Corackerup Creek and Chingarrup Brook

Pool monitoring

Report prepared for Green Skills Inc, Denmark WA.

by Steve & Geraldine Janicke

October 2016

This survey reported here forms part of Green Skills wetland conservation program, with funding from the State Natural Resource Management Program, made possible by the State Government's Royalties for Regions program. Green Skills has also received support through the South Coast NRM through its Regional Facilitator's grant program and the National Landcare program.

Prepared by:

Steve and Geraldine Janicke

Waterways Assessment & Environmental Investigations

October 2016

For bibliographical purposes this report should be cited as;

Janicke S. and Janicke, G. (2016). *Corackerup Creek and Chingarrup Brook – Pool monitoring. October 2016.* Report prepared for Green Skills Inc., Denmark WA.

Cover photo: Steve Janicke measuring water quality of a Corackerup Creek pool (CRK-008.1).

Acknowledgements

The authors would like to acknowledge Basil Schur of Green Skills Inc. and Dr Eddy and Donna Wajon for coordinating the survey and arranging access to the river pools. Thanks also to the Volunteers who assisted with the aquatic survey.

This survey reported here forms part of Green Skills wetland conservation program, with funding from the State Natural Resource Management Program, made possible by the State Government's Royalties for Regions program. Green Skills has also received support through the South Coast NRM through its Regional Facilitator's grant program and the National Landcare program.

CONTENTS

RIVERSCAPE

The Corackerup - Chittowurup Creek catchment (Figure 1) is a sub-catchment of the Pallinup River and its main channel stretches from its confluence with the Pallinup River near Boxwood Hill to the Jerramungup town-site. There are several name changes along the way; Corackerup, Peniup, Hegarty and Chittowurup. The creek system is incised into the vast uneven granite basement that characterises the underlying geological formations of the South Coast. Dolerite dykes intrude into the granite and play a role in channelling groundwater. The meandering floodway form is superimposed upon this foundation with only minor lateral movement of the bends.

The main channel of the creek system is well endowed with large pools and 104 have been identified using aerial imagery. These pools occupy about 40% of the main floodway. The riverbed is typically composed of clay, sand and silt with intermittent granite outcrops, bars and cascades and some longer sections of exposed granite bedrock. Hardy paperbarks, sedges and various shrubs compete with the sporadic flood flows and encroach into the channel trapping sediment, narrowing the dominant channel and dividing high flows into multiple flow paths. These vegetated riffle reaches occupy the other 60% of the trunk. Currently Corackerup Creek has a high level of intact riparian native vegetation and an examination of aerial imagery indicates that landowners have endeavoured to retain some riparian vegetation along the many low order tributaries.

Chingarrup Brook is a tributary of the lower Corackerup and is approximately 22 kilometres long with a highly cleared catchment. It is at risk of further floodway degradation due to the loss of riparian vegetation. An examination of aerial images indicated that numerous actual and potential sources of sediment are present upstream of the Boxwood Hill-Ongerup Road. These appear to have been created by the loss or reduction of vegetation cover in the riparian zone and fringes. The main channel has 38 large pools.

Stream flows vary from no flow to low flow for a significant portion of the year and the pools are the dominant aquatic habitat. The floodway is subject to large, unpredictable flood events, particularly summer storm events. These floods fashion the pool-riffle sequence and maintained their natural structure. However, floods exploit any loss of native riparian vegetation causing bed and bank erosion, creating secondary scours across bends and mobilizing large quantities of coarse sand and silt. Where the natural riparian vegetation has been removed, annual weeds proliferate. These areas in the floodway are extremely erosion prone resulting in bank scours during large flood events as the flow meanders and is deflected where there is an easier route around the well anchored mid-channel vegetation (Figure 10). The sediment moves through the system as extensive sediment slugs and these pose a significant threat to the condition of the river pool-riffle ecosystem.

Threats to water quality are linked to catchment clearing and subsequent land use and potential impacts include, infilling of river pools, Nitrogen and Phosphorus nutrient enrichment from farm runoff, increased salinity of the naturally saline waters and acidification. Green algae is commonly observed throughout the Pallinup River system and it is suspected that the levels of algae exceed what would likely have been found in the original un-cleared catchment.

