Leppington Pastoral Co Pty Ltd

Water Sharing Plan Submission

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24 APRIL 2020

1. Submission to Natural Resource Commission

Natural Resources Commission
Level 6, 52 Martin Place, Sydney NSW
2000 Via email: nrc@nrc.nsw.gov.au

24th April 2020

To Whom it May Concern,

Re: Submission to the Review of the Greater Metropolitan Water Sharing Plan

Leppington Pastoral Co Pty Ltd (LPC) is grateful for the opportunity to make a submission to the review of the Greater Metropolitan Water Sharing Plan currently being undertaken by the NSW Natural Resources Commission as part of their statutory role under s43A of the Water Management Act 2000 to review the sharing plans every 10 years.

This submission will focus on the amendment of Water Sharing Plan (WSP) allocation limits in relation to meeting economic outcomes, and the changes needed to the WSP to improve these outcomes. LPC requests that the WSP be amended to include a water allocation of 01,500ML to their Greenway Property, with the justification laid out in the submission below.

LPC sees this review as an opportunity to correct a legacy issue in the original implementation of the plan, which now threatens the operation of the business that is responsible for 27 million litres of annual milk supply with the product being consumed mainly domestically, with some international consumption. LPC is also responsible for the employment of over 90 people in the region, plus over 10 in Western NSW that provide feed to the dairy. If water cannot be taken from the dams on the Greenway property for the irrigation of crops there will be a substantial impact on the ability of LPC to carry on the dairy farm business as home grown feed enables the business to manage its input costs and quality of feed.

Background:

LPC owns and operates the largest family-owned dairy and the fourth-largest overall in Australia, based in Bringelly. The LPC farm includes 2,500 ha of farm land overall, including the property I refer to in this correspondence, known as ‘Greenway’. The farm’s herd consists of 2,000 milking and over 2,500 non-milking cattle. As part of this operation, the farm has historically produced approximately 16,000 tonne of corn and 4,000 tonne of silage.

The dairy farming business currently employs 53 staff members that are responsible for the direct milking of the cows. We then have support staff, working on the farm, growing the crops, irrigating, fencing and general farm duties, as well as truck drivers bringing feed in and workshop staff. The total employment here is currently 90 people, not including the administration staff and family that work in the business. These figures do not take into account the 9 processors that we supply and the staff that they employ to process our milk.

Despite the fact that four dams on the Greenway property were in existence at the time the Greater Metropolitan Region Unregulated River Water Sources 2011 (Greater Metropolitan Water Sharing Plan) was being prepared by NSW Water and the fact that the property had been used for the purpose of growing crops for more than 40 years, LPC was not consulted by NSW Water in relation to the use of water from the dams nor was it involved in the development and implementation of the Greater Metropolitan Water Sharing Plan.

The Greenway property up until 2010, was milking over 1,000 cows and prior to deregulation, had a substantial quota allocated to the farm. In 2010, it was decided to cease dairying and focusing more on cropping to supply feed to the 2,000 cow dairy operation at the Bringelly based dairy. Between 1993 and 2010, LPC was milking 3,000 cows, including 2,000 at the main farm at Bringelly and 1,000 at Greenway. The cows at Greenway grazed on irrigated pasture and higher quality feed produced on the farm. With the development of the region into housing, and the impact on the main farm at Bringelly from the new Western Sydney Airport, we saw the need to use Greenway as a feed source rather than both a feed source and dairy farm.

The Greenway property is integral to the main farm operation. Over the last 30 years we have invested in technology and undertaken studies to improve efficiency resulting in significant investment in pivot irrigation to ensure the most efficient use of water (Refer to Appendices 1 for a copy of the Irrigation Assessment by the Department in May 2011). We continue to ensure that we have the most relevant crops being grown to ensure that we are efficient users of water. One of our main aims is to use less water per litre of milk that we produce.

It is unclear in the NSW Office of Water's 2011 summary of the Greater Metropolitan Water Sharing Plan how the targeted consultations were undertaken, however the 2009 engagement of the Hawkesbury-Nepean stakeholders in Windsor and Camden did not include the Greenway property.

Water NSW and its predecessors have been aware of the dams on the property for many years, having visited the site on multiple occasions and having been requested by LPC to issue any required approvals on a number of occasions.

LPC was issued with a stop work order direction by NRAR under section 327(2) of the Water Management Act (WM Act) on 2 August 2019. Since this time, LPC has been granted an extension from NRAR, and has been making attempts to rectify the original omission of the dams from the South Creek WSP.
As part of an ongoing effort to secure the 1,500ML required for operation, LPC has

secured a water access license with a zero-share component and has exhausted multiple options to pursue an allocation:

1) Bores for groundwater: (refer to Appendices 2) for a report from consultants recommending we do not bore due to insufficient and poor source.
2) Purchasing unused allocations from other holders in the South Creek. To date we have been able to purchase a small permanent entitlement (100ML) plus a temporary allocation of 70ML. There is minimal trading in this region. We engaged a Water Broker and have independently investigated unused allocations resulting in the above.

Economic impact if the allocation remains unchanged:

In the 2011 Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources Background document, the South Creek Management Zone where LPC is located is included as one of the 13 zones covered by this plan that are considered to have high economic dependence on irrigation for commercial extraction.

As the Greenway property is so integral, the impact of not being able to irrigate would mean that we would lose between 40-50% of our home-grown feed. All the summer crops that we grow are irrigated, and this feed is an integral part of our ration. There are some opportunity crops that we make silage from with rainfall. If we were not able to harvest this volume, it would require us to shrink the size of the herd. Buying in purchased feed is an option, but this would expose the business to larger costs and potentially making the business unprofitable. The number of people that work in our business are heavily related to the number of cows that are being milked. A reduction in the herd would also result in a reduction of staff.

LPC currently pays a levy to Dairy Australia of circa $90,000 per year. This levy is matched by the government and is used for Research and Development for the whole industry. The dairy industry has suffered many issues of the last few years, with Dairy Australia having to reduce their programs for farmers because of the reduction in levy payments with the reduction in the national production.

The growing of crops on the Greenway property is essential for the purposes of supplying feed for the cows in the dairy farm business operated by LPC. If water cannot be taken from the dams on the Greenway property for the irrigation of winter crops there will be a substantial impact on the ability of LPC to carry on the dairy farm business.

Current water management:

At the time of implementation of the Greater Metropolitan Region WSP, the initial outline document (2011) South Creek is not listed as one of the 29 management zones identified as having a high instream value, where trading into the water sources is limited. It is also one of seven management zones where high flow conversion licenses were permitted in the region.

As part of the Hawkesbury and Lower Nepean Rivers Extraction Management Unit, it is part of the region that was listed with the highest number of licenses (1,395) despite having the third largest entitlement of 120,532ML, behind the Upper Nepean/Warragamba (669,520ML) and Shoalhaven River (362,270ML).

Impacts of urbanisation in the catchment:

The Government rezoned and approved the water management regime for the Oran Park Precinct in 2007 as part of the process of planning for urbanisation in the South West Growth Sector, which also includes the ‘Greenway’ property. The water management strategy relies heavily on the detention of stormwater/run-off from developed areas, with the minor flows being managed initially in the urban areas, with the larger storm events being held in existing farm dams downstream prior to discharge into South Creek at pre-development flow rates.

Studies associated with the Upper South Creek Flood Study focused on the role of the existing farm dams in managing the flooding of South Creek. These studies recognised that the removal of the storage associated with many of the large farm dams would result in adverse consequences on the existing flood regime along South Creek. The recommendations of the various flood studies was to ensure the farm dams remain until such time as formal stormwater management systems (detention basins) are in operation.
The Upper South Creek flood study has included the existing farm dams on Oran Park, Pondicherry and Greenway in the modelling which underpins these findings.

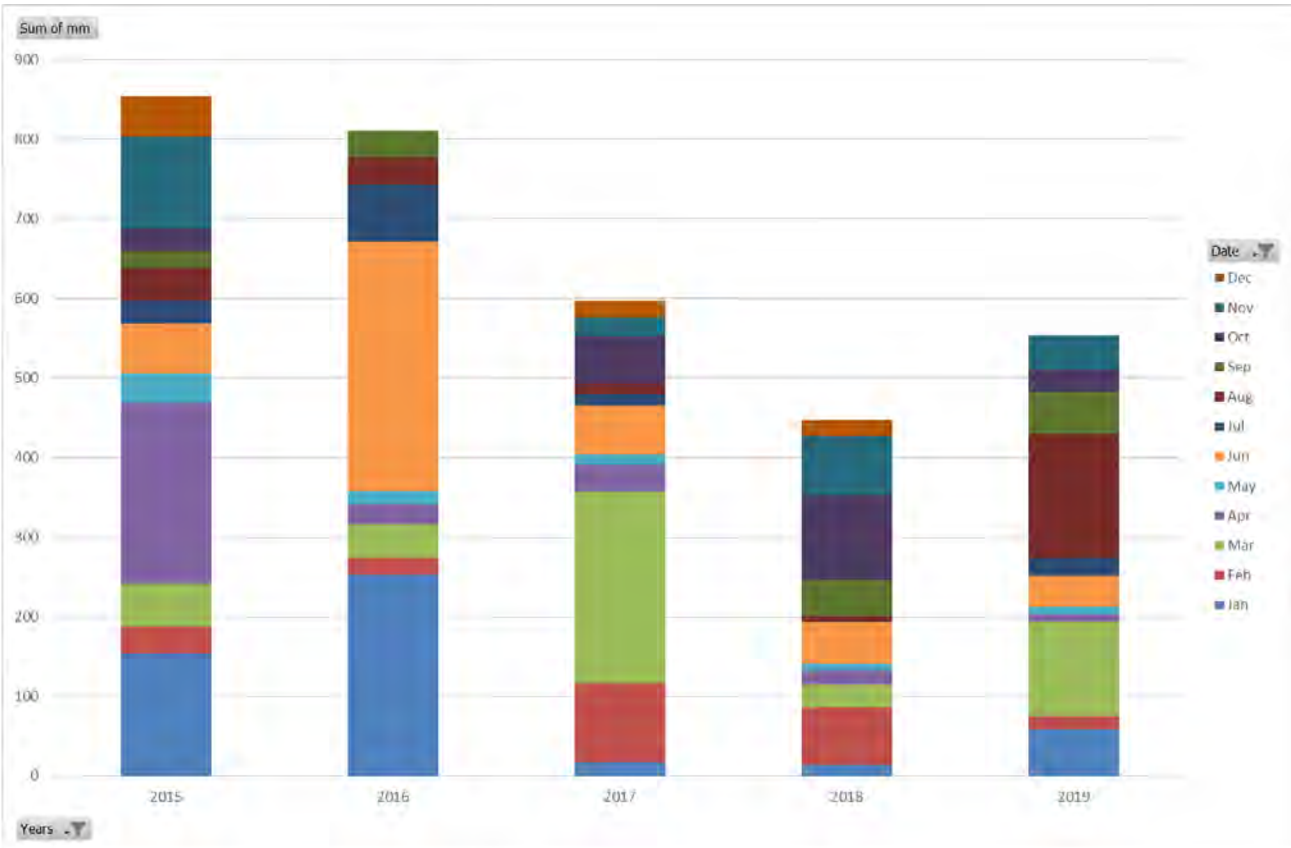
The catchments upstream of these dams are being progressively developed and the existing farm dams will be converted to formalised flood management basins, but until this occurs the farm dams play an important role in maintaining the existing bank forming flows and in the flood management for South Creek.

The increased hardstand (impervious) areas associated with urbanisation not only increase the peak flow off a catchment, but also increase the volume of runoff during a storm event, notwithstanding that urbanisation also introduces additional water into the stormwater system through watering of gardens, washing cars etc. (this additional water does not attract water units under the Greater Sydney Metro Water Sharing Plan). Stormwater quality and quantity are treated in the urbanised catchments, before passing into the farm dams and, ultimately, from the dams to South Creek. As a result of upstream urbanisation, greater post-development flows are now occurring in the system when compared to pre-development flows. The health of the eco-system has relied upon the use of the water from the farm dams to accommodate the increasing upstream input into the system.

Stormwater detention and stormwater reuse are used to counter the effects of urbanisation on natural catchments, as is the reuse of the flow captured in farm dams for irrigation and farming practices. While no detailed modelling has been undertaken to quantify the additional volume of runoff as a result of the development of Oran Park and surrounding areas, the downstream effects of urbanisation are reduced with the use of effective farming practices and reuse of the stormwater for irrigation.

Waterbodies such as the farm dams are also recognized as having benefits in managing the "heat island" effects associated with urbanisation. Government's planning strategies prepared for the Western Sydney Aerotropolis highlight the importance of Blue-Green infrastructure along South Creek. The strategies encourage the retention of existing farm dams and water in the Blue-Green corridors until such time as permanent stormwater management infrastructure has been constructed.

Rainfall data over the last 5 years, shows average rainfall for 2015 and 2016, with below average rainfall in 2017 to 2019. One of the complications with the rainfall pattern presented below, is the is minimal rainfall in the cropping season of Oct to January in most years, which is when we are growing corn for silage.



As included in the document we worked with Department of Primary Industry in 2011 looking at water efficiency projects on farm. They presented a calculation to show the deficit in rainfall for growing corn and cereal crops. This is shown below in the extract from that report, showing the deficit of water for both seasons.

WATER BALANCE CALCULATIONS FOR WATER SMART FARMS PROJECT.

DPI # 8778
Customer Name : Wayne Perich (Leppington Pastoral Company)
Property Address : [redacted] NSW
Irrigated Area : 105.12 Ha
List of Irrigated Crops : Sweet Corn – Summer Crop

Month	Ave Potential ET mm	Rainfall mm	Crop Coefficient %	Deficit mm/Day
JULY (31)	60	39.0	_	_
AUGUST (31)	88	43.4	_	_
SEPTEMBER (30)	117	39.5	_	_
OCTOBER (31)	160	67.1	0.30	_
NOVEMBER (30)	170	74.0	0.40	_
DECEMBER (31)	196	54.8	0.99	139.24mm
JANUARY (31)	205	74.7	1.20	171.30mm
FEBRUARY (28)	170	104.2	1.13	87.90mm
MARCH (31)	158	83.7	0.81	44.28mm
APRIL (30)	88	64.4	0.62	_
MAY (31)	67	58.9	_	_
JUNE (30)	58	58.2	_	_
TOTALS	**1537mm**	**762mm**		**442.72mm**

WATER BALANCE CALCULATIONS FOR WATER SMART FARMS PROJECT.

