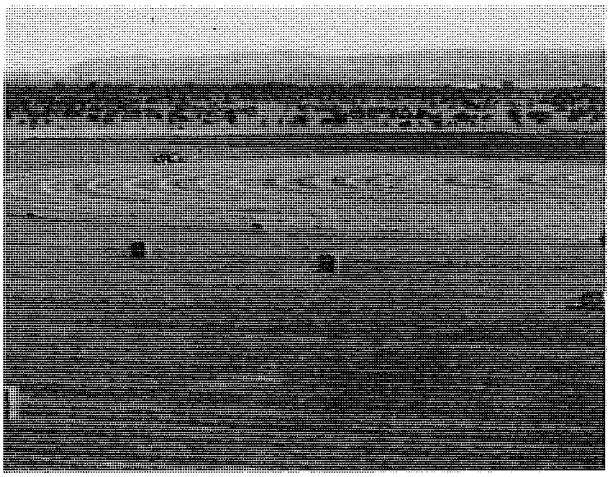
Liveringa STATION BEEF



Cropping on Pivot 1 and [redacted]

Irrigation, Crop Production and Water Management

Annual Report of 2018 Activities

Submitted February 2019

CONTENTS

PROGRESS REPORT IRRIGATION, CROP PRODUCTION AND WATER MANAGEMENT

As from 2007 to 2017 this report addresses the requirements established by Liveringa Station Beef's (LSB) licence to take water. This report is submitted by Liveringa Station Beef (LSB) and Hancock Prospecting PL, to meet the conditions established by the Water Licence and recorded in the 2015 Operating Strategy. The Licence has been extended to 2025, with a new ten-year licence period under Instrument Number SWL156377 (3), and its associated conditions.

This is the fourth report to be submitted under the ownership of Liveringa Station Beef by Hancock Prospecting PL.

SAMPLING AND REPORTING SCHEDULE

Samples and measurements are taken regularly under the conditions outlined in the Operating Strategy and the main report is submitted annually with exception reports expected if any unforeseen circumstances are observed.

Sampling continued regularly during the 2018 season with the key personnel for Cropping and Operations, including water and crop sampling and recording, being Mr Jacob O'Dell, for the annual vegetation recording Dr Doug McGhie, and for the fish health surveys, Dr David Morgan of Murdoch University. The ongoing vegetation and fish surveys were completed late in the 2018 dry season. A third fish survey was completed while the floodway gates were closed. This consolidated report has been prepared by Dr McGhie.

Laboratory analyses of frozen water samples were completed at the end of the year, with the samples being kept frozen until then. Results are reported for the months from April to October 2018.

2018 CROPPING

Decisions on the annual cropping schedule are based on the availability of water before and during the season, so recording and reporting of water quantity and quality is critical to all involved in managing the system and environment. The 2017/18 Wet Season was well above average, with solid flooding across the Camballin Floodplain influencing the floodway gate closure. The benefit of the operational floodway has been seen in the 2018 dry season with an extended irrigation season possible. There was a focus on [redacted] production with the [redacted] Pivot 3 continuing with [redacted] sown in 2018 for [redacted] and Pivot 2 sown to [redacted] for [redacted] and [redacted] Pivot 1, on the freehold area, continued with the [redacted] for [redacted] However, some of the area had been undersown with [redacted] in 2017 and in 2018 the pivot area was undersown with [redacted]

In the 2018 season, irrigation continued until late October on all pivots.

DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION OVERSIGHT OF ACTIVITIES

Department of Water and Environmental Regulation representatives visited Liveringa late in the 2018 dry season, for a familiarisation day at the station with the Station Manager and [redacted] They visited sites of interest, with particular interest in the floodway that was operating for its third season, with the gates just on opening at the time of the visit.

REPORT OUTCOMES

This annual report, along with the associated vegetation survey and fish health reports, continues to demonstrate that the natural environment within which the cropping activity is located remains stable and of a high quality. Occasional peaks of nutrient levels have been identified in past reports but nothing major was observed in 2018.There have been no biological indications (algal blooms, fish kills) of declining water quality resulting from irrigation or cropping activities.

Durack Pool is a significant pool and provides the only water storage for the Liveringa Station cropping program. While water quantity (availability) must always diminish across the dry season the benefit of the floodway was obvious again in 2018 with irrigation possible until late October on all pivots. The water quality generally remained high all of the time, illustrated once again in 2018 by salinity measurements that always maintain drinking water quality[1]. The highest laboratory measurement of 400 µS/cm (230 mg/L) was still well below the drinking water standard of below 500 mg/L.

No major spikes in nutrient (N and P) content of the Durack Pool water were observed during 2018.

Dr Morgan's comments confirm the importance and the health of the Uralla Creek system to the local fish population. His 2018 survey was completed experiencing elevated water levels. He has previously observed that sampling at lower levels demonstrates the challenge of this condition for some species of fish. The 2018 dry season was the third consecutive year in which fish must be sampled above and below the floodway while the gates are closed. The 2018 survey was completed in June, closer to two weeks after closure.

His report concluded that "while the flood gates are likely to act as a barrier to migrating fish, the fauna in Uralla Creek appear to be able to withstand or rapidly recover from most perturbations imposed by the natural seasonal drying of the habitat and the exacerbated drying caused by water extraction at the current level."

He remarks on the value of an additional food web study that could further examine the fishes of Uralla Creek and how the structural and functional integrity of the fauna is maintained during the annual drying and flooding, with the additional pressures of water extraction. Tagging studies could examine the impediment to migratory routes around or through the floodway gates.

While beyond the scope of the licence requirements and anything but a specialist research team, these present an interesting challenge.

The greater depth of Durack Pool at the upstream pump station and the potential for abstraction of water to a greater depth at that site was the subject of a proposal to modify the cease to take level that was considered by the Department of Water, for the 2017 Dry Season. They concluded that during the three-year period of special monitoring for the floodway gates there should be no change. Liveringa remains hopeful that access to this additional water for Pivot 1 may be granted after the three-year review has been completed.

This report has been prepared for Liveringa Station Beef by Dr Doug McGhie using data provided by [redacted], at Liveringa Station, by SGS Analytical Services and collected by the author.

Dr Doug McGhie
Managing Director
Science Matters Pty Ltd
15 February 2019

[1] Department of Health, Govt. of South Australia. (2008) Australian Drinking Water Guidelines (ADWG): "based on taste, TDS in drinking water should not exceed 500 mg/L" although "water with a TDS content of up to 1000 mg/L is acceptable to many", water will become increasingly undrinkable in the 1000-2000 mg/L range.