Figure 1: The Corackerup sub-catchment of the Pallinup River

Steve & Geraldine Janicke

Pools assessed

Four pools (Figure 2) were examined on the 26th and 27th of September 2016, one pool on the Chingarrup Brook and three on Corackerup Creek. The aquatic macro-invertebrate communities were examined and basic water quality measurements were taken. Depth soundings were taken on Chingarrup and one of the Corackerup pools, in order to give a broader context to the sampling environment. The findings are discussed below.

Figure 2: Pool locations and code numbers. The road shown is the Boxwood Hill - Ongerup Road

Note: See Appendix 5 for an explanation of the pool coding system.

Table 1: Location of sampling sites (UTM, Zone 50)

Pool	Pool code	Easting	Northing
Chingarrup	CHI-011	658839	6202356
Corackerup lower	CRK-007	656712	6202888
Corackerup middle (two habitats)	CRK-008	656244 656286	6204119 6204119
Corackerup Nowanup	CRK-026	661110	6211930

Water quality data

Table 2: Surface water readings

Pool	Pool code	Date	AD 32 meter EC (mS/cm)	Salinometer (ppt)	Temp °C	pH	Turbidity (NTU)
Chingarrup	CHI-011	27/9/16	Off scale (> 20 mS/cm)	20	12.4	8.2	50
Corackerup	CRK-007	26/9/16	7.8		15.5	8.1	10 -12
Corackerup	CRK-008	26/9/16	15.4		16.1	8.2	<10
Corackerup	CRK-026	27/9/16	17.1		15.3	8.1	<10

Rough estimates of flow rates were made at the creek crossings on Boxwood-Ongerup Road by observing the culvert discharge.

Corackerup Creek at Boxwood Hill-Ongerup Road crossing

- Date/ Time: 27.09.2016/ 1700
- EC 15.8 mS/cm
- Estimated flow rate 50 - 100 Litres/s

Chingarrup Brook at Boxwood Hill-Ongerup Road crossing

- Date/ Time: 27.09.2016/ 1715
- Estimated flow rate 10 - 20 Litres/s

The moderate salinity (EC) values were consistent with the general characteristics of the waters of South Coast rivers and the recent cool, wet conditions. The pH values were also typical of these saline systems. By way of comparison, seawater has an EC of approximately 52 mS/cm representing a salt concentration of 35 ppt.

Note: See Appendix 5 for an explanation of the pool coding system

Pool depths

Two pools were plumbed using a lead line to obtain a basic longitudinal bed profile. The flows at the time of the assessment were sufficient to describe the pools as 'full'. No benchmarks were established to refer depths to, but Figure 3 and Figure 4 provide some context for what was meant by 'full'.

Corackerup pool CRK-007

- Approximate length of pool when full: 600 metres
- Maximum width: 40 metres
- Deepest point plumbed: 4.2 metres

Figure 3 Pool CRK-007

Figure 4: Pool CRK-007 showing distinctive trees and rock outcrops acting as water level bench marks.

Figure 5: Corackerup pool CRK-007 bathymetry points

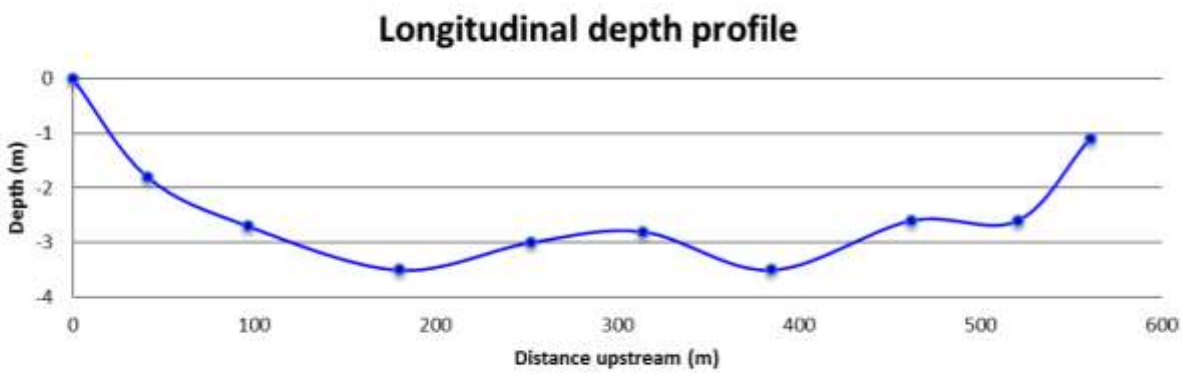

Figure 6: Shows the pool bed profile for CRK-007 (vertical scale exaggerated).