DPI # 8778
Customer Name : Wayne Perich (Leppington Pastoral Company)
Property Address : [redacted] NSW
Irrigated Area : 172.68 Ha
List of Irrigated Crops : Winter Cereal Crop

Month	Ave Potential ET mm	Rainfall mm	Crop Coefficient	Deficit mm/ Month
JULY (31)	60	39.0	1.00	21.00mm
AUGUST (31)	88	43.4	1.15	58.80mm
SEPTEMBER (30)	117	39.5	1.11	90.37mm
OCTOBER (31)	160	67.1	0.58	25.70mm
NOVEMBER (30)	170	74.0	_	_
DECEMBER (31)	196	54.8	_	_
JANUARY (31)	205	74.7	_	_
FEBRUARY (28)	170	104.2	_	_
MARCH (31)	158	83.7	_	_
APRIL (30)	88	64.4	_	_
MAY (31)	67	58.9	0.30	_
JUNE (30)	58	58.2	0.50	_
TOTALS	**1537mm**	**762mm**		**195.87mm**

** Rainfall figures derived from 1994-2010 Average figures measured at Camden Airport
Evapo - Transpiration (Potential) figures derived from Bureau of Meteorology figures 1961-1990.

The dams at Greenway are integral to the cropping operation and therefore the dairy operation.
Under the current cropping rotation, the water use based on the work done by the DPI is shown. This is for an average year, so requirements of water are higher in a drought period.

Summer Irrigation

Irrigation	Ha	ML Required	Irrigation required
Small Pivot 1	16	4.43	71
Small Pivot 2	23.37	4.43	104
Big Pivot	75	4.43	332
Spray Irrigaiton	40.72	4.43	180
Total	155.09		687

Winter Production

Irrigation	Ha	ML Required	Irrigation required
Small Pivot 1	16	1.96	31.4
Small Pivot 2	23.37	1.96	45.8
Big Pivot	75	1.96	147.0
Spray Irrigaiton	98.52	1.96	193.1
Total	212.89		417.3

Based on the calculations through from the DPI and the “average” year, this is a requirement of 1,104ML/year. For summer periods of low rainfall, the higher levels of irrigation have been required to complete the cropping season.

Summary:

LPC is a major supplier of milk to the NSW population through its dairy farm operation located in Bringelly. If the water captured in these dams, that has historically been available, is no longer able to be used for irrigation of the pastures and crops that feed the cattle, the effect on the dairy operation could be catastrophic.

LPC sees the review of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources as an excellent opportunity to rectify the omission in 2011. This inclusion of the necessary 1,500ML allocation would allow the company to continue operations as the biggest primary producer in the region.

Should you require any further information, we welcome any requests for assistance.

Sincerely,

Ron Perich
Joint Managing Director
Leppington Pastoral Co Pty Ltd

Appendices 1 - 2011 Irrigation Assessment Report
Appendices 2 - Ground Water Advisory Service Report Summary

Appendices 1

DPI number (office use only) 8778

Hawkesbury Nepean River Recovery Program

WaterSmart Farms

Irrigation Assessment

for

Wayne Perich

applicant:

of

[redacted]

[redacted]

property address:

Kevin Bolitho

name of assessor

7 May 2011

date

developed by Bill Yiasoumi

please return completed assessments to:

[redacted]

version 22

DPI number *(office use only)* **8778**

1. Auditors Details

auditors name	Kevin Bolitho		
telephone	[redacted]	mobile	[redacted]
date of audit	1st March 2011	fax	[redacted]
postal address	[redacted]		
suburb	[redacted] NSW	postcode	[redacted]
auditors email	[redacted]		

2. Applicants Contact Details (indicate preferred contact with *)

applicants name	Wayne Perich		
telephone	[redacted]	mobile	[redacted]
A.B.N.	83-000420404	fax	[redacted]
postal address	[redacted]		
suburb	[redacted]	postcode	[redacted]
applicants email	[redacted]		

3. Property Owners Details

owners name	Ron Perich		
telephone	[redacted]	mobile	[redacted]
postal address	[redacted]		
suburb	[redacted]	postcode	[redacted]
owners email	[redacted]		

4. Property Details

street address	[redacted]		
suburb	[redacted]	postcode	[redacted]
lot number	100-103	DP number	1,130,969
local council	[redacted]	property area	412.0 ha

5. Enterprise Details

farm type (eg: nursery)	Cropping / Grazing					
list crops / plants grown	1	Corn	2	Oates	3	Pasture
	4		5		6	
	7		8		9	

6. Pre Audit Site Visit Summary (for yes / no answers place an X in the relevant box)

date of pre-audit site visit	18th Febuary 2011				water source	Dams	
SmartFarms Project Officer	Matthew Plunkett					phone	[redacted]
applicants representative	Wayne Perich					phone	[redacted]
is bilingual support required ?		yes	X	no	if yes, what language		

broad description of works / issues to be addressed (place an X in the relevant box)

- [ ] retrofitting an irrigation system
- [X] converting from one irrigation system to another
- [ ] water harvesting (roof runoff) and reuse
- [ ] water harvesting (irrigation/rainfall runoff) and reuse
- [ ] upgrading irrigation equipment such as pumps
- [ ] water quality
- [ ] pathogen control
- [ ] other

refer for:

- [X] full site audit
- [ ] roof runoff assessment
- [ ] partial site audit eg pump upgrade; recycling system only;
- [ ] other, describe:

comments	
	A full site audit was undertaken with GPS points taken for the development of a farm map.

farmer's aspirations	

7. Soils (investigate soil layers to below bottom of root zone)

Soil Profile 1 (add extra sheets for each additional soil profile)

GPS co-ords ^{O}E		0		/		//	GPS co-ords ^{O}S		0		/		//
infiltration rate	25 mm/hr						note: refer to issued soil reference sheets for soil texture classifications & suggested infiltration rates & RAW values					

Soil Profile 1, layer 1 (for yes / no answers place an X in the relevant box)

layer 1 thickness	150 mm	layer 1 texture	Clay/Loam
soil pH	8.5	layer 1 RAW	65 mm/m

impediments in layer 1					comments
water table		yes	X	no	
hard pan		yes	X	no	
salinity		yes	X	no	
other (describe)		yes	X	no	

Soil Profile 1, layer 2

layer 2 thickness	150 + mm	layer 1 texture	Clay
soil pH	6.5	layer 1 RAW	55 mm/m

impediments in layer 2					comments
water table		yes	X	no	
hard pan		yes	X	no	
salinity		yes	X	no	
other (describe)		yes	X	no	

Soil Profile 1, layer 3

layer 3 thickness	mm	layer 1 texture	
soil pH		layer 1 RAW	mm/m

impediments in layer 3					comments
water table		yes		no	
hard pan		yes		no	
salinity		yes		no	
other (describe)		yes		no	

Soil Profile 1, layer 4 (add extra sheets for additional layers as required)

layer 4 thickness	mm	layer 1 texture	
soil pH		layer 1 RAW	mm/m

impediments in layer 4					comments
water table		yes		no	
hard pan		yes		no	
salinity		yes		no	
other (describe)		yes		no	

7. Soils (investigate soil layers to below bottom of root zone)

Soil Profile [ ] (add extra sheets for each additional soil profile)

GPS co-ords ^{O}E	148	0		/		//	GPS co-ords ^{O}S		0		/		//
infiltration rate	25	mm/hr											

Soil Profile 0 layer 1 (for yes / no answers place an X in the relevant box)

layer 1 thickness	250 mm	layer 1 texture	Clay/Loam
soil pH	8.5	layer 1 RAW	65 mm/m

impediments in layer 1					comments
water table		yes	X	no	
hard pan		yes	X	no	
salinity		yes	X	no	
other (describe)		yes	X	no	

Soil Profile 0 layer 2

layer 2 thickness	250 + mm	layer 1 texture	Clay
soil pH	8.5	layer 1 RAW	55 mm/m

impediments in layer 2					comments
water table		yes	X	no	
hard pan		yes	X	no	
salinity		yes	X	no	
other (describe)		yes	X	no	

Soil Profile 0 layer 3

layer 3 thickness	mm	layer 1 texture	
soil pH		layer 1 RAW	mm/m

impediments in layer 3					comments
water table		yes		no	
hard pan		yes		no	
salinity		yes		no	
other (describe)		yes		no	

Soil Profile 0 layer 4 (add extra sheets for additional layers as required)

layer 4 thickness	mm	layer 1 texture	
soil pH		layer 1 RAW	mm/m

impediments in layer 4					comments
water table		yes		no	
hard pan		yes		no	
salinity		yes		no	
other (describe)		yes		no	

8. Water Source

river		yes		x	no	townwater		yes	x	no
license number						townwater meter size	na	mm		
license entitlement	ML					townwater meter ^{0}E		0	/	//
						townwater meter ^{0}S		0	/	//

bore or well		yes		x	no	farm dam	X	yes		no
safe yield	L/s					estimated volume	1850	ML		
bore/well GPS coords ^{0}E		0	/	//		rainwater tank		yes	x	no
bore/well GPS coords ^{0}S		0	/	//		rainwater tank volume	na	litres		
other (describe)		yes		x	no					

9. Water Quality

water source one	Farm Dam	water source two	Farm Dam
EC (dS/m)	No Tests	EC (dS/m)	No Tests
pH	No Tests	pH	No Tests
other	No Tests	other	No Tests
lab tests attached ?	yes / x no	lab tests attached ?	yes / x no

10. Water Supply

a. Are weeds affecting pump, filter or emitter performance ?		yes	x	no
b. Is town water pressure adequate ?		yes	x	no
c. Is town water quantity adequate ?		yes	x	no
d. Are the levels of iron causing blockages or staining ?	x	yes	x	no
e. Is sediment an issue for the irrigation system ?		yes	x	no
f. Is algae an issue ?		yes	x	no

g. If you answered yes to any of the questions in section 10, describe how they could be addressed.

h. Are there other water supply concerns ? Please describe below.

11. Irrigation System

drip irrigation		yes			no	note: go to 11.1 (and if required 11.8)
microsprinklers		yes			no	note: go to 11.2 (and if required 11.9)
solid set sprinklers		yes			no	note: go to 11.2 (and if required 11.9)
handshift sprinklers		yes			no	note: go to 11.2 (and if required 11.9)
side roll sprinklers		yes			no	note: go to 11.2 (and if required 11.9)
travelling gun	x	yes			no	note: go to 11.3 (and if required 11.10)
travelling boom		yes			no	note: go to 11.3 (and if required 11.10)
lateral move		yes			no	note: go to 11.4 (and if required 11.11)
centre pivot	x	yes			no	note: go to 11.4 (and if required 11.11)
bike shift		yes			no	note: go to 11.5 (and if required 11.12)
bottom watering system		yes			no	note: go to 11.6 (and if required 11.13)

11.1 drip irrigation refers to irrigation area [ ] in section 12

make		emitter spacing	m
model		nominal discharge	L/hr
measured pressure	kPa	measured discharge	L/hr

11.2 micro, solid set and handshift sprinklers refers to irrigation area [ ] in section 12

make		spacing along pipe	m
model		spacing between pipes	m
measured pressure	kPa	measured discharge	L/s

11.3 travelling gun or boom refers to irrigation area [ ] in section 12

make		sprinkler make	
model		sprinkler model	
gun rotation angle	degrees	nozzle details	
measured pressure	kPa	measured discharge	L/s

11.4 lateral move, centre pivot refers to irrigation area [ ] in section 12

make	T&L	sprinkler make	Nelson Rotators
model	9 Span (483.35mtr)	sprinkler model	R 3000
measured pressure	20 kPa	measured discharge	71.9 L/s

11.5 bike shift refers to irrigation area [ ] in section 12

make		outlet spacing	m
model		moves per outlet	
measured pressure	kPa	measured discharge	L/s

11.6 bottom watering refers to irrigation area [ ] in section 12

flood floor		yes			no	trough		yes			no
capillary matt		yes			no	ebb and flow		yes			no
cycle time	mins					pot diameter	mm				

11.7 major equipment (if required, further information can be recorded at 11.14)

filtration	x	yes			no	type/make/model/size	DIX Screen Filter
fertigation		yes		x	no	type/make/model/size	

11. Irrigation System (continued)

(please add additional sheets as required)

11.8 drip irrigation 2 — refers to irrigation area [ ] in section 12

make		emitter spacing	m
model		nominal discharge	L/hr
measured pressure	kPa	measured discharge	L/hr

11.9 micro, solid set and handshift sprinklers 2 — refers to irrigation area [ ] in section 12

make		spacing along pipe	m
model		spacing between pipes	m
measured pressure	kPa	measured discharge	L/s

11.10 travelling gun or boom 2 — refers to irrigation area [ ] in section 12

make		sprinkler make	
model		sprinkler model	
gun rotation angle	degrees	nozzle details	
measured pressure	kPa	measured discharge	L/s

11.11 lateral move, centre pivot 2 — refers to irrigation area [ ] in section 12

make	Valley	sprinkler make	Nelson
model	5 Span (268mtr)	sprinkler model	R 3000
measured pressure	320 kPa	measured discharge	26.2 L/s

11.12 bike shift 2 — refers to irrigation area [ ] in section 12

make		outlet spacing	m
model		moves per outlet	
measured pressure	kPa	measured discharge	L/s

11.13 bottom watering 2 — refers to irrigation area [ ] in section 12

flood floor		yes		no	trough		yes		no
capillary matt		yes		no	ebb and flow		yes		no
cycle time	mins				pot diameter	mm			

11.14 major equipment (continued)

filtration 2	X	yes		no	type/make/model/size	
controller		yes		no	type/make/model/size	

other (describe)	
comments	

12. Evaluation of Sprinkler or Emitter Performance

Note: catch can, pressure & flow test results must be attached for each irrigation area

12.1 irrigation area 1 **refers to Section 11.** ☐

Mean Application Rate (MAR)	16.6	mm/hr		
Coefficient of Uniformity (Cu)	-	%	Scheduling Coefficient (Sc)	-
Distribution Uniformity (Du)	80	%		
measured operating pressure	200	kPa	from section 11	
measured discharge rate	71.9	L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1	117	0		/		//		0		/		//
corner 2	127	0		/		//		0		/		//
corner 3	135	0		/		//		0		/		//
corner 4	147	0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

12.2 irrigation area 2 **refers to Section 11.** ☐

Mean Application Rate (MAR)	10.6	mm/hr		
Coefficient of Uniformity (Cu)	-	%	Scheduling Coefficient (Sc)	-
Distribution Uniformity (Du)	81	%		
measured operating pressure	320	kPa	from section 11	
measured discharge rate	26.2	L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1	97	0		/		//		0		/		//
corner 2	98	0		/		//		0		/		//
corner 3	102	0		/		//		0		/		//
corner 4		0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

12.3 irrigation area 3 **refers to Section 11.** ☐

Mean Application Rate (MAR)		mm/hr		
Coefficient of Uniformity (Cu)		%	Scheduling Coefficient (Sc)	
Distribution Uniformity (Du)		%		
measured operating pressure		kPa	from section 11	
measured discharge rate		L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1		0		/		//		0		/		//
corner 2		0		/		//		0		/		//
corner 3		0		/		//		0		/		//
corner 4		0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

12. Evaluation of Sprinkler or Emitter Performance (continued)

Note: catch can, pressure & flow test results must be attached for each irrigation area