CROP PRODUCTION

Three pivots were sown to [redacted] in the 2018 dry season, the fifth time this has been possible since the original licence was granted. Pivot 3 was a carryover from the 2016 [redacted] to [redacted]

Pivot 1 had been sown in 2017 to a mix of [redacted] and the [redacted]. In May 2018 this was supplemented with an under sowing of [redacted] The distribution of the species is shown in the following table. Irrigation of Pivot 1 began in April 2018 and continued until the end of October. The pivot was harvested for [redacted] in its quarters or halves, from April to November 2018 with production of [redacted] tonnes of [redacted] as shown in the table below.

Crop inputs and the seasonal production from Pivot 1 are detailed in the following tables. After seeding and apart from fertiliser this crop was grown with minimal chemical inputs.

Date:	Crop Type	Variety	Area Sown (ha)	Comments
2017	[redacted]	[redacted]	[redacted]	[redacted]
2017				
30/05/2018	[redacted]	[redacted]		

Fertiliser was applied to Pivot 1 as shown in the following table.

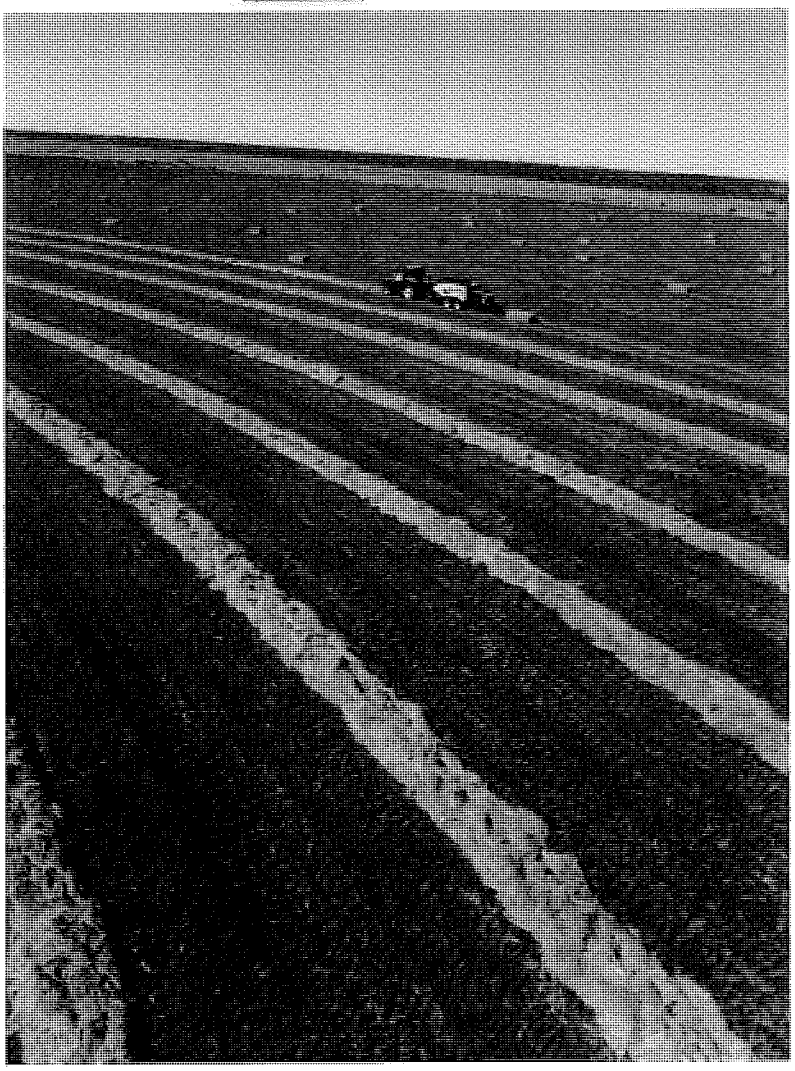
Date	Total Ha	Macropro		Flexi N (L)		Soluzinc		K-Till Xtra		Foliarel (Boron)	
		Kg/ha	Total (T)	L/ha	Total (L)	Kg/ha	Total (T)	Kg/ha	Total (T)	Kg/ha	Total (T)
24/04/2018	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4/05/2018											
4/05/2018											
16/05/2018											
17/05/2018											
24/05/2018											
22/06/2018											
27/06/2018											
1/07/2018											
2/07/2018											
4/07/2018											
4/08/2018											
8/08/2018											
25/08/2018											
27/08/2018											
27/08/2018											
12/10/2018											
Totals:											

The area was harvested several times for [redacted] between April and November 2018.

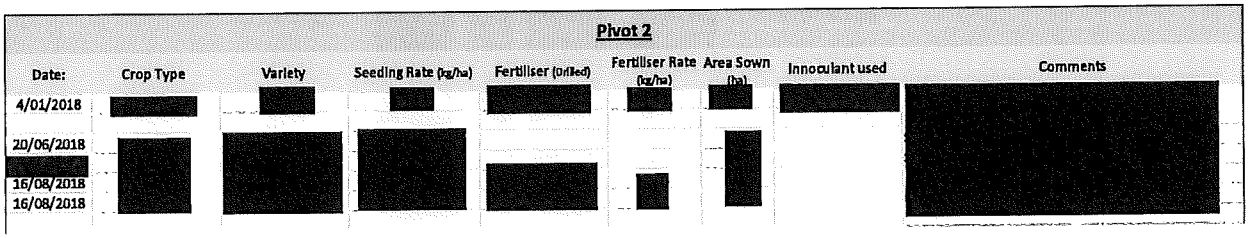
Date	Hay			
	Bales	Avg Weight (kg)	%DM	Tonnes (DM)
22/04/2018				
30/04/2018				
9/05/2018				
3/07/2018				
27/07/2018				
14/09/2018				
25/09/2018				
5/11/2018				
20/11/2018				
Total:				

In total [redacted] tonnes of [redacted] were taken from Pivot 1 over the dry season of 2018.