Evidence of a halocline in pool CRK-007

A water sample was taken, using a hand pump, from a depth of 2.5 metres towards the upstream end of the pool and a lead line indicated that the depth to bed was approximately 2.6 metres. The EC was off limit on the AD 32 probe and the Salinometer showed a salinity of approximately 20 ppt. The surface reading was 7.8 mS/cm (about 5 ppt). This low value likely reflected recent fresher storm flows that would overlay the more saline waters. The pH at depth was 7.5 compared with the surface value of 8.1. These results indicated that the pool was stratified at that time. The windy conditions made sampling difficult and no further depth samples were taken. The existence of a halocline suggested that the waters at depth were not well mixed despite the strong windy conditions. The surface waters were strongly tannin coloured and the turbidity was low

(10 - 12 NTU), although not as low as the next pool upstream (CRK-008) and also the pool at Nowanup (CRK-026).

The depth profile indicated the presence of low sediment plumes, but overall the pool did not appear to be compromised by excessive sediment input at this stage.

Given the high quality of the riparian zone for a significant distance upstream, any trends can reasonably be attributed to influences from higher in the catchment.

Overall the pool appeared to be in excellent condition and it is suggested that it would make an ideal and accessible reference site for tracking stream condition over time.

To gain a better understanding of the system, two more pools could be monitored, one further downstream below the Chingarrup confluence, representing the entire Corackerup catchment and one further upstream (e.g. at Maringarup Rd representing the upper catchment of the Peniup, Hegarty and Chittowurup creek.

Chingarrup reference pool CHI-011

There are 12 river pools along the reaches between the Boxwood-Hill Road and the confluence with Corackerup Creek. The pool sampled is the second one downstream of the road at the Chingarrup sanctuary.

Figure 7: Pool CHI-011 showing the view upstream from the lower end at the time of sampling.

- Approximate length when full: 180 m
- Maximum width: 20 m
- Deepest point plumbed: 1.1 m

The brownish colour was due to the bed being partly visible through the shallow waters and partly due to turbid conditions. The turbidity value was 50 NTU suggesting that suspended sediment, as well as tannins, contributed to the colouring. No bottom sample was taken at Chingarrup pool CHI-011 as the depth was rarely more than 0.7 metres and the waters were well mixed due to wind action and a steady in-flow from at the time of the assessment.

Figure 8: Pool CHI-011 showing the depth sounding points along the pool

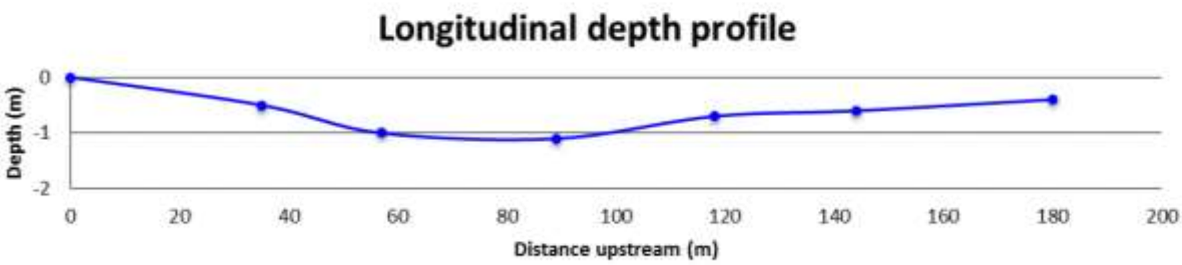

Figure 9: Pool CRK-011 Bed profile schematic showing the shallow depths.

Riverscape Discussion

Extensive re-vegetation work on the north side of Chingarrup pool CHI-011 has been undertaken over recent years. The remnant natural riparian vegetation on both sides of the pool has helped to maintain the natural bank form. However, the typical form of the pool, its shallow depth profile and exposed sediment plumes at the downstream end suggest that it has been filled with sediment. The likely source of this material is the degraded catchment upstream rather than the adjacent banks or soil from upslope on the former farmland.

Steve & Geraldine Janicke

A large scour (Figure 10 looking upstream) along the left hand bank below the pool indicates that flood flows have been directed to that side. Local loss of vegetation along the top of the bank may have weakened this section and this illustrates the important stabilizing effect of the fringing vegetation. Deposition of sediment in the center of the channel is likely to have contributed to deflecting flows. An active head-cut (waterfall) adjacent to the scour (Figure 11) is also an indication that a number of flood flows have concentrated along the left bank over past years. A granite bar (Figure 12) across the channel further downstream places some limit on upstream bed deepening, but it is uncertain how further bed erosion might alter the pool environment.