12.4 irrigation area 4 **refers to Section 11.**

Mean Application Rate (MAR)	mm/hr		
Coefficient of Uniformity (Cu)	%	Scheduling Coefficient (Sc)	
Distribution Uniformity (Du)	%		
measured operating pressure	kPa	from section 11	
measured discharge rate	L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1		0		/		//		0		/		//
corner 2		0		/		//		0		/		//
corner 3		0		/		//		0		/		//
corner 4		0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

12.5 irrigation area 5 **refers to Section 11.**

Mean Application Rate (MAR)	mm/hr		
Coefficient of Uniformity (Cu)	%	Scheduling Coefficient (Sc)	
Distribution Uniformity (Du)	%		
measured operating pressure	kPa	from section 11	
measured discharge rate	L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1		0		/		//		0		/		//
corner 2		0		/		//		0		/		//
corner 3		0		/		//		0		/		//
corner 4		0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

12.6 irrigation area 6 **refers to Section 11.**

Mean Application Rate (MAR)	mm/hr		
Coefficient of Uniformity (Cu)	%	Scheduling Coefficient (Sc)	
Distribution Uniformity (Du)	%		
measured operating pressure	kPa	from section 11	
measured discharge rate	L/s	from section 11	

corners of irrigation area	GPS coordinates °E						GPS coordinates °S					
corner 1		0		/		//		0		/		//
corner 2		0		/		//		0		/		//
corner 3		0		/		//		0		/		//
corner 4		0		/		//		0		/		//
corner 5		0		/		//		0		/		//
corner 6		0		/		//		0		/		//

13.1 Delivery Pump (use additional sheets if more than one delivery pump)

pump coords ^{0}E	47	0		/		//	pump coords ^{0}S	0	/	//
make of pump	Southern Cross						pump model	125x100-400		
pump speed	1700-1800 rpm						primemover speed	1700-1800 rpm		
pump curve attached	x	yes		no			impeller diameter	Full mm		
type of primemover	x	diesel		electric		petrol		gas		other:see comments
make of primemover	Perkins						primemover model	1006-6		
type of pump to primemover coupling/drive		direct	X	belt		gear		angle		
total dynamic head	65 m						duty point flow rate	26.2 L/s		
comments	Diesel was operating Valley Pivot only. Pump Duty 30.68 L/S @ 85mtrs									

14.1 Drainage and Recycling (use additional sheets if more than one system)

drainage storage tank		yes	x	no	if yes		steel		plastic		concrete
drainage storage dam	x	yes		no	if yes		lined	x	unlined		uncertain
storage dam volume	ML				storage tank volume	na kL					
pump coords ^{0}E		0		/	//	pump coords ^{0}S	0	/	//		
make of pump					pump model						
pump speed	rpm				primemover speed	rpm					
pump curve attached		yes		no	impeller diameter	mm					
type of primemover		diesel		electric		petrol		gas		other:see comments	
make of primemover					primemover model						
total dynamic head	m				duty point flow rate	L/s					

sediment traps		yes		no	litter traps		yes		no

pathogen control		yes		no	type	
pathogen control		yes		no	type	
comments						

13.2 Delivery Pump (use additional sheets if more than one delivery pump)

pump coords ^{0}E		0		/		//	pump coords ^{0}S		0		/		//
make of pump	Southern Cross						pump model	150x125-400					
pump speed	1700-1800	rpm					primemover speed	1700-1800	rpm				
pump curve attached	x	yes		no			impeller diameter	Full	mm				
type of primemover	x	diesel		electric		petrol		gas		other:see comments			
make of primemover	Cummins						primemover model	6BT 5.9-C150					
type of pump to primemover coupling/drive	x	direct		belt		gear		angle					
total dynamic head	50	m					duty point flow rate	71.9	L/s				
comments	Pump was operating the T&L centre pivot												

14.2 Drainage and Recycling (use additional sheets if more than one system)

drainage storage tank		yes		no	if yes		steel		plastic		concrete		
drainage storage dam	x	yes		no	if yes		lined		unlined		uncertain		
storage dam volume	100	ML			storage tank volume		kL						
pump coords ^{0}E		0		/		//	pump coords ^{0}S		0		/		//
make of pump	Southern Cross				pump model	80x50-200							
pump speed	2900	rpm			primemover speed	2900	rpm						
pump curve attached	x	yes		no	impeller diameter	228	mm						
type of primemover		diesel	x	electric		petrol		gas		other:see comments			
make of primemover	TECO				primemover model	22 KW							
total dynamic head	75	m			duty point flow rate	15.5	L/s						

sediment traps		yes	X	no	litter traps		yes	X	no

pathogen control		yes	X	no	type	
pathogen control		yes	X	no	type	
comments						

15. Management

15.1 equipment (a subjective assessment)

item	assessment of equipment condition													
pump		as new			good		X	fair			poor			n/a
filter		as new		X	good			fair			poor			n/a
sprinklers or drippers		as new		X	good			fair			poor			n/a
irrigation controller		as new			good			fair			poor		X	n/a
valves generally		as new			good		X	fair			poor			n/a
visible pipework		as new			good		X	fair			poor			n/a
water storages		as new			good		X	fair			poor			n/a

15.2 irrigation scheduling

How does the farmer decide when to irrigate and how long to run the system ?						
plant appearance		yes		X	no	eg. wilting appearance triggers irrigation
fixed time schedule		yes		X	no	eg. irrigate 30 minutes every second day
digging soil		yes		X	no	eg. dig hole next to plant & feel soil
daily water balance		yes		X	no	eg. estimate water use and applied water
weather conditions		yes		X	no	eg. looking at weather forecasts
weather station		yes		X	no	eg. utilise data of rainfall, evaporation (includes SMS)
wetting front detector		yes		X	no	eg. Fullstop
measure soil moisture	X	yes			no	if yes, please pick from the list below
other_please describe		yes		X	no	

Please pick from this list if the farmer uses soil moisture measuring equipment														
tensiometer		yes	X	no	EnviroScan	X	yes		no	C - Probe		yes	X	no
gypsum blocks		yes	X	no	Gopher		yes	X	no	Diviner		yes	X	no
other_please describe		yes	X	no										

15.3 relevant training

list irrigation management training undertaken by the farmer or his employees
1. NA
2.
list irrigation management training requested by the farmer or his employees
1. NA
2.
list irrigation management training you feel is required by the farmer or his employees
1. Waterwise on Farms
2.

16. Recommendations

Describe the irrigation and/or water management works you recommend for this farm based on your audit findings. Each recommendation must include an estimate of the cost of the works (supply, install, commission) and your estimate of the volume of water saved on an annual basis resulting from the implementation of the recommendation.

When applicable, please attach MAR, Du, Sc, operating pressure, flow rates and sprinkler spacing of the existing irrigation system AND the design MAR, Du, Sc, operating pressure, flow rates and sprinkler spacing of the proposed system. In addition, when applicable, also please attach drip emitter spacing and nominal discharge rates, hydrant spacing, hose length and hose diameter of travelling machines, suction lift, dynamic pumping head, pump curves and operating points of proposed pumps, pipe materials, diameters and pipe classes of new mainlines, submains and laterals, tank sizes and tank material, filter type(s) and filter size(s), type of fertigation system and capacity, type of pathogen control, irrigation controller, solenoid sizes, meter type and size, air valve locations, size and location of ball or gate valves and any other information/specification that adequately describes the proposed equipment to allow a full evaluation to be made. Attach this information as Appendix TWO.

16.1 recommendation 1

water saved	83 ML per year		estimated cost	$ 192,450.00 + GST

broad description of works (place an X in the relevant box)

- [ ] retrofitting an irrigation system
- [X] converting from one irrigation system to another
- [ ] water harvesting (roof runoff) and reuse
- [ ] water harvesting (irrigation/rainfall runoff) and reuse
- [ ] upgrading irrigation equipment such as pumps
- [ ] other

detailed description of works

A full description of our recommendations is included in Appendix No.1. Whisch is attached to this audit.

additional notes

16. Recommendations (continued)

16.2 recommendation 2

water saved	ML per year		estimated cost	$

broad description of works (place an X in the relevant box)

- ☐ retrofitting an irrigation system
- ☐ converting from one irrigation system to another
- ☐ water harvesting (roof runoff) and reuse
- ☐ water harvesting (irrigation/rainfall runoff) and reuse
- ☐ upgrading irrigation equipment such as pumps
- ☐ other

detailed description of works

16.3 recommendation 3 (place an X in the relevant box)

water saved	ML per year		estimated cost	$

broad description of works

- ☐ retrofitting an irrigation system
- ☐ converting from one irrigation system to another
- ☐ water harvesting (roof runoff) and reuse
- ☐ water harvesting (irrigation/rainfall runoff) and reuse
- ☐ upgrading irrigation equipment such as pumps
- ☐ other

detailed description of works

Hawkesbury Nepean River Recovery Program
Water Smart Farms

Report to accompany Full Audit Report Carried out by – Kevin Bolitho

Client Name : Leppington Pastoral Company
DPI number : 8778
Date : 2nd May 2011

Property Location / Enterprise

The property is located at [redacted] NSW, irrigation water is pumped from the an on farm dam. A full site audit was undertaken with GPS points taken to produce a map of the irrigated areas.

WATER BALANCE CALCULATIONS FOR WATER SMART FARMS PROJECT.

DPI # 8778
Customer Name : Wayne Perich (Leppington Pastoral Company)
Property Address : [redacted] NSW
Irrigated Area : 105.12 Ha
List of Irrigated Crops : Sweet Corn – Summer Crop

Month	**Ave Potential ET mm**	**Rainfall mm**	**Crop Coefficient %**	**Deficit mm/Day**
JULY (31)	60	39.0	_	_
AUGUST (31)	88	43.4	_	_
SEPTEMBER (30)	117	39.5	_	_
OCTOBER (31)	160	67.1	0.30	_
NOVEMBER (30)	170	74.0	0.40	_
DECEMBER (31)	196	54.8	0.99	139.24mm
JANUARY (31)	205	74.7	1.20	171.30mm
FEBRUARY (28)	170	104.2	1.13	87.90mm
MARCH (31)	158	83.7	0.81	44.28mm
APRIL (30)	88	64.4	0.62	_
MAY (31)	67	58.9	_	_
JUNE (30)	58	58.2	_	_
TOTALS	**1537mm**	**762mm**		**442.72mm**

** Rainfall figures derived from 1994-2010 Average figures measured at Camden Airport
Evapo - Transpiration (Potential) figures derived from Bureau of Meteorology figures 1961-1990.

Conclusions drawn from above figures
Maximum Application Rate / Day : 5.53 mm, Maximum Application Rate / Week : 38.71mm

IRRIGATION INTERVAL
Soil classification/ texture : Clay / Loam
Readily Available Water Holding Capacity (RAW) @ -60Kpa : 65 mm / metre (Water Smart Farms Auditors Information, Table.2.)
Crop Effective root depth : 300mm
Readily Available Water in Root Zone (RAW) : 19.5mm
Maximum Interval between irrigation = 19.5mm RAW divided by depletion rate 5.53mm/day = 3.53 Days
However I think it is better to use the highest daily ET rate and assume there is no assistance from rainfall.
Therefore our maximum interval between irrigation = 19.5mm RAW divided by maximum depletion rate 6.62mm/day = 2.95 Days
.
IRRIGATION SYSTEM PERFORMANCE

Working on worst case scenario the irrigation system has to have the capability of applying 19.5mm of water to the area every 3 days.

The irrigation system must be designed to meet worst case scenario conditions as well as apply the yearly application rate as a minimum.

The Summer time application rate from the above water balance, for this farm is, 442.72mm (4.43 ML/Ha).

Irrigated Area 105.12 Ha x 4.43 ML/Ha/year = 465.69 Megalitres (this figure is the water required if the system is 100% efficient)

** The above figures are to be used as a guide only, if you have any queries, please call Kevin Bolitho Bosch Irrigation Albury [redacted].

WATER BALANCE CALCULATIONS FOR WATER SMART FARMS PROJECT.

DPI # 8778
Customer Name : Wayne Perich (Leppington Pastoral Company)
Property Address : [redacted]
Irrigated Area : 172.68 Ha
List of Irrigated Crops : Winter Cereal Crop

Month	**Ave Potential ET mm**	**Rainfall mm**	**Crop Coefficient**	**Deficit mm/ Month**
JULY (31)	60	39.0	1.00	21.00mm
AUGUST (31)	88	43.4	1.15	58.80mm
SEPTEMBER (30)	117	39.5	1.11	90.37mm
OCTOBER (31)	160	67.1	0.58	25.70mm
NOVEMBER (30)	170	74.0	_	_
DECEMBER (31)	196	54.8	_	_
JANUARY (31)	205	74.7	_	_
FEBRUARY (28)	170	104.2	_	_
MARCH (31)	158	83.7	_	_
APRIL (30)	88	64.4	_	_
MAY (31)	67	58.9	0.30	_
JUNE (30)	58	58.2	0.50	_
TOTALS	**1537mm**	**762mm**		**195.87mm**

** Rainfall figures derived from 1994-2010 Average figures measured at Camden Airport
Evapo - Transpiration (Potential) figures derived from Bureau of Meteorology figures 1961-1990.

Conclusions drawn from above figures
Maximum Application Rate / Day : 3.02 mm, Maximum Application Rate / Week : 21.14mm

IRRIGATION INTERVAL
Soil classification/ texture : Clay / Loam
Readily Available Water Holding Capacity (RAW) @ -60Kpa : 65 mm / metre (Water Smart Farms Auditors Information, Table.2.)
Crop Effective root depth : 300mm
Readily Available Water in Root Zone (RAW) : 19.5mm
Maximum Interval between irrigation = 19.5mm RAW divided by depletion rate 3.02mm/day = 6.46 Days
However I think it is better to use the highest daily ET rate and assume there is no assistance from rainfall.
Therefore our maximum interval between irrigation = 19.5mm RAW divided by maximum depletion rate 5.17mm/day = 3.78 Days
.
IRRIGATION SYSTEM PERFORMANCE

Working on worst case scenario the irrigation system has to have the capability of applying 19.5mm of water to the area every 3 - 4 days.

The irrigation system must be designed to meet worst case scenario conditions as well as apply the yearly application rate as a minimum.

The Summer time application rate from the above water balance, for this farm is, 195.87mm (1.96 ML/Ha).

Irrigated Area 172.68 Ha x 1.96 ML/Ha/year = 338.46 Megalitres (this figure is the water required if the system is 100% efficient)

Total Water Requirement for the Greenways farm is 465.69 ML (Summer) + 338.46 ML (Winter) = 804.15ML.

** The above figures are to be used as a guide only, if you have any queries, please call Kevin Bolitho Bosch Irrigation Albury [redacted]

Review of Existing Irrigation Infrastructure

Water Source : Water Storage Dam
License Number :
Licence Entitlement :

The water source for this irrigation system is the large on site water storage dams. Water is pumped directly from these dams to the centre pivots & travelling irrigators.

Soil Properties
A soil pit was dug in a representative area of the irrigated low input pasture area, the soil test results are included in the full audit report and water balance above.