[redacted] **Pivot 1, July 2018**

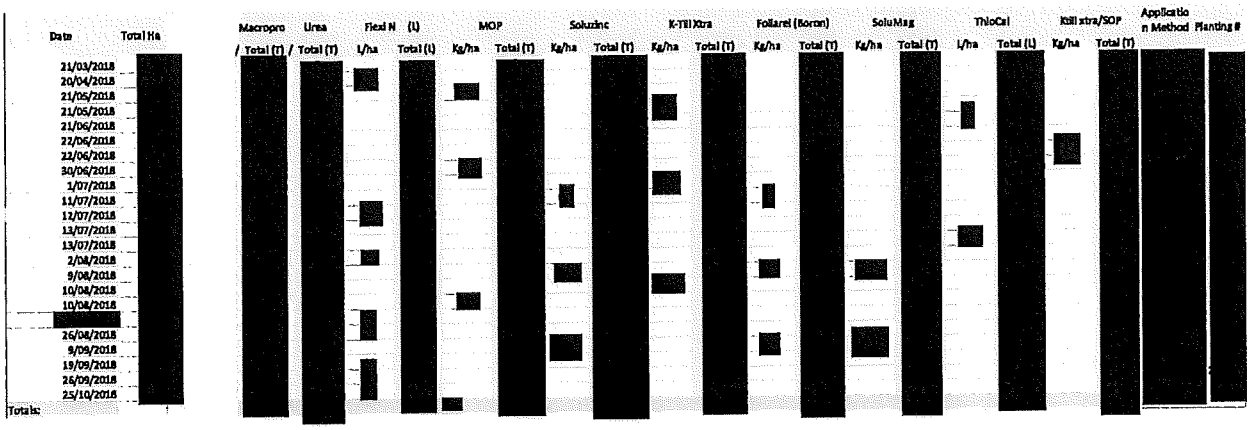


Pivot 2 remains a more complicated area, with the lower half subject to more inundation or wetness to later in the dry season than the top. Consequently, it was sown in stages as the land became cultivable. Seeding was spread from early January to mid-August in 2018.

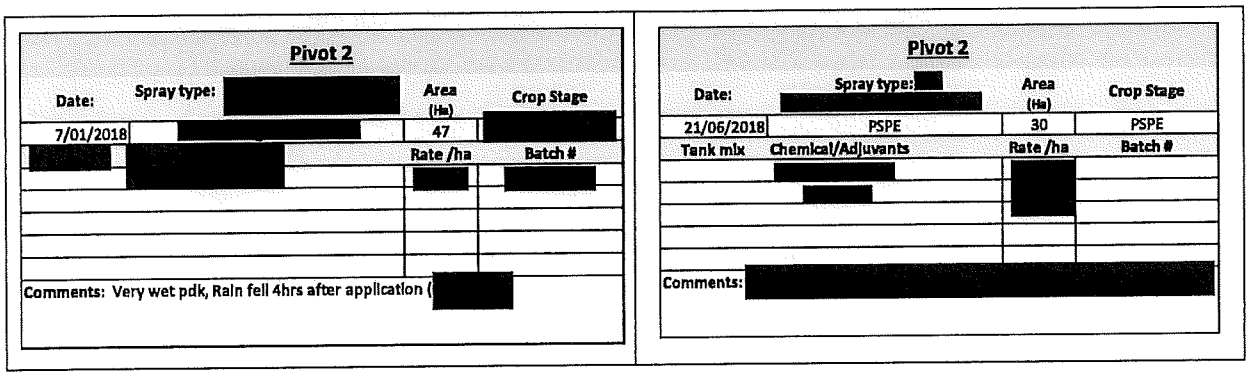


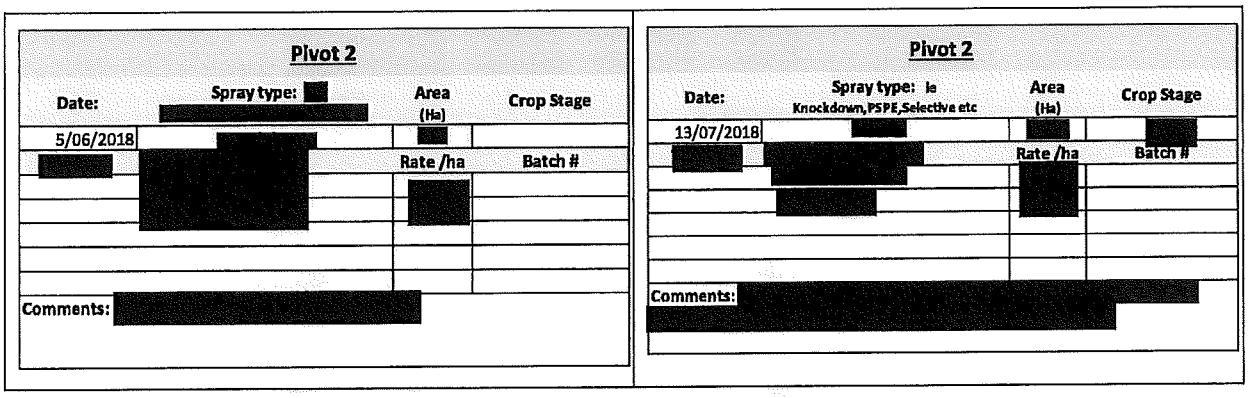
The wide spread of planting times, from January to August again highlights the impact of a heavier wet season on delaying planting on the lower reaches of Pivot 2. The crop was harvested for [redacted] in September, October and December, reflecting the staggered planting for a total production of [redacted] In late December a further harvest yielded [redacted]. The final total production of [redacted]

The complicated planting regime is reflected in the application of fertiliser to the various parts of the pivot as they were ready.



Weed and pest control were similarly complicated with the applications recorded in the following tables.





Pivot 2

Date:	Spray type:	Area (Ha)	Crop Stage
5/06/2018			
		Rate /ha	Batch #
Comments:			

Pivot 2

Date:	Spray type: ie Knockdown, PSPE, Selective etc	Area (Ha)	Crop Stage
13/07/2018			
		Rate /ha	Batch #
Comments:			

Pivot 2 was harvested for in May tonnes) and in October tonnes) and November (tonnes) 2018, for a total production of tonnes of

Pivot 3 was sown to at the beginning of the 2016 dry season to establish a source of and to Pivot 3 as it had mainly been cropped annually to for nearly years by then.

Given the solid base of the well-established it was carried over and regularly throughout the 2017 season and again into 2018. The schedule is shown in the table below.

		Fertiliser Product									
Date	Total Ha	Macropro	Urea		Flexi N (L)		MOP		K-Till Xtra		Ktill xtra/SOP	
		Kg/ha	Kg/ha	Total (T)	L/ha	Total (L)	Kg/ha	Total (T)	Kg/ha	Total (T)	Kg/ha	Total (T)
6/04/2018												
7/04/2018							190					
7/04/2018												
14/04/2018												
16/04/2018												
16/04/2018												
30/04/2018												
1/05/2018												
7/05/2018												
12/05/2018												
17/05/2018												
17/05/2018												
18/05/2018												
28/05/2018												
29/05/2018												
1/06/2018												
19/06/2018												
13/07/2018												
21/07/2018												
21/07/2018												
30/07/2018												
4/08/2018												
10/08/2018												
27/08/2018												
10/09/2018												
19/09/2018												
9/10/2018												
12/10/2018												
Totals:												

No weed or pest control was required.

