IRRIGATION NEW ZEALAND

Irrigation Development Checklist

Introduction

Welcome to the Irrigation Development Checklist

This checklist provides a step by step process to ensure the right irrigation system is designed and built on your property.

When developing irrigation "specification" is a critical task, it involves determining all the requirements of the system and documenting them as a "design brief".

Irrigation New Zealand has produced an Irrigation Development book that accompanies and expands on this checklist. It provides guidelines for farmers to determine the best irrigation solutions for their farm. The Irrigation Development book contains detailed explanations of all the information needed to successfully "specify" an irrigation system and prepare a "design brief". This is then used to develop a "construction contract" to ensure the irrigation system is built as designed.

The Irrigation Development book and checklist assumes the case for irrigation has been established, water is available and the decision to develop irrigation has been made.

Section A outlines the core information needed to produce a design brief (with examples) taking into account, crop, soils, climate, water source as well as land and general information. Careful consideration of how to collect your data and what data to use is vital.

Section B is where the design brief is determined. This uses the information gathered in Section A to produce a design brief particular to the needs identified. The design brief will form the basis of the design outputs and ultimately the contract, including the commissioning plan.

Section C is a template where you can fill out the information particular to your farm.

To complete these sections, it is suggested that the Irrigation Development book is used. This specifies the process and parameters in more detail. (The information in this booklet shows tables as examples)

Section A

Core information

1. General

Purpose of system: Just irrigation? What about frost-fighting, stock-water and domestic water?

Required service period: How many years do you want it to last? What is the future use of the land? What is the term of the consent? What is the investment period?

System down time: How long can your system be down before it costs you money?

1. GENERAL	
PURPOSE OF SYSTEM	*Irrigation and stock water*
REQUIRED SERVICE PERIOD	*20 years and 1800 hours per annum*
SYSTEM DOWN TIME (DAYS)	*2 days*
IRRIGATION OPERATION PER 24 HOURS	*22 hours*

2. Land

Location: Where is your property?

Land area: How big is the area? Will this change in the future?

Plans: Planned irrigated area, existing infrastructure, land topography, water source(s), drainage patterns, streams and rivers and any other relevant information.

Layout: Are there any restrictions or sensitive areas on your property? For example, the topography (land slope, hills, waterways, wetlands, flood risk), infrastructure or energy source may affect the design.

2. LAND	
LOCATION	*Dunsandel, Canterbury*
LAND AREA (HA)	*50 HA*
PLANS	*Plans attached*
LAYOUT	*Two flat areas dissected by approx 3 metre high terrace with small stream along terrace.*

3. Water source

Supply: What kind of supply is it – river, storage, bore, scheme? How reliable is it throughout the season?

Quality: What could be detrimental to your system? For example algae, bacteria, sand, silt, iron, and calcium carbonate.

Maximum physical abstraction rate: In particular a river will have a range of flows over the season and is likely to be at a minimum at the height of summer.

Maximum legal abstraction rate: Environmental, cultural, recreational and other users may make the legal rate less than the above.

Plans Consents and Permits: Does the plan require you to have a consent to take and use the water? Who regulates this consent – local authority (regional council or unitary authority), iwi, DoC? Before you start your irrigation project you need to have water secured and importantly understand what your consent allows you to do.

3. WATER SOURCE												
SOURCE TYPE (RIVER, BORE, STORAGE AND/OR TOWN SUPPLY)	*Bore*											
QUALITY	*Filtrate for sand*											
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
MAXIMUM PHYSICAL ABSTRACTION RATE (L/S)	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*	*33*
MAXIMUM LEGAL ABSTRACTION RATE (L/S)	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*	*30*
RELIABILITY (%)	*100*	*100*	*100*	*100*	*100*	*90*	*90*	*100*	*100*	*100*	*100*	*100*
CONSENT ISSUES	*Read and understand consent conditions*											

4. Crop

Type: Crop type dictates water demand and also season length. What crops will be grown in the short and long term? What is their season length? What rotation are they on? Do you have a crop contract that imposes conditions on the irrigation type/amount?