Soil Texture : Clay/Loam
Readily Avaliable Water : - 60 Kpa 65mm/metre
Root Depth : 300
Irrigation Interval : 3.0 days (worst case scenario) 3.53 days (from water balance)

System Performance

The system requires the capacity to apply 19.50mm of water over 105.12 hectares in 2 – 3 days, in summer time, and 19.5mm on 172.68 hectares in 3 – 4 days in winter.

Existing Irrigation Infrastructure

Diesel Drive Pumpunit No.1. Water Storage Dam
Valley Pivot
Pump Type : Southern Cross
Pump Model : 125 x 100 - 400
Diesel Engine : Perkins 1006-6, six (6) cylinder
Engine Speed (Small Pivot) : 1400-1500 rpm
Engine Speed (2xTravellers) : 1600-1700 rpm
Pump Duty (Small Pivot) : 26.2 L/Second @ 60 metres
Pump Duty (2xTravellers) : 31 L/Second @ 85 metres
KW Required at Duty Point (Small Pivot) : 29 KW
KW Required at Duty Point (2xTravellers) : 53.50 KW
KW Delivered by Diesel Engine @ 1500 rpm 58 KW
@ 1700 rpm 65 KW
Fuel Consumption of Diesel @ 1500 rpm 7.40 Litres per hour (215 g/kwhr)
@ 1700 rpm 13.8 Litres per hour (218 g/kwhr)

Operating Cost for Diesel Pumpunit

Small Pivot	$8.14 per hour
Travellers x 2	$15.18 per hour

Diesel Drive Pumpunit No.2. Water Storage Dam
T&L Centre Pivot

Pump Type : Southern Cross
Pump Model : 150 x 125 - 400
Diesel Engine : Cummins 6 B T 5.9 – C 150
Engine Speed (Big Pivot) : 1300-1400 rpm
Pump Duty (Big Pivot) : 71.9 L/Second @ 55 metres
KW Required at Duty Point (Big Pivot) : 55.20 KW
KW Delivered by Diesel Engine @ 1400 rpm 75 KW

Fuel Consumption of Diesel @ 1400 rpm 14.0 Litres per hour (215 g/kwhr)

Operating Cost for Diesel Pumpunit

Big Pivot $15.40 per hour (Diesel cost $1.10/ litre after rebate)

Springers Dam Pumpunit

Pump Type : Southern Cross
Pump Model : 80 x 50 -200
Electric Motor : Brook Crompton
Motor Rating : 22 KW, 2900 rpm
Pump Speed @ Duty Point : 2900 Rpm
Pump Duty : 15.47 L/Second @ 75 metres
KW Required at Duty Point : 17.31 KW
KW Delivered by Electric Motor : 22 KW
Operating Cost : $2.60 per hour (electricity cost used is 15 cents per unit)

Travelling Irrigators (Five machines were on site at time of visit)

Irrigator Make : Trailco
Irrigator Model : T 400
Big Gun Type : Nelson SR 150
Nozzle Size : 1.18’’ ring nozzle
Hose Combination : 200mtrs x 4 1/2’’ layflat hose
Nozzle Flowrate : 15.47 Litres/second
Estimated Sprinkler Pressure : 50mtrs (71psi)

Mainlines

The property is set up with three (3) mainlines, to service the different each mainline is connected to a pumpunit. There appears to be no inter connection between the mainlines.

Big pivot mainline is 250mm PVC and connects the T&L centre pivot to the Cummins diesel unit on the main irrigation dam, length is approximately 950 metres.

The second mainline services the small Valley centre pivot as well as some irrigator runs in the mastitis paddocks and the flats. This mainline is 200mm, the total length of pipe running in two directions is approximately 2500 meters, with two (2) centre pivot points and fifteen (15) irrigation hydrants.

The third mainline connects the Springers paddocks to the front dam, this mainline is 150mm AC/Fibro pipe and has ten (10) hydrants. The approximate length is 1600 metres.

Centre Pivot Irrigators

T & L Centre Pivot
Number of Spans : 9 spans w/ overhang
Span Configuration : 5 x 48mtr (208mm), 4 x 54mtr (168mm), 27mtr O/Hang
Machine Length : 483.35 meters (1585.8 ft)
Area Under Machine : 73.4 Ha (181.30 ac)
Machine Flowrate : 71.9 litres per second
Inlet Pressure at Machine : 180 Kpa (25psi)
End Pressure : 100 Kpa (14psi)
Gross Application Rate : 8.5mm / day
Sprinklers : Nelson Rotators w/ red plates
Pressure Regulators : 15 psi, fitted to each drop pipe
Power Plant : Diesel drive hydraulic oil pump (located at pivot centre)

Valley Centre Pivot
This machine is towable and can irrigate two (2) sites

Number of Spans : 5 spans w/ overhang
Span Configuration : 3 x 50mtr (114mm), 2 x 55mtr (114mm), 8mtr O/Hang
Machine Length : 268 meters (880 ft)
Area Under Machine : 22.60 Ha (55.83 ac) per circle
Machine Flowrate : 26.2 litres per second
Inlet Pressure at Machine : 315 Kpa (45psi)
End Pressure : 14.5 Kpa (21psi)
Gross Application Rate : 10mm / day
Sprinklers : Nelson Rotators w/ red plates
Pressure Regulators : 15 psi, fitted to each drop pipe
Power Plant : Connected to mains power

Centre Pivot Testing

T & L Centre Pivot 483.85 mtr

The testing was undertaken on site over the harvested corn ground, there was little or no wind at the time of the testing.

Distribution Uniformity 80%, this figure is quite low for a centre pivot installation, the pressure at the centre point and end pressure is adequate to operate the rotators as designed.

There seems to be problems under the first two (2) spans and under span number eight (8), the collected volumes are all over 200ml whereas for the rest of the machine, maximum volume collected is 175mm.

The original sprinkler printout should be checked against the sprinklers on the centre pivot.

There were two faulty/blocked sprays on the system, under span four (4) and under span nine (9), these sprays should be repaired.

Normally centre pivots operate at a DU 85-90%.

Your machine could is operating up to 10% under optimal efficiency, which in theory is using more water.

Valley Towable Centre Pivot 268 mtr

The testing was undertaken on site over the harvested corn ground, there was little or no wind at the time of the testing.

Distribution Uniformity 81%, this figure is quite low for a centre pivot installation, the pressure at the centre point and end pressure is adequate to operate the rotators as designed.

The reduction in uniformity was caused by several blocked & partially blocked sprays. These sprays were un blocked by the farm manager during the test and resulted in less water being captured.

Normally centre pivots operate at a DU 85-90%.

I feel confident that with all sprays un blocked this centre pivot would achieve the above percentages.

The only area of concern with this centre pivot is pipe leak in span number one (1), caused by a spilt pipe or blown gasket.

Yearly Water Use & Operating Cost

Following are estimates of you current water usage and operating costs.

Summer Cropping

T&L Centre Pivot
73.3 Ha x 4.43 ML/Ha = 324.72 ML divided by T&L efficiency 80% = 405.90 ML
Valley Centre Pivot
45.2 Ha x 4.43 ML/Ha = 200.24 ML divided by Valley efficiency 81% = 247.21 ML
Trailco Traveller
12.52 Ha x 4.43 ML/Ha = 55.46 ML divided by Trailco efficiency 70% = 79.25 ML

Total ML used on Summer Crops 732.36 ML

Operating Cost for Summer Months

T&L Centre pivot 1568 hours x $15.40 per hour	=	$24,147.20
Valley Centre pivot 2621 hours x $8.14 per hour	=	$21,359.36
Trailco Irrigators 711.50 hours x $15.18 per hour	=	$10,800.57
Total Operating Cost for Summer Cropping	**=**	**$56,307.13 (Diesel Fuel Only)**

Comparison with electricity cost

T&L Centre pivot 1568 hours x $8.28 per hour	=	$12,983.00
Valley Centre pivot 2621 hours x $4.35 per hour	=	$11,401.35
Trailco Irrigators 711.50 hours x $8.03 per hour	=	$ 5,713.35
Total Operating Cost for Summer Cropping	**=**	**$30,097.70 (Power cost only)**

(Electricity rate used is 15 cents per unit)

Winter Cereal Cropping

T&L Centre Pivot
73.3 Ha x 1.96 ML/Ha = 143.67 ML divided by T&L efficiency 80% = 179.59 ML
Valley Centre Pivot
45.2 Ha x 1.96 ML/Ha = 88.60 ML divided by Valley efficiency 81% = 109.39 ML
Trailco Traveller
80.10 Ha x 1.96 ML/Ha = 157 ML divided by Trailco efficiency 70% = 224.29 ML

Total ML used on Summer Crops 513.27 ML

Operating Cost for Winter Months

T&L Centre pivot 694 hours x $15.40 per hour	=	$10,688.00
Valley Centre pivot 1160 hours x $8.14 per hour	=	$ 9,442.40
Trailco Irrigators 1348 hours x $15.18 per hour	=	$20,463.00
Trailco Irrigators 1332 hours x $2.60 per hour	=	$ 3,463.20 (Springer Pump)
Total Operating Cost for Winter Cropping	**=**	**$44,056.60 (Diesel Fuel & Power costs only)**

Comparison with electricity cost

T&L Centre pivot 694 hours x $8.28 per hour	=	$ 5,746.32
Valley Centre pivot 1160 hours x $4.35 per hour	=	$ 5,046.00
Trailco Irrigators 1348 hours x $8.03 per hour	=	$10,824.44
Trailco Irrigators 1332 hours x $2.60 per hour	=	$ 3,463.20 (Springer Pump)
Total Operating Cost forWinter Cropping	**=**	**$25,079.96 (Power cost only)**

(Electricity rate used is 15 cents per unit)

There are significant operating cost savings if the pump station on the main dam was converted to electric pump units.

The yearly saving on energy costs would be $45,186.00 if the above amount of water is applied to the Greenways farm.

The cost of electricity is set to rise, however electric pumps are far cheaper to operate than the diesel engines. If the Australian dollar starts to drop and the cost of oil remains the same, the increase in electricity costs will be minor compared to the potential price rise of diesel.

Water Saving Recommendation Number.1.
Water Saving : 84 ML

Our recommendation will be to make changes to the existing system as listed below.

- **Investigate sprinkler package on T&L centre pivot irrigator**
- **Un block & service all sprinklers on Valley centre pivot**
- **Install Hose Pull lateral move irrigator to the flats & Springers paddocks, to replace travelling irrigator runs**

T&L Sprinkler Package

As previously discussed there needs to be some investigation into the sprinkler package on the big T&L centre pivot. From the testing it appears that the sprinklers on spans 1, 2 & 8 are putting out significantly more water than the other spans.

If you had the sprinkler package printout, the positions of the sprays & the nozzle sizes can be checked, the sprinklers are usually numbered, so the sequence can be looked at.

Sorting out the sprinkler package should bring the centre pivot DU% back up to 85%, which could save up to **34 ML/year**

Un-Block & Repair Span Pipe on Valley Pivot

The watering pattern under the Valley pivot seems quite uniform, however the blocked/partially blocked sprays did effect the performance. The span pipe should be repaired as it is a significant loss of water.

Un blocking sprays & repairing leaks will increase the DU% TO 85% and save up to **17 ML/year**.

Install Hose Pull lateral move irrigator to the flats & Springers paddocks, to replace travelling irrigator runs

Our recommendation would be to install a hose pull lateral move irrigator to irrigate the flats & springer paddocks. The irrigator will be designed to irrigate the entire area 66.5 Ha during winter cropping, and approximately 50 Ha if used for summer crops.

Width of the lateral move irrigator will be 440 metres and be fed by a 125mm x 200mtr lay flat hose. The machine will travel the entire length of the Flats paddocks, then pivot inside to line up with the Springers paddocks.

The existing mainlines will be modified to have hydrants every 400 metres to attached the irrigator hose too.

Lateral Move irrigators apply very efficiently and at lower pressures than the travelling irrigators, the DU% for the new irrigator will be 85%.

The annual savings in water use will be **33 ML**, the annual saving in operating costs will be $11,800.00.

Annual operating costs have been calculated using the diesel pump on the main irrigation dam, however the electric pump on the Springers dam could be up graded to operate the lateral move irrigator. If this pump was to be used the mainline would require an up grade to 200mm.

Your annual operating cost to run the Lateral move irrigator with the electric pump would be $3,928.40.

The above saving will be larger if the area is utilized for summer cropping.

Yearly Water Use & Operating Cost

Summer Cropping

T&L Centre Pivot
73.3 Ha x 4.43 ML/Ha = 324.72 ML divided by T&L efficiency 85% = 382 ML
Valley Centre Pivot
45.2 Ha x 4.43 ML/Ha = 200.24 ML divided by Valley efficiency 81% = 235.58 ML
Trailco Traveller
12.52 Ha x 4.43 ML/Ha = 55.46 ML divided by Trailco efficiency 70% = 79.25 ML

Total ML used on Summer Crops 696.83 ML

Operating Cost for Summer Months

T&L Centre pivot 1476 hours x $15.40 per hour	=	$22,730.40
Valley Centre pivot 2498 hours x $8.14 per hour	=	$20,333.72
Trailco Irrigators 711.50 hours x $15.18 per hour	=	$10,800.57
Total Operating Cost for Summer Cropping	**=**	**$53,865.00 (Diesel Fuel Only)**

Comparison with electricity cost

T&L Centre pivot 1476 hours x $8.28 per hour	=	$12,221.28
Valley Centre pivot 2498 hours x $4.35 per hour	=	$10,866.30
Trailco Irrigators 711.50 hours x $8.03 per hour	=	$ 5,713.35
Total Operating Cost for Summer Cropping	**=**	**$28,800.93 (Power cost only)**

(Electricity rate used is 15 cents per unit)

Winter Cereal Cropping

T&L Centre Pivot
73.3 Ha x 1.96 ML/Ha = 143.67 ML divided by T&L efficiency 85% = 169.03 ML
Valley Centre Pivot
45.2 Ha x 1.96 ML/Ha = 88.60 ML divided by Valley efficiency 85% = 104.24 ML
Trailco Traveller
12.52 Ha x 1.96 ML/Ha = 24.54 ML divided by Trailco efficiency 70% = 35.06 ML
Linear Move Irrigator
67.56 Ha x 1.96 ML/Ha = 132.42 ML divided by Linear efficiency 85% = 155.79 ML

Total ML used on Summer Crops 464.12 ML

Operating Cost for Winter Months

T&L Centre pivot 653 hours x $15.40 per hour	=	$10,056.20
Valley Centre pivot 1105 hours x $8.14 per hour	=	$ 8,994.70
Trailco Irrigators 315 hours x $15.18 per hour	=	$ 4,781.70
Linear Irrigator 920 hours x $7.94 per hour	=	$ 7,304.80
Total Operating Cost for Winter Cropping	**=**	**$31,137.40 (Diesel Fuel only)**

Comparison with electricity cost

T&L Centre pivot 653 hours x $8.28 per hour	=	$ 5,406.84
Valley Centre pivot 1105 hours x $4.35 per hour	=	$ 4,806.75
Trailco Irrigators 315 hours x $8.03 per hour	=	$ 2,529.45
Linear Irrigator 920 hours x $4.27 per hour	=	$ 3,928.40
Total Operating Cost for Summer Cropping	**=**	**$16,671.44 (Power cost only)**

(Electricity rate used is 15 cents per unit)

There are significant operating cost savings if the pump station on the main dam was converted to electric pump units.