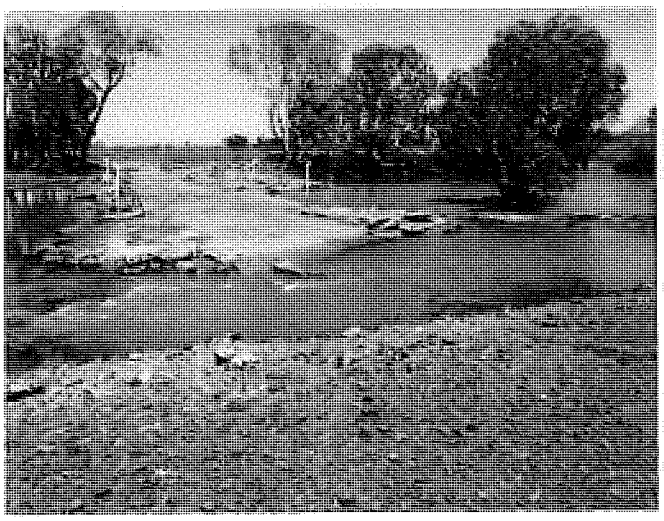
The pivot was cut on several occasions to yield . The harvesting progress is recorded in the following table.

Date	[redacted]	[redacted]	[redacted]	[redacted]
5/04/2018	[redacted]	[redacted]	[redacted]	[redacted]
13/04/2018				
15/05/2018				
27/05/2018				
18/07/2018				
8/08/2018				
19/09/2018				
8/10/2018				
2/11/2018				
Total:				

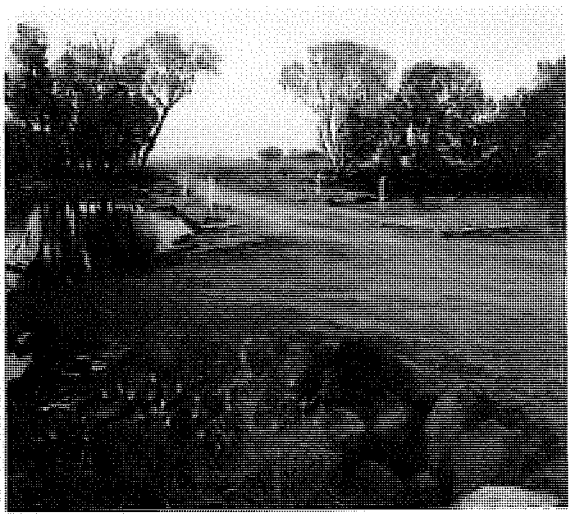
WATER USE

A heavy wet season in 2017/18 resulted in some useful storage of water behind the levy banks/elevated station roads on the flat area near Blina Creek, but not as significant as in 2017. The storage behind the closed floodway was the main source of water for crop production. The floodway was damaged in the 2017/18 wet season and was repaired in March 2018, as s illustrated in the following pictures.

Floodway Damage



Floodway - Repaired



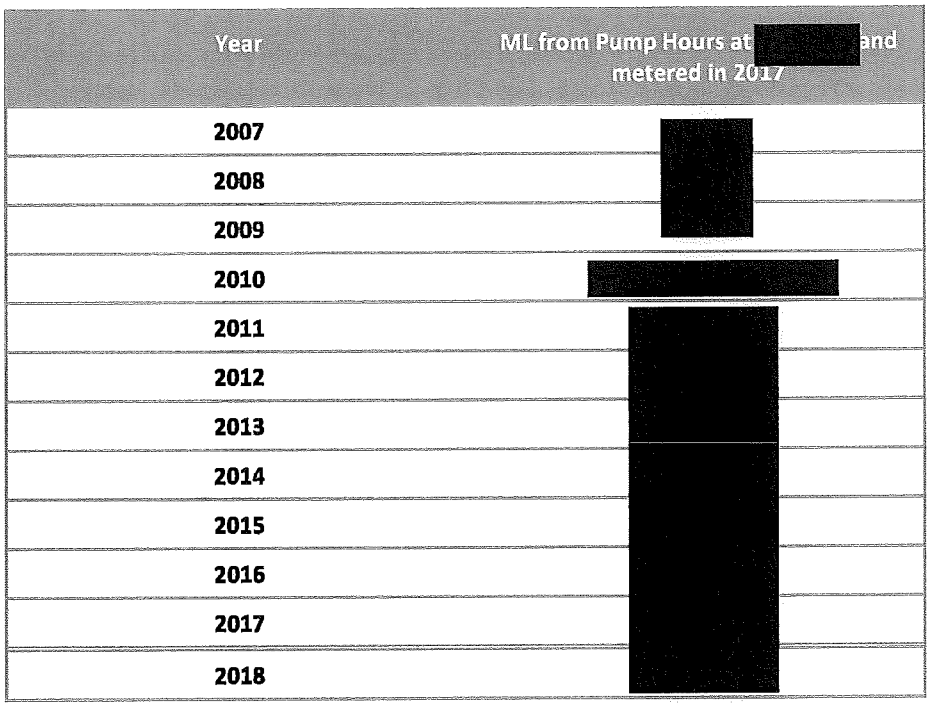
Uralla Creek fell to the cease to flow level (38.6 M AHD) in mid-September 2018 and the level declined slowly over the rest of the dry season. The floodway gates were removed on October 1, 2018.

Pump records show irrigation was applied through three pumps across the season from April to the end of October 2018when irrigation was concluded.

The meter on Pivot 1 was inoperable early in the season and was replaced by mid-May.

Water use on each of the pivots across the whole irrigation season is shown in the following table. Because of the lack of the meter on Pivot 1 for the first month the total is estimated to have exceeded [redacted] for the season, the second time this total has been achieved.

Annual Totals					
Pivot #	Current Meter Reading	Water usage (KL)	Water usage (ML)	Water usage (GL)	Meter reading at start 2018
1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2					
3					
Total:		[redacted]	[redacted]	[redacted]	



Heavier river flows in the 2017/18 wet season delayed the closure of the gates again, with the gates closed at SL 10.66 at the Barrage, well below the operating strategy level of SL 10.8. Seasonal irrigation was effective with three pivots planted and irrigated while water was relatively abundant early in the dry season and given the late flows and higher levels at the floodway, irrigation continued on all pivots towards the end of the dry season.

As explained each year, water use will always be affected by the time of planting, as influenced by rain, river flows, soil conditions and staff availability. Later plantings will always lead to lower water use as water availability is decreasing as the demand increases with the age and stage of the crop. With its low position in the topography and late season wetness, the lower half of Pivot 2 suffers particularly from this. Water that is available for irrigation late in the season is extremely valuable!

ENVIRONMENTAL REPORTING REQUIREMENTS

Table 5 in the previous operating strategy provided a summary of scheduled environmental reporting commitments for the project and we have recorded a summary of the activities against these requirements in the following table.