Figure 10: An older flood bypass scour along the left bank a short distance below the pool CHI-011.

Figure 11: Looking upstream and showing how the head-cut has proceeded in the upstream direction towards the pool CHI-011.

Figure 12: The rocky bar (looking upstream). Note the active bank undercutting opposite the well vegetated bank and indicating that flood flows have been deflected to the opposite side (north bank) of the channel downstream of the scour shown in Figure 10.

The shallowing of waters of the pool will mean that temperatures will be higher over the summer months and evaporation will concentrate salts creating a hyper-saline environment that limits the type of aquatic biota that can exist there. The higher salinity of the water (20 ppt) reflected the salinity of flows from the upper catchment since there was sufficient low flow to replace the pool volume every 1 to 2 days. Anoxic ooze was observed in the shallows adjacent to the pool banks and recognised by the characteristic 'rotten egg' smell of Hydrogen Sulphide), but the central area of the pool bed was firmer and appeared to consist of coarse sand.

Revegetating the toe of the flood scour, with deep rooted plants and sedges, may afford some protection to the bank and reduce local contributions to the sediment load in the creek.

Efforts to return the pool to its original natural depth will depend on whether sediment sources on the farms upstream can be stabilized. If this can be achieved, future large floods can act to re-excavate the pool rather than moving more sand into the system.

It was concluded that infilling with sediment was the main factor impacting pool health.

Corackerup pool (CTK-007) provides a suitable pool against which to rate general stream health since it appears to be in excellent condition despite potential pressures from upstream.

Chingarrup pool (CHI-011) provides a suitable pool to monitor future environmental pressures from the catchment upstream.

Enhancement of weak points of the riparian zone will help to protect the banks from further degradation.

AQUATIC ECOLOGY OF SELECTED POOLS

Method

Four pools (Figure 2) were sampled on the 26th and 27th of September 2016 for macroinvertebrate composition. Aquatic macroinvertebrates were sampled using a 250-µm mesh net to sweep around as many habitats as possible adjacent to a 20 metre section of river foreshore. Samples were placed into buckets with water and live picked back at the shed with the help of some volunteers. All animals were placed into sampling containers with 70% ethanol, and returned to the laboratory for further processing, where all specimens were identified to the lowest taxonomic level possible.

Macroinvertebrates

A total of 29 macroinvertebrate species were collected from the four pools, with several species collected from only one pool (singleton species). The Middle Corackerup Pool CRK-008 which was at the end of the Corackerup Ochre Cliffs proved to have the highest diversity of macroinvertebrates with 19 species collected from various habitats including the only Ruppia meadow sampled (Figure 14). The lower Corackerup Pool CRK-007 had the lowest diversity of macroinvertebrates with 6 species collected from submerged vegetation. See Appendix 2 for the list of species collected.

Figure 13: Volunteers helping Geraldine to live-pick macroinvertebrates.

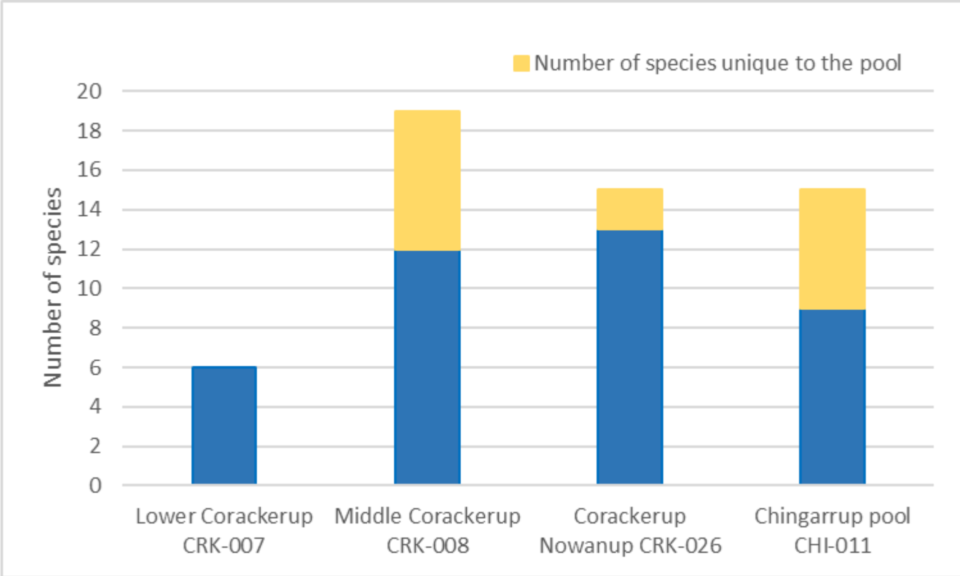

Figure 14: Number of species collected from the four pools sampled on the Corackerup and Chingarrup pools.