The yearly saving on energy costs would be $45,186.00 if the above amount of water is applied to the Greenways farm.

Budget Costing For Recommendation Number.1.

Hose Pull Linear Move Irrigator
1 – Reinke or similar,Hose Feed Maxigator or similar Hose pull linear move irrigator including four (4) wheeled galvanized hose pull cart with on board genset & fuel tank, to provide power to the tower electric motors. (Hydraulic oil machines will also be suitable for this installation)
1 – 125mm x 200 metre layflat flexible with fittings for the irrigator and hydrants
8 – 50 metre galvanized steel x 168mm span pipe with truss rods, high tensile stays, nuts & bolts. Sprinkler outlets are spaced along the span pipes, wheel gearboxes & with turf tyres.
1 – 40 metre Galvanised steel x 168mm span pipe with truss rods, high tensile stays, nuts & bolts. Sprinkler outlets are spaced along the span pipes, wheel gearboxes & with turf tyres.

1 – Cable or furrow guidance system for end tow cart
1 – Complete set of Senniger IWob or Nelson rotator sprinklers, pressure regulators, weights & drop pipes
1 – Main control panel mounted on tow cart to control the speed & direction of the machine.
1 – Installation & Commissioning of Linear Move irrigator

Budget Estimate $154,500.00 + GST

Mainline Extension & Hydrants
1 - 200 & 150mm PVC mainline with 125mm outlet hydrants to suit the Linear Move irrigator run (660mtrs x 200mm, 450mtrs x 150mm approx). Pipeline to be installed and connected to the existing mainlines.

Budget Estimate $34,450.00.00 + GST

Investigate Pivot Sprinkler Packages & Un Block Sprays

1 – Compare sprinkler positions with original sprinkler printout, remove, replace faulty sprinklers, repair any damaged drop hoses.
1 – Unblock sprinklers on Valley centre pivot, repair leak in span pipe

Budget Estimate $3,500.00 + GST

TOTAL PROJECT BUDGET PRICE $192,450.00 + GST

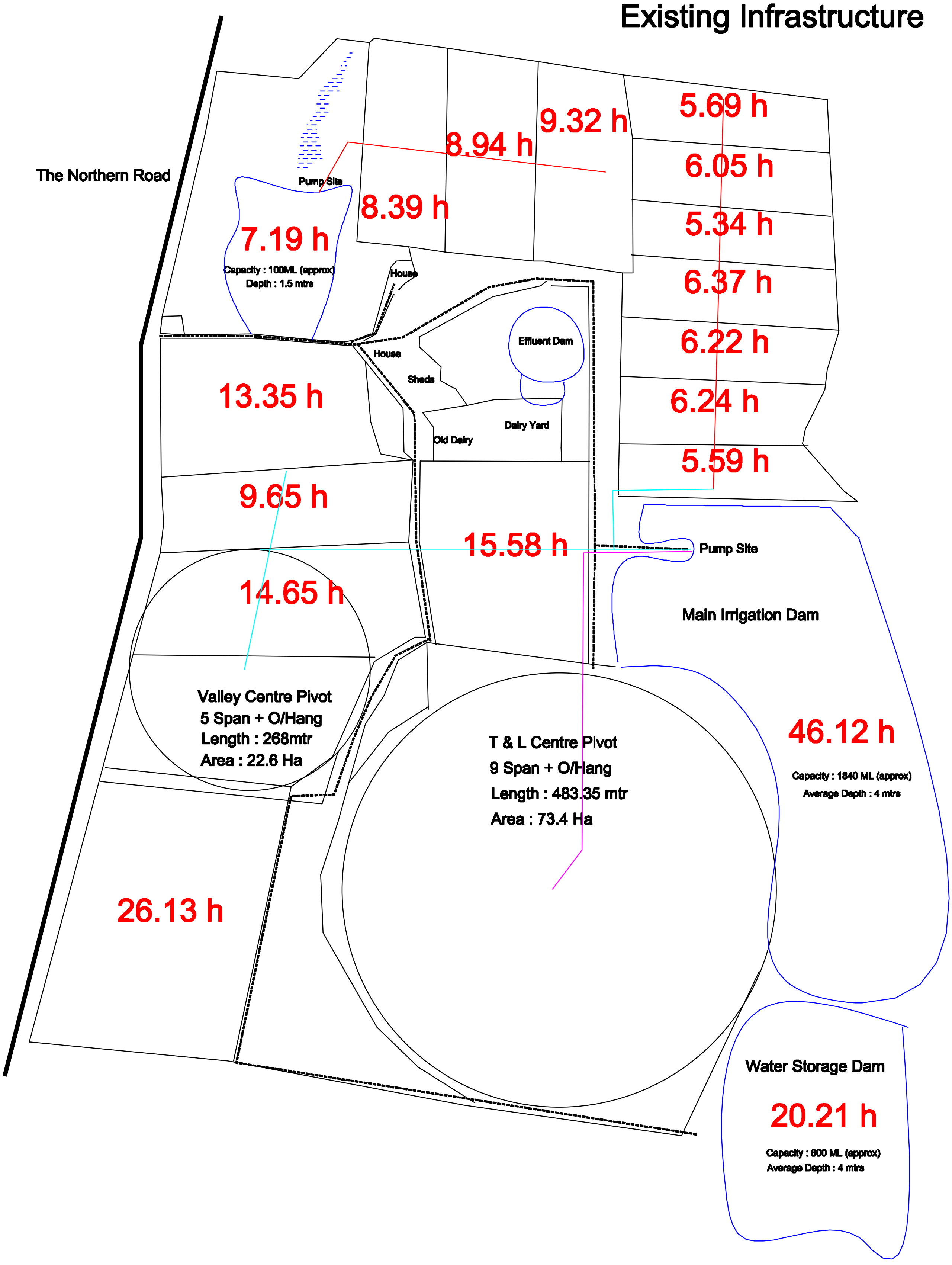
The above pricing is budget only and quotations and final site measurements for the work should be obtained from your local irrigation suppliers.

I would be happy to discuss any or all of the above recommendations, I can be contacted [redacted]

Regards

Kevin Bolitho
Bosch Irrigation Albury.

Existing Infrastructure



DISTANCE

0 50 100 200 300 400 500

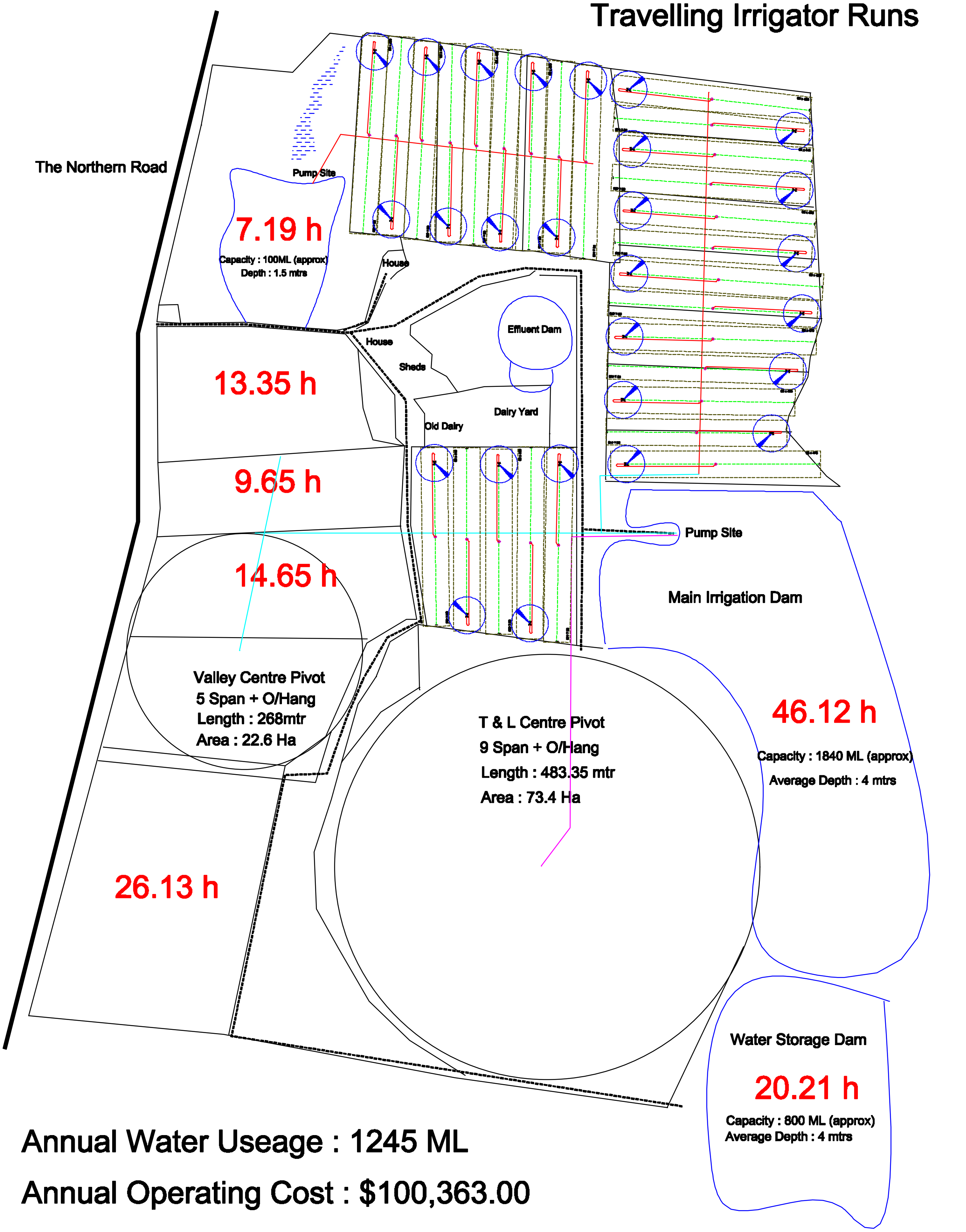
Bosch Irrigation Albury

For Leppington Pastoral Company

[redacted]

DRAWN : KJB	SCALE : 1: 9400 A3P	REV NO.:
DESIGN : KJB	DATE : 03 / 03 / 2011	DATE:
DRAWING NAME: Baseplan Greeways.dcd		DESIGN:
		Aquaflow ®

Travelling Irrigator Runs



Annual Water Useage : 1245 ML

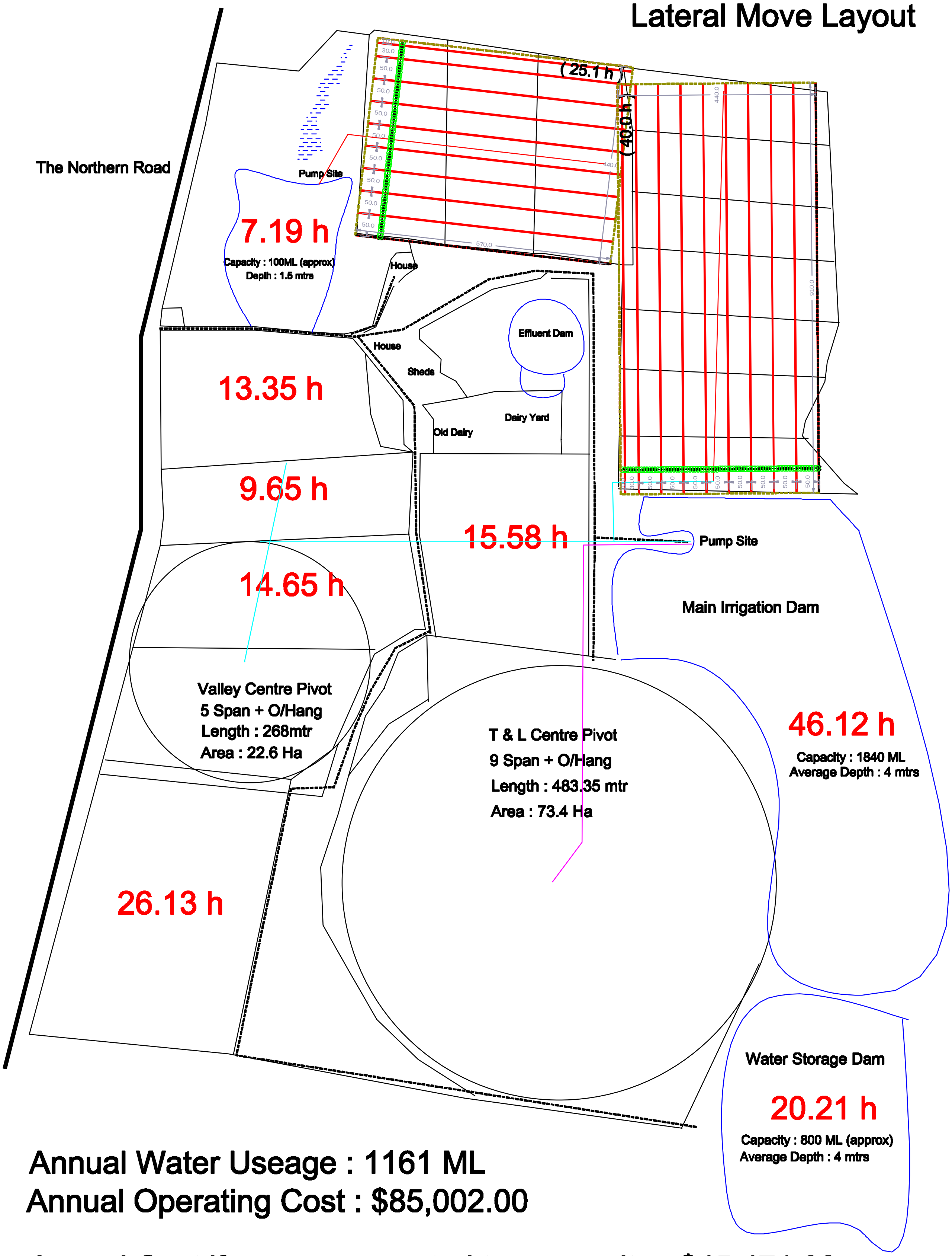
Annual Operating Cost : $100,363.00

Annual Operating cost if power conneced to pump site : $55,177.00

DISTANCE
0 50 100 200 300 400 500

Bosch Irrigation Albury	For Leppington Pastoral Company [redacted] NSW	DRAWN : KJB	SCALE : 1: 9400 A3P	REV NO.:
		DESIGN : KJB	DATE : 03 / 03 / 2011	DATE:
		DRAWING NAME: Baseplan Greeways.dcd		DESIGN: Aquaflow ®

Lateral Move Layout



Annual Water Useage : 1161 ML
Annual Operating Cost : $85,002.00

Annual Cost if power connected to pump site : $45,471.00

DISTANCE

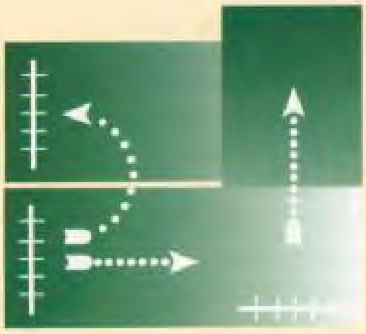
0 50 100 200 300 400 500

Bosch Irrigation Albury	For Leppington Pastoral Company [redacted]	DRAWN : KJB	SCALE : 1: 9400 A3P	REV NO.:
		DESIGN : KJB	DATE : 03 / 03 / 2011	DATE:
		DRAWING NAME: Baseplan Greeways.dcd		DESIGN: Aquaflow ®

Reinke
IRRIGATION SYSTEMS
Maxigator™

4 - Wheel Power Tower

Get maximum pulling power on large fields with the Reinke 4-wheel drive power tower. This unit matches the demands of higher water flow requirements of large hoses by providing reliable positive traction and labor savings.