Activity Summary 2018

Value	Location	Measurement	Action Summary
Water Quantity	• Fitzroy Barrage	• Depth over barrage sill	• Diversion at Barrage now ceases at stage 10.30 m, with the installation of the elevated sill in 2008. Sill repaired during 2010, still in good condition
	• Uralla Creek Floodway	• Depth of water above and below floodway • Pump motor hours converted to water volume abstracted	• Gauge boards replaced late 2012, DoW gauge boards installed during 2013 as the new standard from 2014 onwards; • Floodway now installed; • Gauge boards still to be installed below floodway, but current measurements done accurately using tape over the floodway wall; • Water use recorded by meters and reported (ML and GL); • Total volume submitted in February 2018.
	• Liveringa Pool	• Liveringa pool water level to be recorded weekly during the dry season.	• Monthly records no longer recorded as the pool maintains a depth above cease to take limit throughout the season
Water Quality	• Uralla Creek Floodway	• Parameters listed in operating strategy, measured using on site meter or samples sent to Perth	• Samples taken during dry season of 2018 – results reported herein.
Riparian Vegetation	• Uralla Creek at 2 sites above and 1 site below floodway/channel offtake.	• Use pastoral monitoring techniques to record vegetation health, including a photographic record.	• Three sites were monitored in mid-September 2018; • Few changes recorded; • Sites generally maintaining their health.
Fish Communities	• Uralla Creek, above and below floodway	• Annual monitoring in conjunction with Murdoch University using local TO and Looma assistance.	• Sampling completed in 2018 by Dr Morgan; • Report provided by Dr Morgan; • Sampling in Durack Pool demonstrates health of the Uralla Creek system;
	• Liveringa Pool	• Simplified annual monitoring in conjunction with Murdoch University using local TO and Looma assistance.	• Sampling completed in 2018 by Dr Morgan; • Report provided by Dr Morgan; • Sampling in Liveringa Pool demonstrates health of the Uralla Creek system;
Local Culture	• On site meetings developing from signed MOU towards a coexistence Agreement.	• Particular criteria have been established in the MOU, including considerations of TO heritage and cultural protection, environment and land access.	• No on-site meeting with the local TOs in 2018, however, Station Manager and Cropping Manager are in regular contact with local TOs; • Meetings are planned for 2019 as part of the three-year review

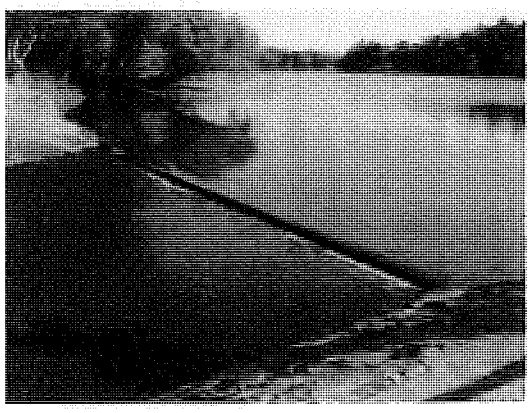
WATER QUANTITY

There are several locations at which commitments have been made by LSB to manage water flows or quantity.

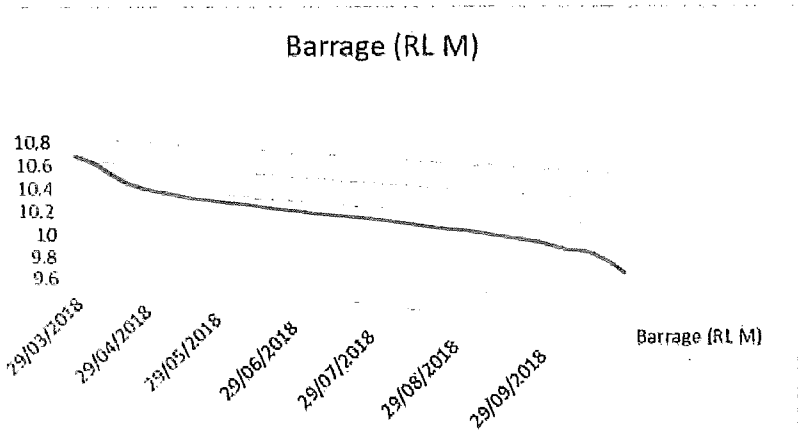
FITZROY BARRAGE

The permanent concrete sill continues to operate at the Fitzroy Barrage and was repaired during 2010. The concreted batters on the Durack Creek flume at the barrage were repaired during 2011 and the structure was in good shape at the end of the 2018 dry season. Further repairs will be made as required

Elevated Concrete Sill at Barrage – 2011 repair – September 2017



The level at the barrage, as monitored continuously by the Department of Water and Environment, is used to determine the closure for the floodway gates. As shbown in the figure below the level dropped throughout the 2018 dry season.



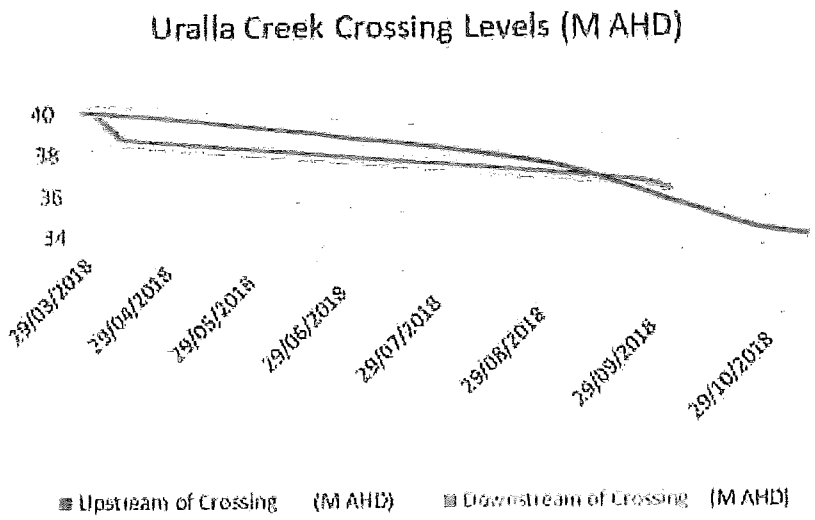
DURACK POOL

The DoW&E gauging board at the channel offtake was used for the measurements in Durack Pool for the 2018 irrigation season. The accepted cease to flow level is 38.6M AHD and the cease to pump level is 37.0M AHD.

Three pivots (1, 2 and 3) were irrigated in the 2018 dry season with the extraction of water from the pool [redacted] the [redacted] amount in the licence period, and the second with water meters on the pivots. Once again [redacted] was irrigated. Water use is higher than in many early seasons, demonstrating the value of the closed floodway. The gates to the floodway remained closed until October 1st, 2018, adopting the environmental flow trigger of maintaining the downstream pool within 0.5M of the cease to flow level of 38.6M AHD. Whenever the level in the downstream pool dropped to or near 38.1M AHD the environmental flow gates was used to maintain the water level at or above that level and this was correctly done until the October opening date.