The Chingarrup pool had the same species richness as Corackerup pool adjacent to Nowanup however the composition was quite different with several Ostracod species and the saltwater mosquito larvae (*Aedes (Ochtlerotatus) camptorhynchus*) present only in the Chingarrup pool.

The Swan River (Blue spot) Goby (*Pseudogobius olorum*) was present in all four river pools sampled. This species is endemic to southern Australia and can live in a range of conditions from freshwater, brackish to saline rivers and estuaries usually over mud and rock bottoms. They are generally carnivorous, eating crustaceans, like amphipods and ostracods. They are a food source for several water birds including the Hoary-headed Grebe.

The introduced Mosquito Fish (*Gambusia holbrooki*) were found in two pools in the Corackerup and have been in the Corackerup and Pallinup Rivers for many years. They feed on a range of small invertebrates and the eggs, larvae and juveniles of native fishes and frogs. They have been implicated in the decline of at least 9 fish species and more than 10 frog species across Australia. They compete with native fishes for habitat and food, and are very aggressive towards other species. Their impact in the Corackerup would mainly be in macroinvertebrate composition and would provide food for a number of water birds.

Three species of macroinvertebrates were found in all four pools, a Calanoid copepod, a midge larvae *Dicrotendipes conjunctus* and a caddisfly larvae *Symphitoneura wheeleri* (Figure 15Figure 14). The caddisfly larvae is endemic to southern Australia preferring saline waters. Several estuarine species were collected including the mussel, *Fluviolanatus subtorta* and the shrimp *Palaemonetes australis*. Both these species are present throughout Australia.

Discussion

Although saline water was common in our South Coast river systems before land-clearing there is evidence that salinity levels have been steadily rising in some river systems (Janicke, S. (2003), Halse (2003)). Raper *et al* (2014) indicate that between 2007 to 2012 groundwater levels of three bores in the upper Corackerup catchment have still been rising while two other bores have been falling. How these changes are impacting Corackerup Creek is unknown as there has been no consistent monitoring of the creek. Secondary salinisation changes composition and richness of aquatic invertebrate communities, with the gradual replacement of salt sensitive species by a smaller set of salt tolerant and halophilic (salt loving) species as salinity levels increase.

All the species collected from this sampling event were either halotolerant (salt tolerant), halophilic or halobiont (salt dependent) and reflect the loss of diversity of a secondary salinized system. Pinder *et al* (2004) records the average species richness for naturally saline or degraded saline south coast rivers and wetlands as being between 18 and 36 species. The Middle Corackerup Pool CRK-008 with a species richness of 19 fits within this average however the lower pool (CRK-007) is well below this average with 6 species collected. The higher species richness in the Middle Corackerup Pool CRK-008 may be due to the presence of the aquatic Swan grass (or Widgeon grass) *Ruppia megacarpa* which is a sheltered habitat for many macroinvertebrates including the ostracod, *Mytilocypris mytiloides/henricae* (Figure 15). A possible reason for the low species richness at the lower pool (CRK-007) could be the high water levels, the reduced habitat diversity at the sampling site (inundated samphire and Melaleucas) and the high numbers of introduced predatory mosquito fish found in this habitat. Since species presence and density varies across the seasons, a more accurate estimation of the aquatic biodiversity would require further monitoring.

Threats to aquatic ecosystems are secondary salinisation, loss of freshwater cues for hatching, changes in hydrology with increased run-off, simplification of habitats through sedimentation, loss of riparian vegetation, the introduced mosquito fish and increases in algae. Salinisation is a catchment scale issue and protection of these river pools requires protection of all the river and creeks upstream, including the first order small streams. The work of the various conservation groups to make the vision of Gondwana Link happen will all contribute to improvement in health of Corackerup Creek. Chingarrup Brook has significant sediment entering the stream contributing to the degradation of the aquatic habitat. Sedimentation and infill of pools is observable in both Corackerup Creek and Chingarrup Brook. The sources of sediment (as discussed earlier) would be flood erosion of banks and lateral creep of sediment into the channel as well as reworking of sediment within the channel. During significant floods water often bypasses vegetated channels and scours across meander bends dragging sediment into the river system. These scoured areas are visible in 2009 aerial imagery of Chingarrup Brook within 2 kilometres of the Chingarrup Sanctuary.