Minimum application uniformity: This is a measure of how evenly the irrigation needs to apply water depending on the crop type. The range of uniformity depends largely on depth and width of a crop's root structure. Do your crops have shallow narrow roots or deep, wide roots?

Crop root depth: This defines the amount of water the crop can access in the soil. What is the depth at which your crops extract water? Does this differ much with your different crops?

Crop factor (Crop coefficients): These are different for each crop and also changes through a particular crops development. What crop coefficients will you be using?

Maximum allowed depletion (MAD): This is a measure of how much soil moisture depletion may occur before crop stress happens. It is also known as the 'stress point' or 'critical deficit'. What MAD values will you be working with?

4. CROP												
TYPE	*Pasture*											
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
MINIMUM APPLICATION UNIFORMITY (%)	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*	*80*
CROP ROOT DEPTH (MM)	*300*	*300*	*300*	*300*	*300*	*300*	*300*	*300*	*300*	*300*	*300*	*300*
CROP FACTOR	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
MAXIMUM ALLOWED DEPLETION MAD (%)	*50*	*50*	*50*	*30*	*30*	*30*	*50*	*50*	*50*	*50*	*50*	*50*

5. Climate

Evapotranspiration: Evapotranspiration is the sum of evaporation and plant transpiration from the land surface to the atmosphere. Do you have a record of daily evapotranspiration values for a number of years? If not, use potential evapotranspiration adjusted by relevant crop factor.

Rainfall: Do you have a record (preferably >10years) of monthly rainfall? Does your local authority have a more reliable record?

Wind: Is wind a factor during operation? Do you have a record of the predominant wind direction?

Soil temperature: All crops require optimum soil temperatures to grow. The seasonal soil temperature variations dictate what crops can be grown and their growing season. Do you have a record of soil temperature on your farm?

5. CLIMATE												
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
POTENTIAL EVAPOTRANSPIRATION (MM/DAY)	*2.2*	*2.4*	*3.5*	*4.5*	*4.5*	*4.5*	*3.4*	*2.1*	*1.3*	*0.8*	*1.0*	*1.6*
RAINFALL (MM/ MONTH)	*50*	*63*	*32*	*20*	*10*	*10*	*10*	*56*	*32*	*52*	*50*	*57*
WIND (DIRECTION)	*NW*	*NW*	*NW*	*NW*	–	–	–	–	–	–	–	–
SOIL TEMPERATURE (°C)	*8*	*10*	*13*	*15*	*17*	*18*	*17*	*16*	*13*	*9*	*8*	*7*

6. Soil

Types: What are the soil types in your property? Is there much variability? Where is the location and area of each? What is the depth of each?

Total Available Water (TAW): Is the size of the soils water storage from which plants can draw water. What is the TAW of the different soils on your property?

Infiltration Rate: This is a measure of the rate at which soil is able to absorb water. This rate decreases as the soil becomes saturated. What infiltration rates do you have for your different soils? How much do they differ?

6. SOIL – SOIL PROFILE 1		
INFILTRATION RATE (MM/HR)	*15*	
PROFILE	DEPTH (MM)	AVAILABLE WATER HOLDING CAPACITY (MM/100MM)
Silt Loam	*300*	*22*
Silt Loam with 40% stones	*200*	*12*
Stones	*600*	*< 5*

Section B

Design brief

The design brief provides the basic design parameters (specification) that enable an irrigation design to be completed. These are based on the information gathered in Section A. Some of the values come directly and others derived from the gathered information. This design brief and the parameters it contains should be agreed before any major works start.

These should be given to the irrigation designers and from there they will be able to give you a list of the outputs from the system they designed. These outputs should be compared to choose the best design for you.

A pasture example is outlined below.