The following graph shows the fall in water levels in Durack Pool through the 2018 dry season. The floodway gates were closed on March 29th, 2018 when the water level at the barrage was RL 10.66M, and the height at the floodway as 39.86M AHD. With the gates closed and Uralla Creek continuing to flow the pool rose to a peak of 39.9M AHD on April 17th 2017, never overtopping the floodway at 40.1M AHD, so storage was not maximised at any time in the dry season. Subsequently the pool dropped to its "full" or cease to flow level around 38.6 M AHD in September 2018, and continued to fall towards 37.0 M AHD through October and November, reaching the cease to take level in early November when irrigation was halted.

Water Levels Durack Pool 2018 (M AHD)



Water levels were also recorded at the Barrage, using the Department of Water and Environment's River Monitoring site (http://kumina.water.wa.gov.au/waterinformation/wir/reports/publish/802003/tel.htm) to ensure the gates on the floodway could be closed in accordance with the operating strategy (RL 10.8M). In fact, the gates were closed when the level was lower than that allowed (RL 10.64M). The good wet season and late flows over the barrage allowed the floodway gates to be managed as closed for longer than anticipated. However, the floodway never overtopped (>40.1M AHD) and storage never reached its full capacity.

LIVERINGA POOL

Liveringa Pool depths were not recorded but occasional observations confirmed that it maintained a level near the tree line. The pool was observed to be well filled in late September 2017.

WATER LEVEL MANAGEMENT

The operating strategy requires that the 300mm bypass pipe will be used to keep the downstream pool within 50cm of the cease to flow level (38.6M AHD), i.e. at above 38.1M AHD. The 300mm bypass pipe has excess capacity to replace any water lost through seepage and evapotranspiration. It has a gated valve to allow control of flows to the downstream pool to maintain the required level.

As shown in the above water level figure, in 2018 the downstream level did not drop to 38.1 until the gates were removed in early October. The environmental flow gate was used to manage the downstream level so it did not fall too low.

WATER QUALITY

LSB takes on-site measurements of temperature, pH and salinity (electrical conductivity) with its portable meter. Samples are taken near the sites established in 2007 on the northern bank of the pool above and below the channel offtake. The 2018 readings below are the second with the new meter. Bottled samples are taken monthly and frozen for a later and wider ranging laboratory analysis.

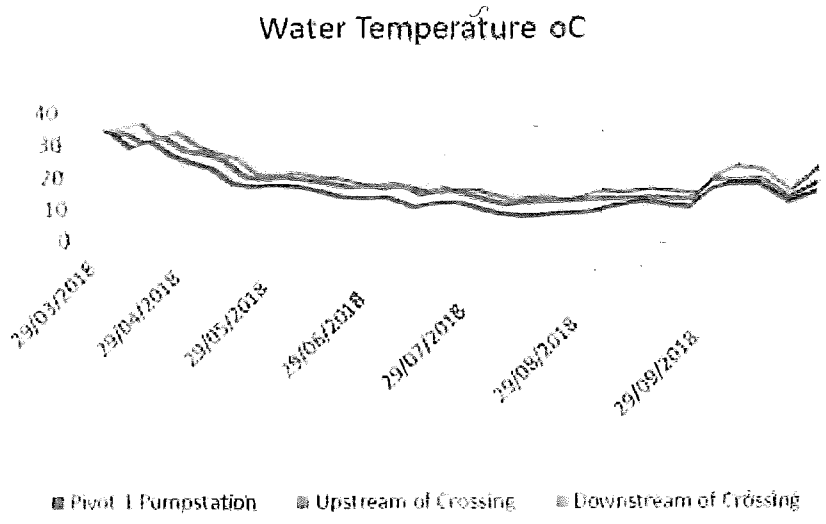
Under the operating strategy, the required laboratory analyses are pH, EC, Total P and Total N. However, some field measurements for dissolved oxygen were also completed and are reported here.

A small one monthly spike was observed for each of the N and P frozen analyses, followed by the usual return to standard levels the month after, except for December, the final sample for the year. Temperature, pH and conductivity measurements are similar to previous years, with similar seasonal variations.

TEMPERATURE

Field measurements of temperature show the expected mid-year lows with temperatures rising again through September and to December 2017.

Temperature (°C) Durack Pool 2018



DISSOLVED OXYGEN

Dissolved oxygen no longer has to be measured but there are standards established over many previous years. Dr Morgan usually measures dissolved oxygen in the field at the time of fish sampling. These readings are reported below.

Site	Year	Dissolved Oxygen (%)	Dissolved oxygen (ppm)
Durack Pool	2008	90.8	6.61
	2009	67.9	4.93
	2010	53.0	3.73
	2012	80.9	5.93
	2013	65.1	4.62
	2014	78.1	6.11
	2015	52.6	3.70
	2016	43.5	3.5
	2017	67.7	5.11
	2018 (June)	90.4	7.5

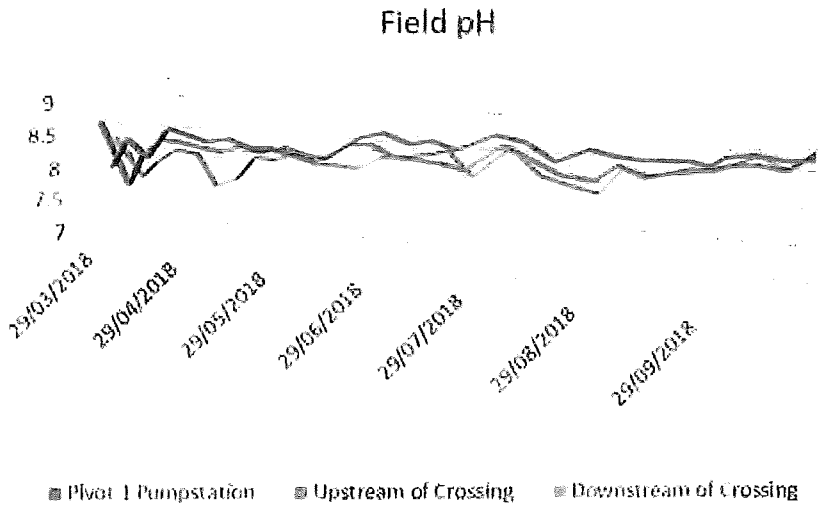
The June reading was amongst the highest ever.

