile Available Water given in the ECan GIS system is for a soil depth of 900mm.
- Determining the Soil Water Holding Capacity Class – The SWHC class labelled as “60mm”, for example, represents the range of soil water holding capacities in the range 50mm to 69mm. The “80mm” class represents the range 70mm to 89mm, and so on.

Step 2: Find out the seasonal irrigation water limit for pasture on your farm

To do this you need to use the seasonal irrigation water use map that is labelled as an 80% Efficient irrigator AND the SWHC class of your farm AND the “reliability” standard of 4 years in 5. You will find this map in Appendix B of Aqualinc Report Number C09065 (November 2009).

Locate your farm on the map that is labelled with the 80% Efficient Irrigator and the SWHC for your farm and the 4 years in 5 “reliability” standard.

Once you have located your farm on this map, use the colour at that location with the legend at the top left corner of the map to find the seasonal volume contours that the farm lies between.

For example, if your farm was located in the middle of the Burnham military camp it lies between the 700 and 750mm seasonal irrigation water use limits. Linearly interpolate between the contours that lie either side of the farm to get the seasonal irrigation water use limit for that farm.

For this example the policy compliant seasonal irrigation water use limit is 745mm.

Step 3: If the farm is an Arable Farm, Convert the Seasonal Volume for a Pasture-based Farm to the Arable Farm equivalent.

Arable Farm Seasonal Volume = Pasture-Based Farm Seasonal Volume multiplied by 0.65

For example, if the farm at Burnham was an arable farm its seasonal volume would be

$$745\text{mm} \times 0.65 = 484\text{mm}$$

Step 4: Convert the Seasonal Volume, in mm, to Seasonal Volume in cubic metres

Seasonal Volume in cubic metres = Seasonal Volume (in mm) x 10 x the area irrigated (in hectares).

For example, if Seasonal Volume from the map is 745mm and you irrigate 100 hectares the Seasonal Volume in cubic metres is $745 \times 10 \times 100 = 745,000$ cubic metres.

Guidance Notes for more detailed applications

What if you have several soil types or several irrigation systems on your farm?

Work out the seasonal volume for each relevant combination of soil type and 80% Efficient Irrigator and add the volumes up.

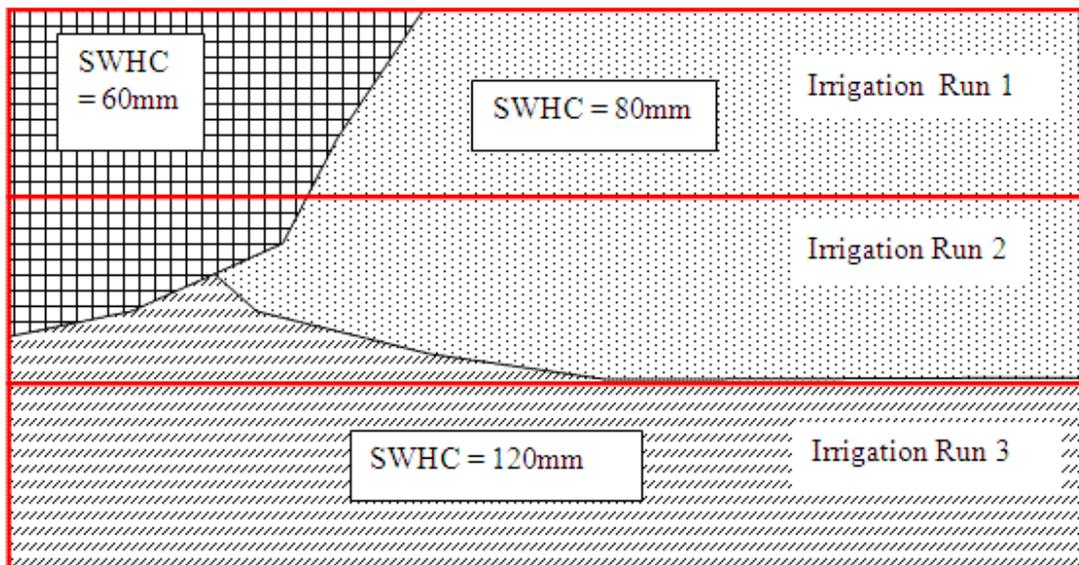
For example, if on the one farm at Burnham you had 150 hectares with SWHC of 60mm and another 50 hectares of 120mm SWHC soil, you would need to use the maps to look up seasonal volumes for each of the following and then add the volumes together.

SWHC	Irrigator	Seasonal Use (mm) from map	Area (hectares)	Seasonal Use (cubic metres)
60 mm	80% Efficient	745	150	1,117,500
120 mm	80% Efficient	697	50	348,500
Total Seasonal Volume for Farm =				1,466,000

What if an irrigator traverses more than one soil type on its run – which soil do I use?

Sometimes an irrigator will irrigate more than one soil type on its run. In this case the operation of the irrigator will probably be based on the soil type that has the smallest soil water holding capacity. It is this soil water holding capacity that should be used to calculate the seasonal irrigation volume for that irrigator run. The seasonal volume should be calculated for each irrigator run (or circle) and added up to give the total for the farm.

The following diagram illustrates this situation.



In this situation a judgement must be made about which SWHC to use for each irrigation run. Justification of the user’s subjective decision about which soil water holding capacity to use is required. In this example use of a SWHC of 120mm and of 80mm for runs 3 and 2, respectively, is a straightforward decision. For run 1 it is not so clear-cut. If the crop grown is sensitive to soil water deficits then a SWHC of 60mm should be used. If it is not then a SWHC of 80mm would probably be appropriate.