The Reinke hose drag system can be pivoted in a corner or at field's end for irrigating "L" shaped or rectangular fields.

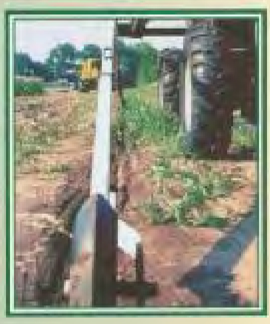
BURIED WIRE GUIDANCE OPTION ALSO AVAILABLE

cable

Above ground cable positive guidance system assures accurate lateral movement and uniform water distribution over the entire field.

furrow

Our patented furrow guidance system uses specially designed wheels that track a V - furrow parallel to the travel path.



Power Tower / Features

The Reinke Maxigator™ family leads the industry in lateral move systems. Primarily designed to irrigate square or rectangular fields, the Maxigator travels in a straight line across the field.

Reinke Maxigators are available in either canal feed (below) or hose drag options (right). A Maxigator can irrigate nearly 100% of any rectangular field. Get optimum efficiency and reliability with a Reinke lateral move system.

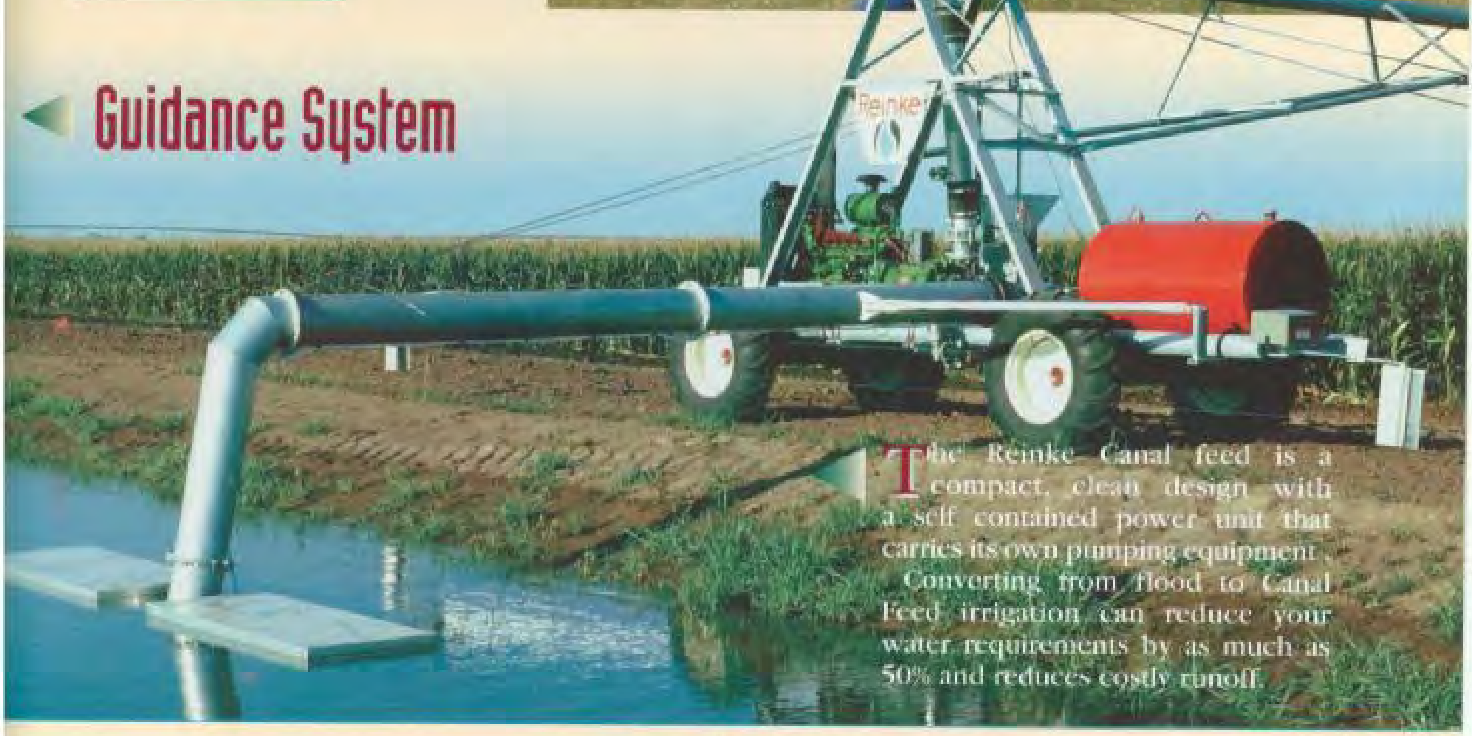
2 - Wheel / Hose Pull

Two wheel power tower option gives great versatility to the Maxigator. With forward and reverse tow options, this unit carries a self-contained power supply.

Hose pull systems feature double inlets, internal check valves, and quick coupler connections on both ends of the power tower. Water pick-up optional on last tower.

Optional jack assembly for turning wheels to tow position.

Guidance System



The Reinke Canal feed is a compact, clean design with a self contained power unit that carries its own pumping equipment.

Converting from flood to Canal Feed irrigation can reduce your water requirements by as much as 50% and reduces costly runoff.

LEADERSHIP IN

LATERAL SYSTEMS

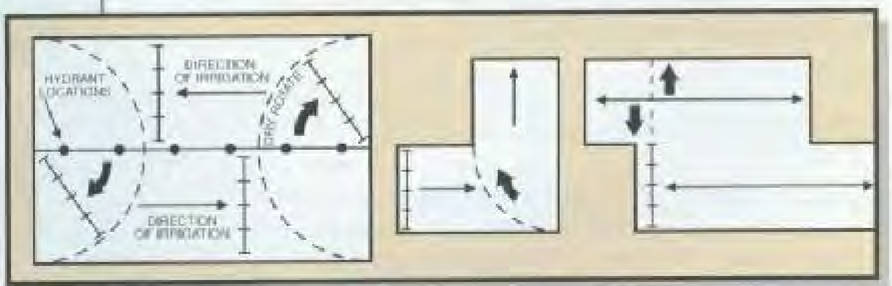
MORE OPTIONS TO GAIN MAXIMUM COVERAGE

When fields have only a moderate grade, Zimmatic Lateral Move Systems are an attractive alternative to center pivot irrigation. Because they travel in a straight line, they can bring up to 98 percent of square or rectangular fields into full production. In addition, some models can be pivoted or towed to handle adjacent fields. To enable more irrigators to use the coverage available from these versatile systems, Zimmatic has engineered them to be highly adaptable with a broader choice of water supply methods, including hose-fed, ditch-fed and enclosed pipeline. Take a look at the options shown here and talk to your Zimmatic dealer.

HOSE-FED

Hose-fed Zimmatic laterals get water from a pressurized mainline through a large diameter flexible hose. They are ideal for gaining maximum coverage in fields where the grade and/or soil conditions make the use of a ditch impractical. Their versatility, including the option of being pivoted or towed (see diagrams), makes them our most widely-used lateral move design.

- Available with 2-wheel or 4-wheel cart depending on the size and length of hose required.
- Choice of four-, six- and eight-inch flexible hose (10.2, 15.3, 20.3 cm) to handle fields up to 160 acres (65 ha).
- Power supplied from an on-board diesel generator set or a heavy-duty electric cable.
- Easily-established furrow guidance system plus options for guidance by buried or above-ground cable.



PIVOT/TOW FOR EXPANDED COVERAGE

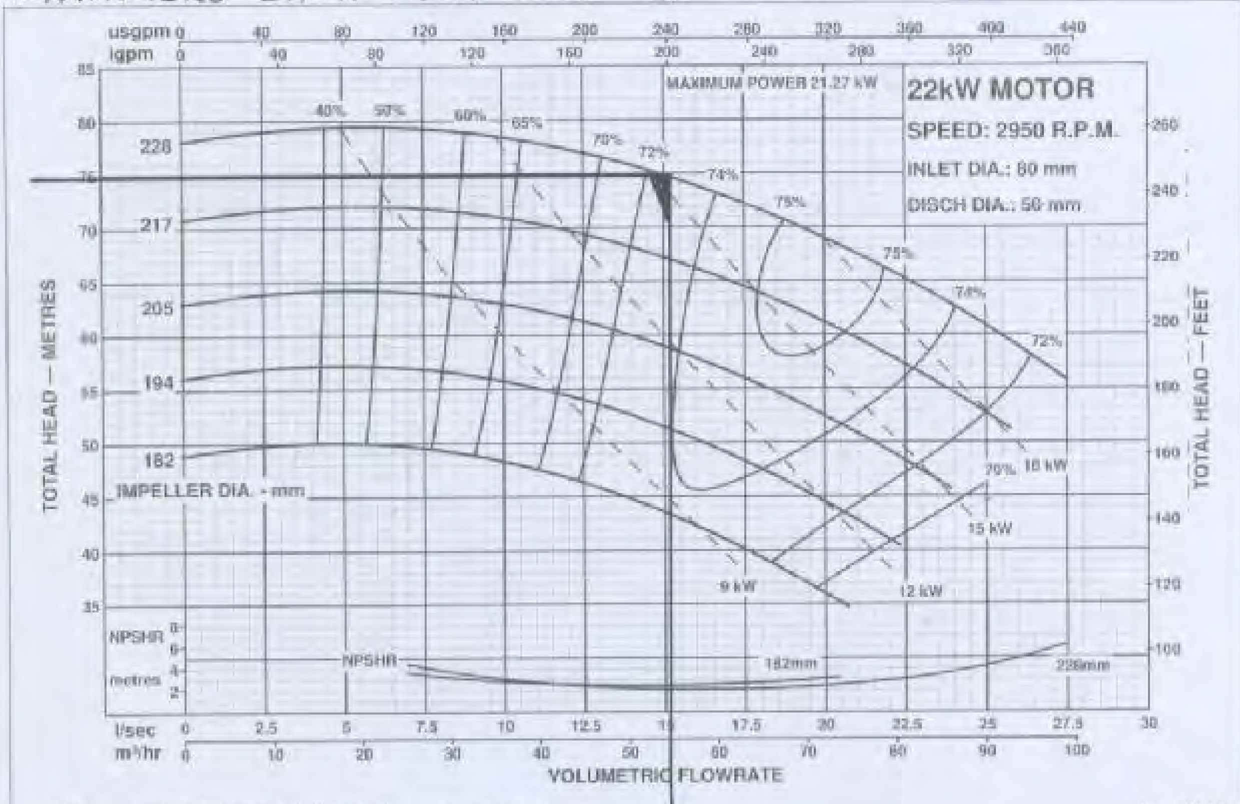
As shown here, special options allow Zimmatic hose-fed lateral move systems to be pivoted or towed for irrigating "L-shaped," offset or adjacent fields. This allows significant reduction of per-acre equipment cost.

Southern Cross

STAR LINE / STAR PRO 80 x 50-200

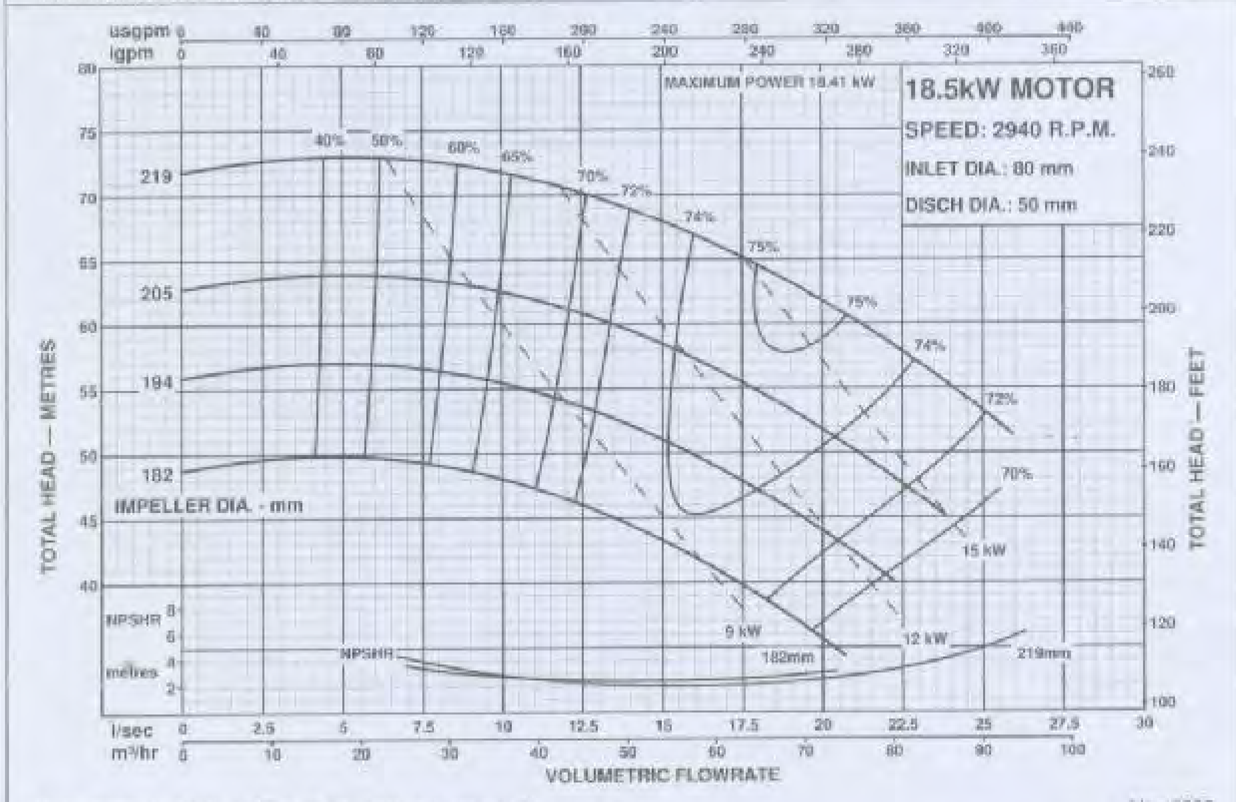
CENTRIFUGAL PUMP PERFORMANCE DATA

* STRINGERS DAM. PUMP UNIT *



Performance to AS2417 Grade 2 for clean, cold water only.