Site	Year	Dissolved Oxygen (%)	Dissolved oxygen (ppm)
Liveringa Pool	2008	85.9	6.38
	2009	65.5	4.61
	2010	54.6	3.92
	2012	90.1	6.70
	2013	27.3	2.05
	2014	70.5	5.48
	2015	64.3	4.60
	2016	31.3	1.2
	2017	69.3	5.44
	2018		

PH

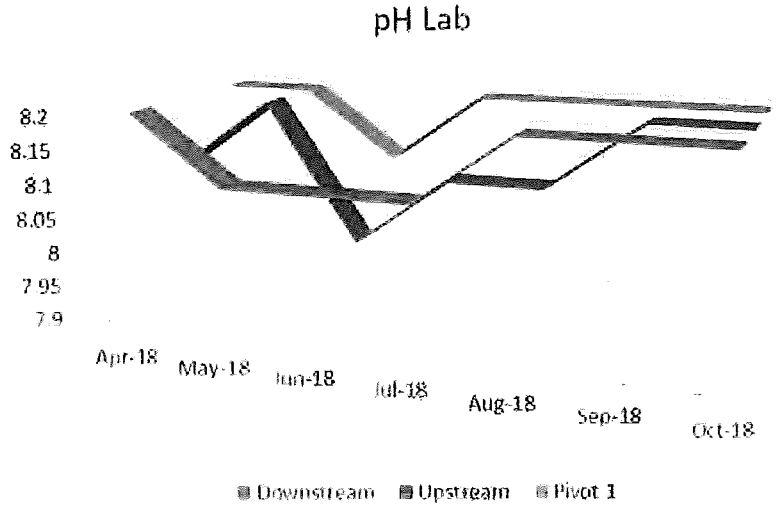
Field measurements of pH showed similar variations to previous years, but were consistently within the range of pH 7 and 8.7, again with marginally higher field readings at the upstream pump station throughout 2017. The new portable field meter gave field readings that are much closer to those measured in the laboratory on the samples collected and frozen before transport to Perth.

Field pH Durack Pool (2018)



Laboratory analysis found that pH in Durack Pool varied from around pH 8.0 to pH 8.2 at all sites throughout the dry season, with no apparent seasonal influence. Readings at the freehold pump station were no higher than those recorded downstream. These readings are slightly lower than those from previous years.

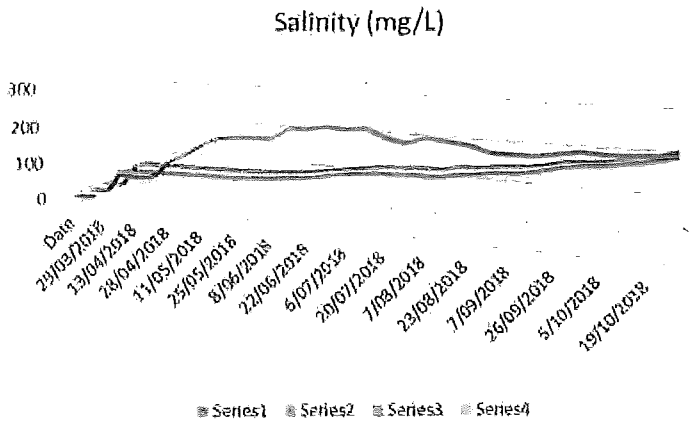
Laboratory Samples pH 2018, all sites



ELECTRICAL CONDUCTIVITY/SALINITY

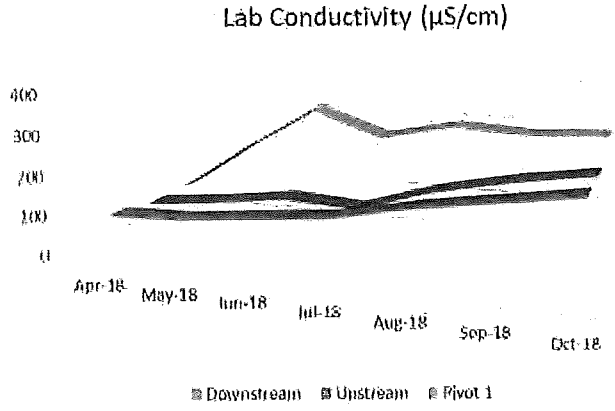
The electrical conductivity (salinity) in Durack Pool, as measured in the field, increased with evaporation (concentration) as the dry season progressed, from less than100 mg/L (ppm), in March, to just over 230mg/L at the Pivot 1 site in late October 2018, confirming very fresh water. Sampling concluded in October 2018, the last month of irrigation. All of the readings from field and laboratory analysis were of drinking water quality, based on Water Corporation standards[2] and there was no evidence of deteriorating water quality, a similar result to that observed from 2006 to 2017.

Field Salinity, Durack Pool (2018)



The laboratory measurements (in µS/cm) are similar to the field measurements (ppm), allowing for the conversion between units (see below), all within drinking water quality ranges. Once again water appears fresher at the downstream site (Pivot 3).

2018 Stored Sample Conductivity (µS/cm)



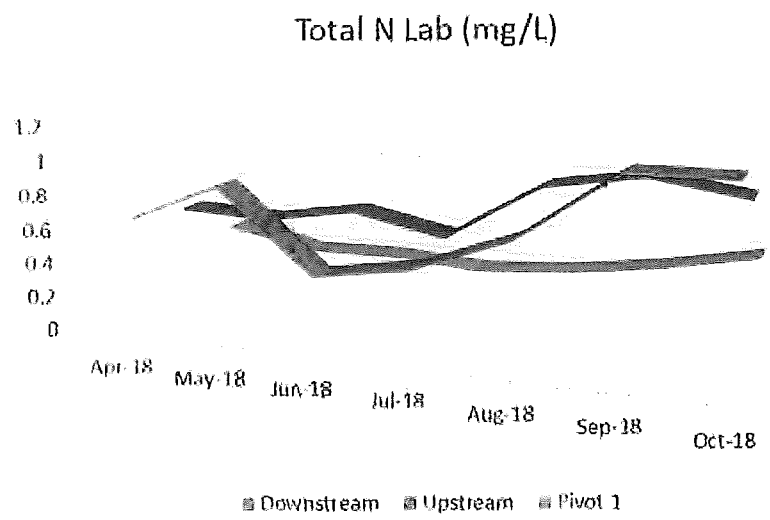
(Note units X mg/L = 0.64*X µS/cm)

[2] https://www.watercorporation.com.au/-/media/files/residential/about-us/our-performance/drinking-water-quality/annual-report-2013.pdf

NITROGEN

Total nitrogen (mg/L) in 2018 was lower than found in recent seasons and tended to increase until September for all sampling points with no spikes at any site. This suggests careful management of all fertiliser applications.