7. DESIGN BRIEF		
INPUT DESCRIPTION	VALUE	WHERE FROM
REQUIRED SERVICE PERIOD (YEARS)	*20*	*table 1*
SYSTEM DOWN TIME (DAYS)	*2*	*table 1*
MINIMUM APPLICATION UNIFORMITY DU_{LQ} (%)	*80*	*table 4*
MAXIMUM SOIL APPLICATION INTENSITY (MM/HR)	*15*	*table 6*
MAXIMUM DAILY APPLICATION DEPTH (MM/DAY)	*4.5*	*calculation 1 below*
MAXIMUM RETURN PERIOD (DAYS)	*4–5*	*calculation 2 below*
MAXIMUM REQUIRED SYSTEM FLOW RATE (L/S)	*28*	*calculation 3 below*
MAXIMUM WATER ABSTRACTION RATE (L/S)	*30*	*table 3*
VOLUME REQUIRED PER SEASON FOR 90% RELIABILITY (M^3)	*375,000*	*Use Irricalc www.irrigationnz.co.nz/irrigators/water-allocation/*
STORAGE VOLUME REQUIRED (M^3)	*0*	*Suggested to engage consultant*

Calculation 1 takes PET values from table 5 and adjusts for crop factor values from table 4.

Calculation 2 takes values from table 4, 5 and 6. Max return period = Readily available water/peak crop demand where RAW = TAW adjusted by crop root depth and MAD.

Example

(22*3) * 30% = 22

$$\frac{22}{4.5} = 4.8 \text{ (or 4-5 days)}$$

Calculation 3 takes values from table 1, 2 and 5.

Required system flow rate = area * max daily application depth adjusted by the available operation time.

Example

$$\frac{50*4.5*10000}{3600*22} = 28$$

Section C: Template

1. GENERAL INFORMATION	
PURPOSE OF SYSTEM	
REQUIRED SERVICE PERIOD	
SYSTEM DOWN TIME (DAYS)	
IRRIGATION OPERATION PER 24 HOURS	

2. LAND INFORMATION	
LOCATION	
LAND AREA (HA)	
PLANS	
LAYOUT	

3. WATER SOURCE INFORMATION												
SOURCE TYPE (RIVER, BORE, STORAGE AND/OR TOWN SUPPLY)												
QUALITY												
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
MAXIMUM PHYSICAL ABSTRACTION RATE (L/S)												
MAXIMUM LEGAL ABSTRACTION RATE (L/S)												
CONSENT ISSUES												

4. CROP INFORMATION												
TYPE												
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
IRRIGATION UNIFORMITY												
CROP ROOT DEPTH (MM)												
CROP FACTOR												
MAXIMUM ALLOWABLE DEPLETION (MAD)												

5. CLIMATE INFORMATION												
MONTH	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
EVAPOTRANSPIRATION (MM/DAY)												
RAINFALL (MM/ MONTH)												
WIND (DIRECTION)												
SOIL TEMPERATURE (°C)												

6. SOIL INFORMATION – SOIL PROFILE 1		
INFILTRATION RATE (MM/HR)		
PROFILE	DEPTH (MM)	AVAILABLE WATER HOLDING CAPACITY (MM/100M)

7. DESIGN BRIEF	
INPUT DESCRIPTION	VALUE
REQUIRED SERVICE PERIOD (YEARS)	
ALLOWABLE DOWN TIME (DAYS)	
MINIMUM UNIFORMITY RATE DU_{LQ} (%)	
MAXIMUM SOIL APPLICATION INTENSITY (MM/HR)	
MAXIMUM DAILY APPLICATION DEPTH (MM/DAY)	
MAXIMUM RETURN PERIOD (DAYS)	
MAXIMUM REQUIRED SYSTEM FLOW RATE (L/S)	
MAXIMUM WATER ABSTRACTION RATE (L/S)	
VOLUME REQUIRED PER SEASON FOR 90% RELIABILITY (M^3)	
STORAGE VOLUME REQUIRED (M^3)	

Additional information

Design outputs

This is information that comes out of the design process and describes a number of measurable factors about the proposed system's performance. These factors are part of system commissioning and on-going performance monitoring.