May 2005



Performance to AS2417 Grade 2 for clean, cold water only.

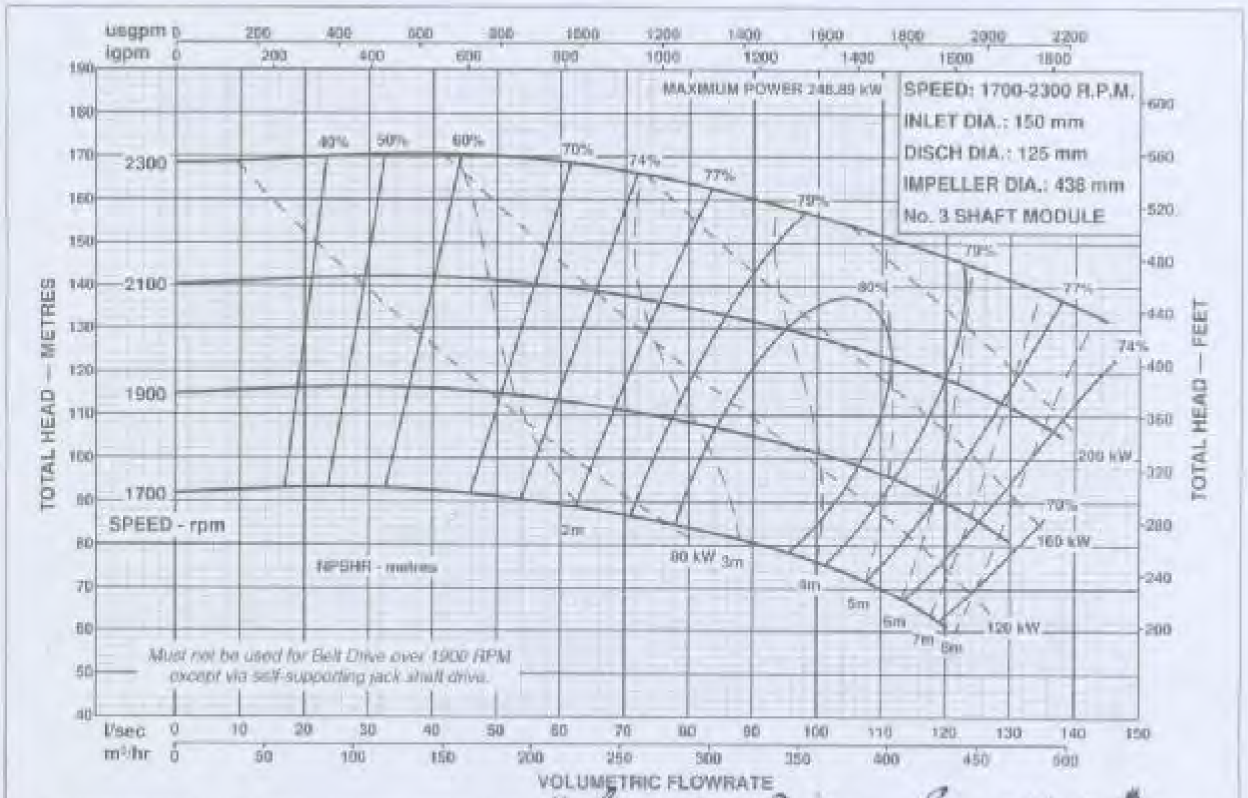
May 2005

A division of tyco Flow Control Pacific Pty Ltd A.B.N. 83 000 922 690

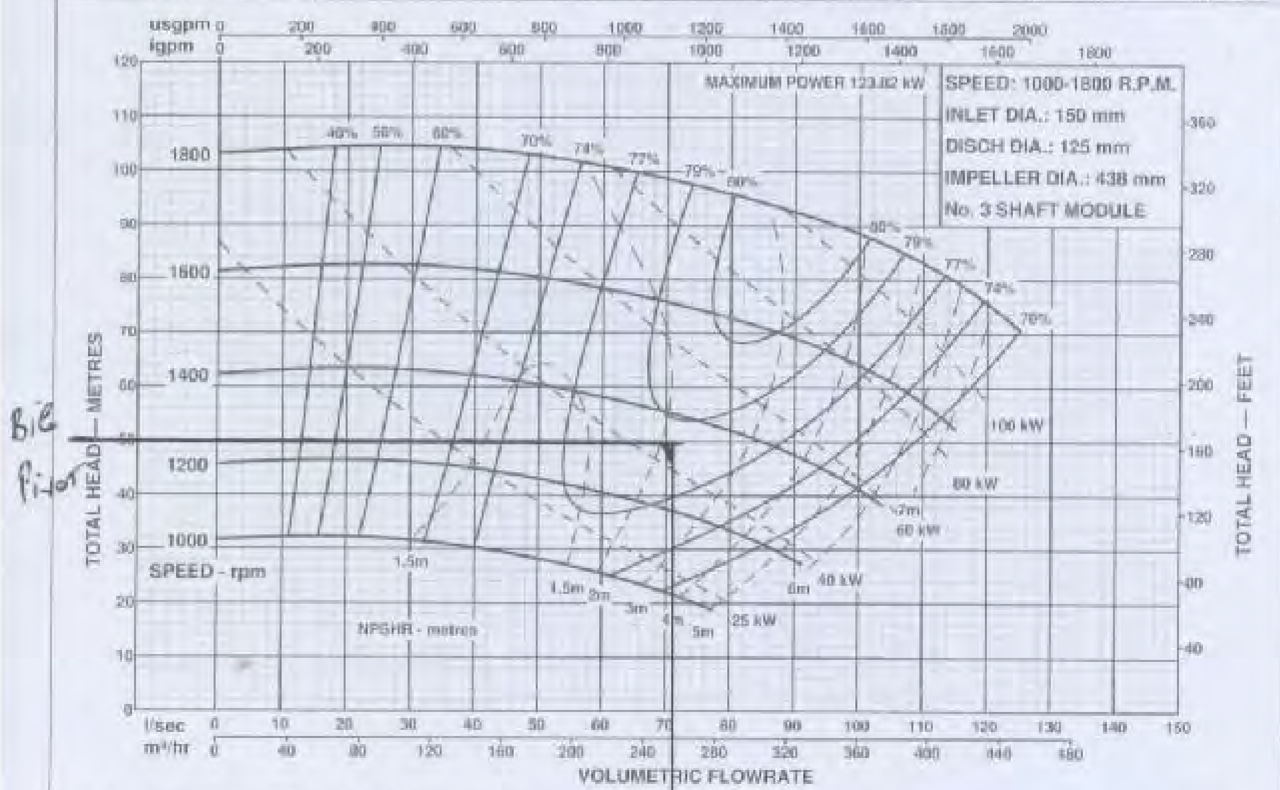
150 x 125-400 ISO-PRO

Southern Cross

CENTRIFUGAL PUMP PERFORMANCE DATA



Performance to AS2417 Grade 2 for clean, cold water only. * Cummins Diesel Pump Unit * May 2005



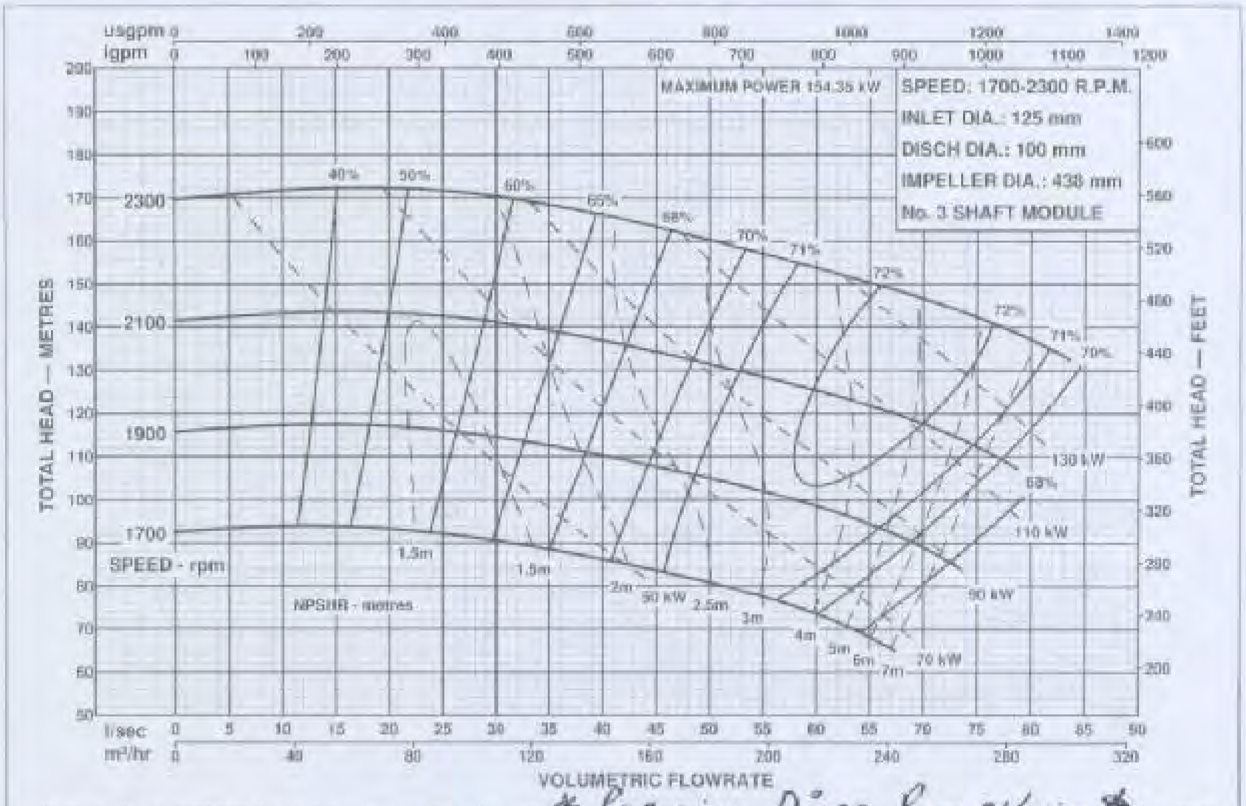
Performance to AS2417 Grade 2 for clean, cold water only. 71.9 l/s. May 2005

A division of tyco Flow Control Pacific Pty Ltd A.B.N. 83 000 922 690

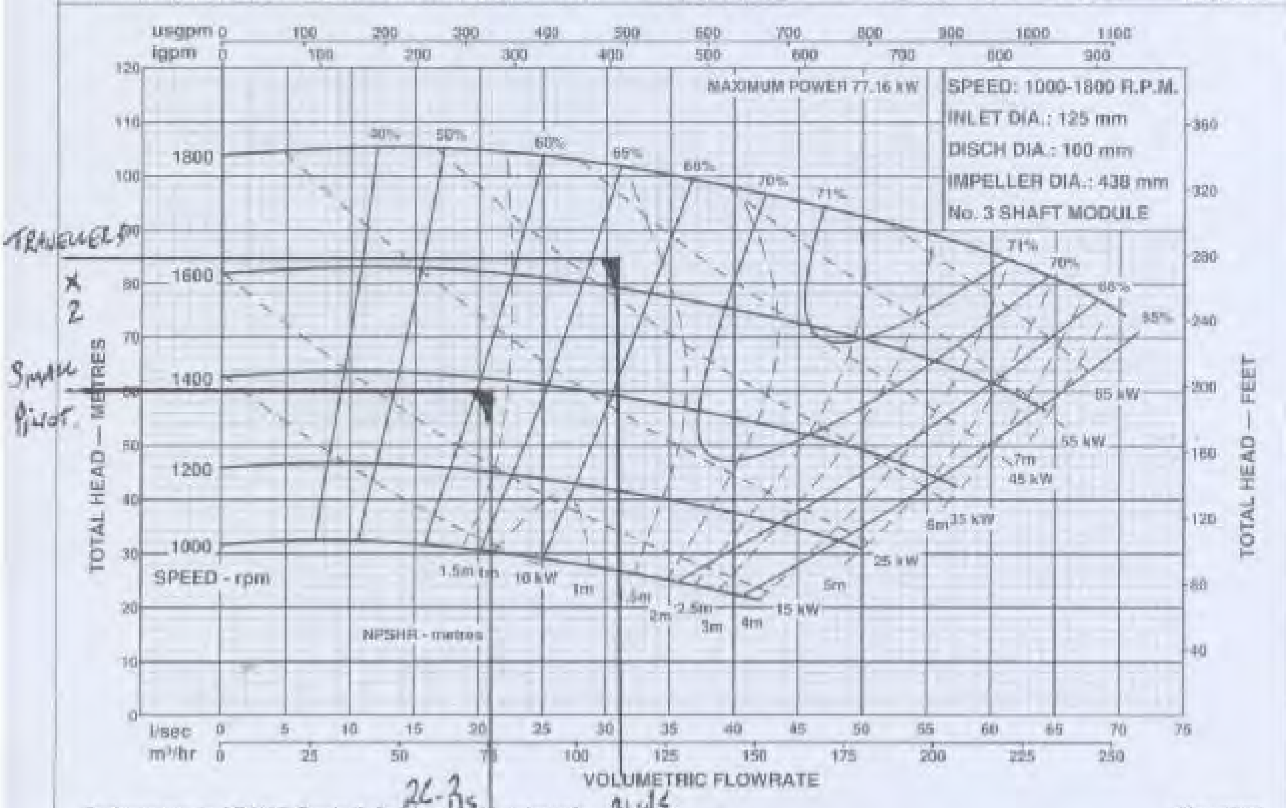
125 x 100-400 ISO-PRO

Southern Cross

CENTRIFUGAL PUMP PERFORMANCE DATA



Performance to AS2417 Grade 2 for clean, cold water only. * PERKINS DIESEL PUMPUNIT * May 2005



Performance to AS2417 Grade 2 for clean, cold water only. 26-35 31.15. May 2005

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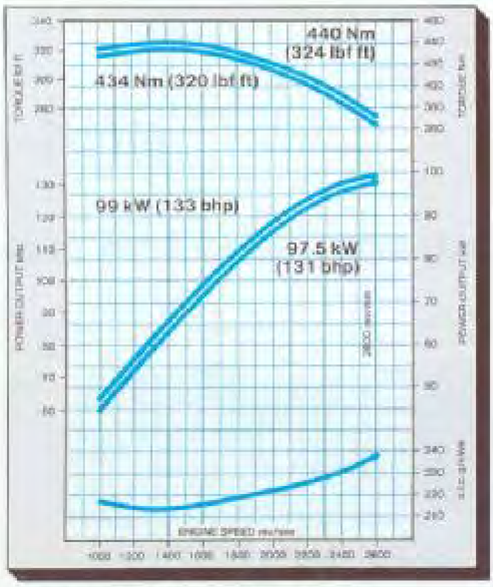
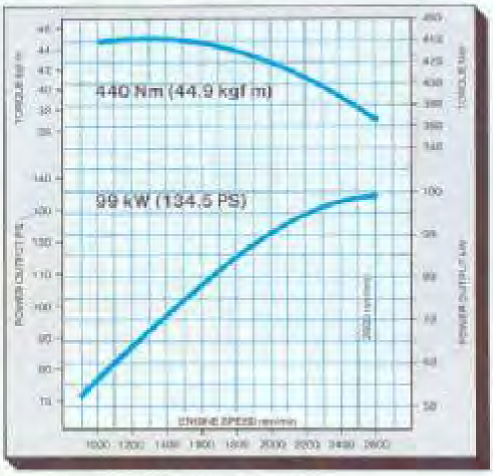
1000 Series

1006-6



Maximum power to BS AU 141a 1971/SAE J1995 3.1 conditions



Maximum power to DIN 70020 conditions (without fan)

GENERAL DATA

Bore/Stroke	100mm (3.937in)/127mm (5.00in)
No of cylinders	6 in line vertical
Cubic capacity	6.0 litres (365.0 cu in)
Cycle	4 stroke
Aspiration	Natural
Combustion system	Quadram direct injection
Compression ratio	16:1
Firing order	1.5.3.6.2.4
Rotation	Clockwise, viewed from front
Fuel pump	Rotary
Governing	Mechanical
Injectors	Low inertia
Cooling	Liquid
Weight*	410kg (902lb)
Length	944mm (37.2in)
Width	610mm (24.0in)
Height	780mm (30.7in)
Thread form	Metric
Electrical	12 Volt (24 Volt optional)
Power take off	Single or twin PTO's up to limit of 50kW (65bhp)

* Engine without fan drive, balancer, flywheel, flywheel housing and starter motor. Weight does include alternator and filters.