Total Nitrogen 2018

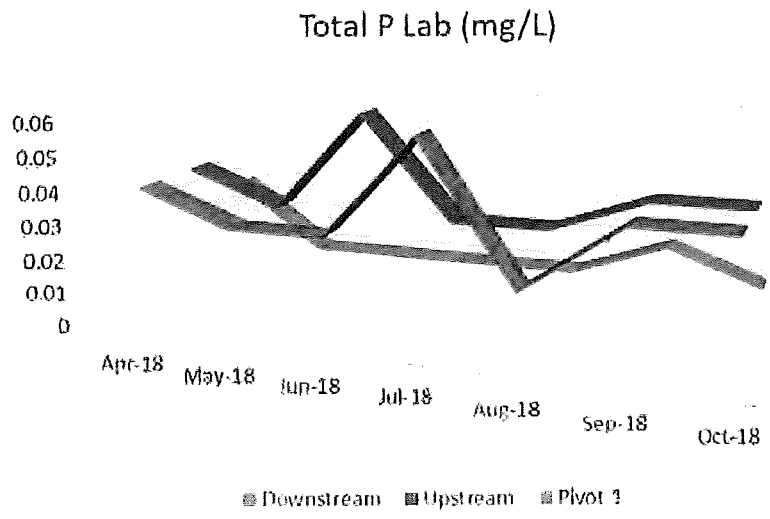


PHOSPHORUS

Filterable reactive Phosphorus (FRP) was measured up until 2015 but is no longer required.

Total phosphorus (mg/L) in 2016 varied between 0.09 and 0.20 mg/L, more like the readings from most prior years and well below the record levels from 2015.

Total Phosphorus 2018 (mg/L)



These readings are lower by an order of magnitude than those in previous years. The small spikes in the June and July readings are well below common levels from past years. No spills were observed in 2018.

Comparisons of the 2018 results with the submitted triggers are shown in the following table. Invariably some of the upper readings are higher than triggers but generally the results from 2018 are lower than previous readings. The health of the water body and the safety of the irrigation practices have been confirmed each year by the response of the riparian vegetation and the health of fish in the water. Fish appear to respond more to low water levels and there have been some fish deaths observed at other sites on the Fitzroy following major inflows of water leading to a depletion of oxygen at the site (most recently Geikie Gorge).

2018 returned another complete set of frozen samples for laboratory analysis and there were no odd peaks confirming careful sampling and no chemical spills. .

Water Quality Triggers

Physical and Chemical Indicator	Default Trigger	Laboratory Actuals 2017	Field Actuals 2017
Total Phosphorus (µg P L^{-1})	10	–10 - 60	
Total Nitrogen (µg N L^{-1})	200 – 300	–180 - 1100	
Salinity (EC) (µS/cm or mg/L)		–75 - 290 (µS/cm)	**60.2 – 231.5 mg/L**
Temperature			**18.8 to 34.4°C**
Dissolved Oxygen (% Saturation) (lower limit)	85	not measured (see fish report)	
pH (Lower Limit)	**6.0 – 8.0**	**8.0 to 8.2**	**7.765 – 8.784**

These figures continue to contribute to the development of standards for Durack Pool.

Highlights from the above table include the freshness of the water, and the lower levels of N and P in the water.

RIPARIAN VEGETATION

All three sites were monitored in late September 2018 using the 2007 manual as the basis.

A copy of the vegetation report is included as a separate item.

FISH COMMUNITIES

Dr David Morgan from Murdoch University was able to complete the full fish monitoring program in both Durack and Liveringa Pools in 2018, including the third of three years of monitoring above and below the closed floodway. In a previous report Morgan noted that the fish communities vary with the water levels across the years. Drier years, with lower water levels in Durack Pool, have supported lower numbers of some species and are different from wetter years, with higher water levels.

In 2018 he sampled when there were unusually high levels and this resulted in a good capture in Durack Pool using the established sampling methods.

Morgan has noted that it appears that the drawdown of water from Uralla Creek at its current level is sustainable, but it is likely to play a role in the faunal composition of Durack Pool when water levels become very low, such as during 2016, thereby increasing predation from piscivores and also reptiles. Water levels in Durack Pool decrease each year as a consequence of irrigation, seepage and evaporation. He has also suggested that predation is a factor below the floodway when the gates are closed.

This year (2018) provides the first indication of changes that may be experienced in Durack Pool with the operation of the floodway, and monitoring of its impact on fish populations is recognised to be most important.

Morgan speculated in 2016 that the high numbers of predatory fish and reptiles in the system are suggestive of a large biomass of prey. This was certainly true for the late dry of 2016 when the density of fish captured via seines was considerably higher than at all other times of the study. Water levels during 2016were at the lowest they had been at

any other point in the study, both as a consequence of an extremely dry wet season of 2015/2016, but also due to water extraction and as a consequence of evaporation. In October 2017 he observed particularly low numbers of predators, especially fresh water crocodiles. By 2018 numbers had largely recovered but he observed differences in recruitment of some species above and below the floodway. Between 2017 and 20198 the fish fauna of Liveringa Pool varied as did Durack Pool. Crocodile activity, unsurprisingly, appears to be strongly related to the number of prey fish present.

Morgan noted that while the flood gates are likely to act as a barrier to migrating fish, the fauna in these pools appear to be able to withstand or rapidly recover from most perturbations imposed by the natural seasonal drying of the habitat and the exacerbated drying caused by water extraction. The impacts to migratory fishes and their pathways are currently unknown, but like fish communities elsewhere that become trapped below barriers, increased mortality by predation is likely to occur.

LOCAL CULTURE

LSB remains committed to the support and maintenance of local culture and various beneficial forms of collaboration, as demonstrated by their support of the December 2005 MOU.

There was no on-site meeting in 2017 but Station and Cropping Managers met occasionally with representatives of the Nyikina Mangala traditional owner group. While it is not a condition of the licence the Department of Water and Environmental Regulation encourages regular interaction between LSB and the Traditional Owners and has suggested to the KLC that the TOs request copies of LSB's reports.

REPORTING

We now have another full season's irrigation activity with three pivots operating for much of the dry season. The fourth did not operate in season 2018 because it was not installed and there is unlikely to be sufficient water for the irrigation of a fourth pivot. Once again there have been several meetings and regular communication between LSB and DoW&E staff over the last 12 months.

This report reflects the additional requirements that result from the installation and operation of the new floodway.

POTENTIAL TO VARY ESTABLISHED CEASE TO PUMP STANDARDS

The survey of Durack Pool was commissioned and submitted to the Department of Water and Environmental Regulation in 2016. Permission to take water to greater depth was not approved during the three-year period of trial for the floodway. Liveringa is keen to see that option reconsidered after the trial period is completed and the impact of the gates is fully appraised.

QUERIES

Should there be any queries on this report please contact Dr Doug McGhie using established contact details.