The design output information also allows a fair and convenient way to compare different design options.

Design outputs include:

- Economic variables
  - Capital and operating costs
  - Power, labour and maintenance costs
- System duty points
  - System flow rate
  - System pressure at key points
  - Motor and pump efficiencies
  - Maximum and minimum pipeline velocities
- Equipment and materials selected
  - Storage
  - Motors and pumps
  - Filters and water meters
  - Pipes and valves
  - Sprinklers and emitters
  - Control system

Construction checklist

A construction checklist helps ensure the system is built as designed and clarifies responsibilities, construction details and costs. Main components are:

- General contract conditions
- Construction specifications
- People and capabilities
- Health and Safety

General contract conditions

Contracting involves a number of specialist tasks and legal conventions. Large projects warrant professional support in setting and managing contracts. Smaller projects do not have the same risks, but still justify care in contracting. If nothing else, the parties involved have a record of what they agreed to do.

IrrigationNZ has developed a standard irrigation contract specific to contracting irrigation projects.
In general, some items to check are:

- How is the contract structured? Is it clear and concise?
- What contract standards will apply? i.e. NZS 3910 or something else?
- What payment structure is agreed? i.e. Lump sum or measure and value?
- Which costs are fully covered within the contract price?
- Which costs are not covered, tagged or may vary? e.g. Consenting, power connection, trenching or anything else?
- What provision is made for retentions? Do they cover practical and final completion, and maintenance period?
- What insurance cover and/or bonds are in place? Who is responsible for their cost and will they protect both parties from financial failure?
- Who is the contractor?
- Who is the Principal? Is it you?

Construction specifications

The construction specifications deal with the specific issues needed to successfully complete the works required.
Check that the following items are known and satisfactory:

- Project plan
  - — Is it realistic?
  - — Are the contractor and sub-contractors sufficiently resourced?
  - — What methods and standards will be used?
- Commencement and completion dates and any consequences of failure to meet them
- Contract duration. Has the 'Critical Path' been identified to ensure efficient progress?
- Is the scope of work clearly defined?
- Is the schedule of quantities clearly defined?
- Construction methods and standards
  - — Storage, intake and wells
  - — Trenching
  - — Motors
  - — Pumps
  - — Filters
  - — Pipes
  - — Automatic and manual valves
  - — Emitters and lateral
  - — Control system
- Are their methods and standards valid?
- Who will be responsible for practical commissioning and completion and what standards apply?
- Who will be responsible for final commissioning and completion and what standards apply?

People and capabilities

Make sure the contractor has people allocated to your project who have the required skills and experience. Ask for references and undertake background checks of previous projects they have been involved with.

Health and safety

While a contractor is responsible for the health and safety of their staff, the land owner/purchaser also has responsibilities. Make sure that any on-site hazards are clearly communicated to the contractor and retain written evidence of this.

Among the hazards that may be present are:

- Working at height
- Working in trenches
- Working with electricity
- Working with pressure
- Working in wet, muddy slippery conditions

System commissioning

Commissioning is an important process. It is the quality control ensuring the system is installed and operating correctly. The commissioning process will determine whether or not all components of the system are installed and operating properly, in accordance with the system's specification over the range of on-site conditions expected.

Commissioning is a technical task completed by trained people. It includes:

- System testing
- Procedures for correcting poor performance
- Documentation that needs to be provided
- Producing as-built plans

Operation

Development is only part of the story. To achieve economic, sustainable and optimal irrigation, each of the key components (specify, design, install, maintain, operate and evaluate) must be correctly completed and revisited. That will ensure on-going sustainability and continuity over the investment time frame.

EECA BUSINESS

Ministry for Primary Industries
Manatū Ahu Matua

www.irrigationnz.co.nz