What if the farm is located in an inland basin, such as the Mackenzie Basin?

The IrriCalc method uses a crop factor that has been calibrated for growing conditions on the Canterbury Plains. The length of the growing season in inland, high altitude, basins is significantly shorter than the growing season on the Plains. This will change some characteristics of the crop factor to be used. The IrriCalc method should, in this situation, be used with a crop factor that has been constructed using information contained in FAO Paper 56, “Crop Evapotranspiration: Guidelines for computing crop water requirements”, 1998. Justification of any subjective decisions made by the user in the construction of the crop factor is required.

Section 3: Frequently Asked Questions – June 2010

What is IrriCalc and how does it work?

IrriCalc is a single-layer soil water balance model developed by Aqualinc Research Limited (ARL). It uses an equation to update the calculated soil water content on a daily basis from daily measurements or estimates of rainfall, irrigation, drainage and actual evapotranspiration. More detail on the equation and how IrriCalc works is provided in Bright (2009). Also a summary document “How to calculate a farms seasonal irrigation water limit using the Aqualinc maps” is provided (see Appendix 1).

Where are the maps and how do I obtain a copy?

The maps for each of the Canterbury Plains regions are available as PDF files on CD. At this stage ARL have copies available for distribution. Environment Canterbury is planning to incorporate the maps into its existing GIS system. This is a major task and the CD’s will need to be used manually in the interim.

What is the purpose of the criteria and how do I use them?

A set of criteria have been developed in consultation between ECan, ARL, and Irrigation NZ. These criteria are intended to provide consultants and farmers with a set of requirements for a model and data used to calculate seasonal irrigation volumes. They include the required capability of the model, documentation of methods, model parameters, model testing and input data, as well as the reporting of the model application. These criteria should be used to validate any calculations of seasonal irrigation volumes, if a model other than the pNRRP Schedule WQN9v3 is used. The policy-compliant version of the IrriCalc model has been endorsed by ECan as an approved method of calculating seasonal irrigation volumes. ECan is satisfied IrriCalc provides an appropriate method of calculating seasonal irrigation volume and is consistent with the policy requirements of the pNRRP.

If my irrigator is less efficient than 80%, can I use the maps for the less efficient irrigation systems and still be compliant with Policy WQN17 of the PNRRP?

Irrigation systems will be assumed to be 80% efficient, even if the actual system has a lower application efficiency. If your system is more efficient than 80%, then the higher efficiency figure will be used. This is consistent with Policy WQN17(2), Chapter 5 of the PNRRP, which states:

- “(2) When assessing water permit applications for irrigation...:
(b) assume that there is an irrigation efficiency of at least 80% even if the actual system being used has a lower application efficiency. Where the water permit application is for an irrigation system with a higher application efficiency, the higher figure will be used.”

If I already have an annual volume (AV), can I use IrriCalc to increase my AV automatically?

No, but you are free to apply for an increase in AV as a new consent. However you will be in the same position as anyone else applying for new water and if you are in a “red” zone you will need to pass the tests set out in the pNRRP.

If my consent doesn't have an AV, can I use IrriCalc to obtain an AV?

Yes. If you have an existing consent that does not have an AV, you will be able to use IrriCalc to calculate a seasonal irrigation volume for your consent.

How do I use IrriCalc to obtain an AV?

Refer to Section 2: "How to calculate a farms seasonal irrigation water limit using the Aqualinc maps" for guidance on how to use the Soil Water Holding Capacity maps and the seasonal irrigation volume maps to derive an AV.

What situations may preclude use of the standard IrriCalc maps?

If your farm is located in an inland basin, such as the Mackenzie Basin. The IrriCalc method uses a crop factor that has been calibrated for growing conditions on the Canterbury Plains. The length of the growing season in inland, high altitude, basins is significantly shorter than the growing season on the Plains. This will change some characteristics of the crop factor to be used. The IrriCalc method should, in this situation, be used with a crop factor that has been constructed using information contained in FAO Paper 56, "Crop Evapotranspiration: Guidelines for computing crop water requirements", 1998. Justification of any subjective decisions made by the user in the construction of the crop factor is required.

What if I have system capacity issues?

The IrriCalc maps provide a prediction of a farms irrigation requirement and can be considered as the volume of water required for your crop assuming you can deliver the full irrigation volume on a daily basis. If there is a water volume shortfall between what is required for your crop, and the volume of water that is able to be delivered, then you should seek advice to look at ways to remodel your farms individual irrigation requirements.

What if I already have an alternative source of water (e.g. irrigation scheme water) on my property?

In evaluating your annual volume requirements for your farm, as part of a water permit application, you will need to consider and also disclose how the sources of water will operate together both on a return period and annual basis. In issuing consents to take and use water Environment Canterbury may have discretion on how takes from different sources are operated together. If you wish you may seek pre-application advice from Environment Canterbury's Consents section as each scheme will have individual characteristics that need to be considered on a case-by-case basis.

What is I have mixed soil types on my property?

Refer to Section 2: "How to calculate a farms seasonal irrigation water limit using the Aqualinc maps" for guidance on mixed soil types.

Section 3 References

Bright JC (2009): Estimation of seasonal irrigation water use – Method development. Aqualinc Report C08000/1, prepared for Irrigation New Zealand