Perkins power

Including the 1000 Series, Perkins' industrial and agricultural engine range extends up to 2500bhp**, with premium specification power units offering performance and options to suit a wide range of machines without compromise. Using computerised scheduling systems, Perkins offers delivery flexibility and accuracy to match customers' build programmes.

Perkins has a massive distribution network with over 4,000 outlets worldwide. Professional back up and genuine parts are never far from any Perkins powered machine.

VARITY Perkins

Perkins Group of Companies
Peterborough PE1 5NA England
Telephone +44 (0) 1733 583000
Fax +44 (0) 1733 582240

Design by Omega, Peterborough Printed in England © Perkins Group Ltd 1997

[IKG904L]

Water Resources

CONSULTING SERVICES

Mr W Perich
[redacted]

[redacted]

Contact Name: I. Krumins
[redacted]

"Status of Greenways" for Underground water → note info. on back indicates different salt levels etc for humans, animals + plants etc.

G/ways + salt tolerances etc

GROUNDWATER ADVISORY SERVICE
Groundwater Prospects - Summary Report

APPLICANT'S REQUIREMENTS

NAME OF PROPERTY
PROPERTY DESCRIPTION

[redacted]

DATE OF REQUEST

22nd February 1995

PURPOSE

A supply is needed to irrigate 300 acres of various grasses.

SPECIFIC REQUIREMENTS

A supply of 90 to 100 litres per second would be needed to satisfy requirements.

HYDROGEOLOGICAL ANALYSIS

TOPOGRAPHY

The property is situated in undulating country about 90 metres above the sea level.

GEOLOGY

The area is underlain by a shale formation which is between 100 and 120 metres thick at the property. The shale is in turn underlain by an extensive layered sequence of sandstone (Hawkesbury Sandstone).

EXPECTED YIELD In the order of 1 litre per second.

EXPECTED WATER QUALITY

Probable salinity: 10,000-20,000 milligrams per litre (mg/L) total salts if water is from the shale or 3000-5000 (mg/L) if from sandstone.

Department of Water Resources • 10 Valentine Avenue, Parramatta 2150 • P.O. Box 3720, Parramatta NSW

PROSPECTS FOR YOUR REQUIREMENTS

Good[] Reasonable[] Fair[] Poor[] **Drilling not[x] Recommended**

OTHER REMARKS

The sandstone and shale yield only relatively small amounts of water. The supply even under the most favourable conditions would be only a very small fraction of the total requirements. The water in the shale is known to be extremely salty. A bore would have to penetrate through this shale into the sandstone below and the salty water form the shale excluded from the bore by pressure cementing.

The quality in the sandstone is not known in the area. This is because the salty water in the thick layer of shale has discouraged further drilling. However, in similar situations in other areas i.e. central parts of the Sydney Geological Basin the water in the sandstone has also been too saline for most water supply purposes.

In our opinion, the risks (and expense) involved with drilling and pursuing groundwater option are such as to be not worth taking.

D. McKibbin

HYDROGEOLOGIST
27. 3. 95
[redacted]

INFORMATION SUPPLIED

Map[] Bore Data[] Licence Forms[] **Brochures[x]**

RAA Loan Application[] Other[]

PLEASE NOTE: This summary report has been compiled from published geological and topographic information, and bore records from the Department's Groundwater Data Base. The reliability of this analysis is a function of the amount of interpretation, and the bore data largely reported to the Department by landholders or drilling contractors.

Water Resources

GUIDELINES TO WATER QUALITY AND USE

CRITERIA FOR LIVESTOCK DRINKING WATER SUPPLIES

Stock	Desirable max. level for healthy growth (i)		Max. level at which good condition can be expected (ii)		Max. level which may be safe for limited periods (ii)	
	µS/cm	mg/L	µS/cm	mg/L	µS/cm	mg/L
Sheep, dry feed	10 000	6 000	22 000	13 000	23 300	14 000
Beef cattle	6 7000	4 000	8 300	5 000	16 700	10 000
Dairy cattle	5 000	3 000	6 700	4 000	10 000	6 000
Horses	6 700	4 000	10 000	6 000	11 700	7 000
Pigs	3 300	2 000	5 000	3 000	6 700	4 000
Poultry	3 300	2 000	5 000	3 000	6 700	4 000

NOTES: (i) The suggested limits apply when salinity is mainly due to sodium chloride. If purgative salts such as magnesium sulphate or sodium sulphate are presented in appreciable quantities, concentrations given should be reduced.

(ii) Level depends on type of feed.

GENERAL GUIDELINES FOR SALINITY OF IRRIGATION WATER

The suitability of water for irrigation depends on salinity and a variety of different factors, including type of crop, leaching, frequency and method of application, climate, soil type and others. The water has been divided into 5 classes and their suitability for use on various plants is given in the tables below.

Class	Comment	Electrical conductivity (µS/cm)	(mg/L)
1	Low-salinity water can be used with most crops, most soils and with all methods of water application with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.	0-280	0-175
2	Medium-salinity water can be used if moderate leaching occurs. Plants with medium salt tolerance can be grown, usually without special measures for salinity control. Sprinkler irrigation with the more-saline waters in this group may cause leaf scorch on salt-sensitive crops, especially at high temperature in the daytime and with low application rates.	280-800	175-500
3	High-salinity water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required, and the salt tolerance of the plants to be irrigated must be considered.	800-2,300	500-1,500
4	Very high-salinity water is not suitable for irrigation water under ordinary conditions. For use, soils must be permeable, drainage adequate, water must be applied in excess to provide considerable leaching, and salt-tolerant crops should be selected.	2,300-5,500	1,500-3,500
5	Extremely high-salinity water may be used only on permeable, well-drained soils under good management, especially in relation to leaching and for salt-tolerant crops, or for occasional emergency use.	>5,500	>3,500

Source: Hart (1974) A compilation of Australian Water Quality Criteria

RELATIVE TOLERANCE OF CROP PLANTS TO SALINE IRRIGATION WATER

Electrical Conductivity (µS/cm)	Total Salts (mg/L)	Suggested plant			
		Pastures and fodders	Fruit	Vegetables	Ornamentals
Class 1 and 2 0-800	0-500	Ladino clover Red clover Alsike clover White Dutch clover Subterranean clover	Persimmon Loquat Passionfruit Strawberry Avocado Almond Apricot Peach Plum Lemon Grapefruit Orange Grape Walnut	Parsnips Greens beans Celery Radish Cucumber Squash Peas Onion Carrot Potatoes Sweet corn Lettuce French beans	Violet African violet Primula Gardenia Begonia Azalea Camellia Magnolia Fuchsia Dahlia
Class 3 800-2,300	500-1,500	Cocksfoot Perennial ryegrass	Mulberry Apple Pear Raspberry Quince	Cauliflower Bell pepper Cabbage Broccoli Tomato Broad beans Field beans Sweet potato Artichoke	Geranium Gladiolus Bauhinia Zinnia Rose Aster Poinsettia Musa Podocarpus
Class 4 2,300-5,500	1,500- 3,500	Oats (hay) Wheat (hay) Rye (hay) Lucerne Sudan grass *Paspalum dilatatum* Strawberry clover Sweet clovers Millet Wimmera ryegrass Rhodes grass Couch grass Barley Birdsfoot trefoil	Olive Fig Pomegranate Cantaloupe	Spinach Asparagus Kale Garden beets Gherkins	Stock Chrysanthemum Carnation Hibiscus Oleander Bougainvillea Vinca Aust. hop bush Coprosma (green and Variegated) Japanese pepper *Ficus spp.* in gen. *Ficus hillii* False acacia Qld pyramid tree NZ Christmas bush False mahogany Rottnest ti-tree C. *cuppressiformis* Rottnest cyprus *Acacia longifolia* Buffalo grass Kikuyu grass Portulaca Boobyalla Morrel Swamp yate York gum Couch grass Bamboo Kondinin blackbutt
Class 5 >5,500	>3,500	Seashore paspalum *Puccinella ciliata* *Saltwater couch*	Date palm		Canary palm *Paspalum vaginatum* Salt sheoaks Salt river gum Tamarisks (evergreen and deciduous) Saltbushes

Please Note

The plant and water groupings are not meant to be rigid, but merely provide a general guide. Plants are arranged in approximate order to salt tolerance in each column, with the least tolerant at the top. Soil texture and drainage may be extremely important. Plants listed as suitable for saline water will grow better with less - saline water.

Source: Hart (1974)

(µS/cm) x 0.68 = (mg/L) = p.p.m.

CRITERIA FOR HUMAN CONSUMPTION

Substance	Maximum allowable concentration (mg/L)	
	1	2
Total soluble salts	1500	1000-1500
Iron	1	0.3
Manganese	0.1	0.1
Copper	1.5	1
Zinc	15	5
Arsenic	0.05	0.05
Lead	0.05	0.05
Calcium	200	-
Sulphate	400	400
Magnesium	150	-
Chloride	600	400
Magnesium and sodium sulphates	1000	-
Nitrate	45	10 (as N)
Fluoride	1.5	0.5-1.7
Cyanide	0.2	0.1
pH	6.0-9.2	6.5-8.5

1. World Health Organisation International Standard, 1984.
2. National health and Medical Research Council and Australian Water Resources Council, 1987. Guidelines for Drinking Water Quality in Australia (Australian Government Publishing Service: (Canberra).

There is no evidence of deleterious effects occurring in humans consuming water that exceeds 1000 mg/L total soluble salts. The guideline is based on taste considerations; above 1500 mg/L, taste generally renders water unacceptable for human consumption. Most urban consumers would reject drinking water with total salts above approximately 500 mg/L.

Please Note:

The suitability of water for human consumption, is a specific function of the Health Department of N.S.W. Advice on such matters should be sought in the first instance by reference to the local Town, Municipal or Shire Health Officer.

Total Salts or Total Soluble Salts

The soluble mineral and organic matter content of water is known as "total dissolved solids." In groundwater the dissolved solids are almost entirely salts hence "total salts" or "total soluble salts" is used.

The concentration of total soluble salts is expressed as "milligrams per litre" (mg/L) which is identical to "parts per million" (p.p.m.).

Electrical Conductivity

Electrical conductivity is a measure of the ability of water of conduct an electric current between two electrodes. The value obtained relates to the nature and amount of salts present and increases with concentration. It is a quick way of obtaining the approximate salinity of the water without identifying individual constituents.

Electrical conductivity is usually given as "microsiemens per centimetre" (µS/cm.) at 25° Celsius.

Hydrogen Ion Activity (pH)

pH is a measure of acidity or alkalinity expressed on a logarithmic scale between 0 and 14. Between 0 and 7 is acidic and between 7 and 14 is alkaline or basic, 7 is neutral neither acid or alkaline.
Since the scale is logarithmic each pH unit represents an order of magnitude. The extreme range of groundwater composition spans a range of hydrogen ion concentration of over 12 orders of magnitude. Groundwater mostly falls in the range 5 to 8. Most plants grow adequately between 5 and 8. The acceptable range for domestic and stock use is 6.5 to 8.5.

Sodium Hazard

When sodium is in excess of calcium and magnesium (taken together), a hazard may exist to healthy crop growth due to excessive uptake of sodium by the plant or the restriction of uptake of calcium and magnesium.

Irrigation water, even when relatively low in total soluble salts, may be detrimental to the maintenance of good soil structure, due to a poor balance between sodium and calcium and magnesium. It may be necessary to make amends by applying soil dressing of the deficient elements.

Hardness

The principal hardness-causing substances in water are calcium and or magnesium salts. Hard water reacts with soap to form a greasy scum and soap will not lather until all the calcium and magnesium has been used up. Hence more soap is needed. Calcium salts can also form an encrustation of calcium carbonate which eventually blocks irrigation equipment and hot water systems. Deposits on heating elements will cause the elements to overheat and burn out.

It is desirable that domestic water supplies contain less than 100 mg/L hardness. Defined limits for specific farm uses are:

Hardness (mg/L)	*Purpose*
150	Dairy equipment and hot water systems.
200	General domestic use - washing, cooking, personal hygiene.
300	Dips and chemical sprays.
over 300	Septic tanks and hosing down

The most effective way to treat hard water for domestic use is to install an ion exchange resin softener. When the water is passed through the softener, the calcium and magnesium are replaced by sodium from the exchange resin.

This results in an increase in sodium salts in the supply, which is undesirable but may be preferable in some cases.

The reaction is reversible and the "exhausted" exchange resin can be regenerated by flushing with a solution of sodium chloride (common salt).

Iron In Groundwater

Iron in a water supply is highly undesirable as it affects the taste and causes plugging and staining problems. Unfortunately groundwater quite often contains dissolved (ferrous) iron. When this iron comes in contact with oxygen it oxidises and forms insoluble (ferric) iron which precipitates out of the water. This precipitated iron encrusts well screens, clogs pipes and stains clothes and plumbing fixtures. The presence of iron bacteria can make the problem worse as they produce a slime which can also plug aquifers, pumps, well screens and distribution systems.

Some of the problems, but not all, can be eliminated quite simply and inexpensively by aerating the water. Several methods can be employed such as spraying, cascading or agitating to maximise the air-water contact. The oxidised iron can be removed by settling. Commercial in-line filters are also available.