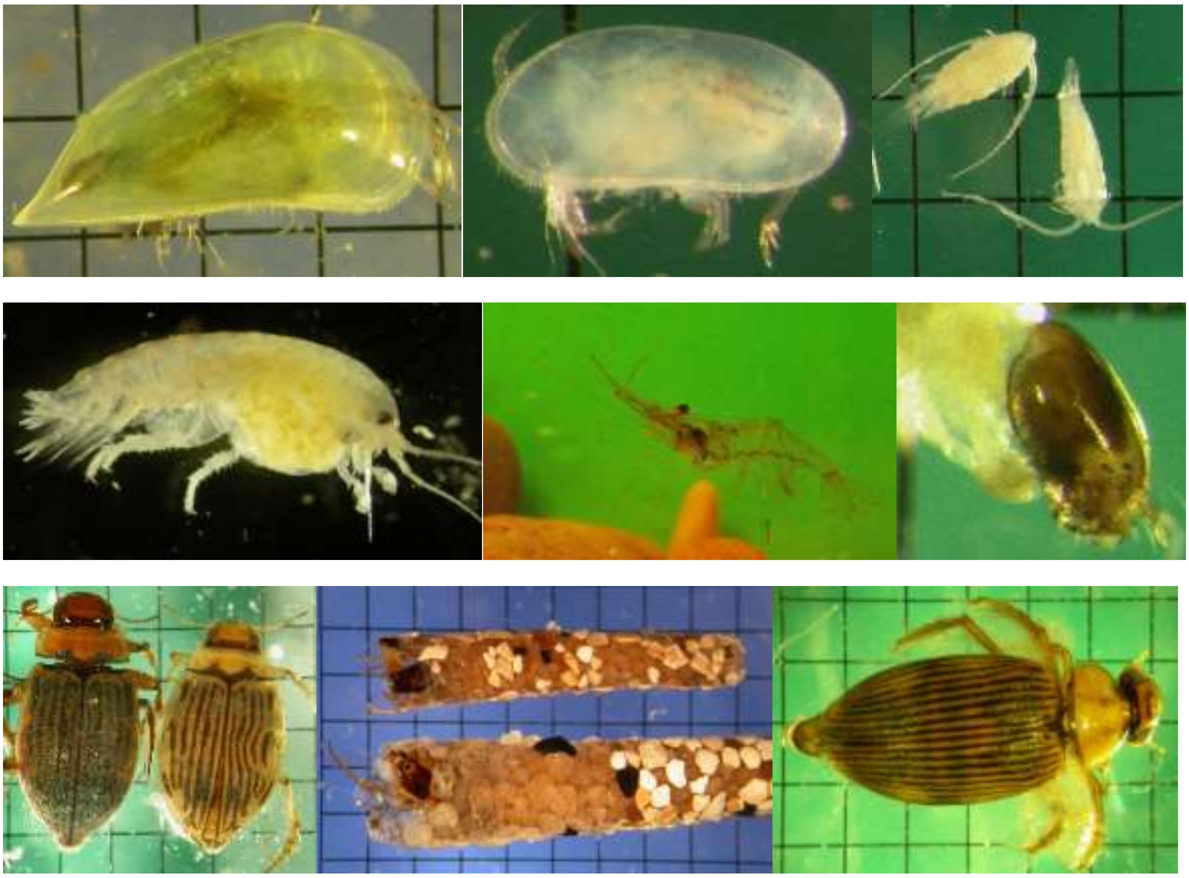

Figure 15: Macroinvertebrates found in the Corackerup and Chingarrup pools. Top row: Ostracods, *Mytilocypris mytiloides/henricae* & *Ilyodromus* sp. and Calanoid copepods. Middle Row; Amphipod *Austrochiltonia subtenuis,* Shrimp *Palaemonetes australis* and the Chironomid *Dicrotendipes conjunctus*. Bottom row; Dytiscid diving beetle *Necterosoma penicilatus*, Caddisfly larvae *Symphitoneuria wheeleri* and Hydrophilid scavenger beetle *Berosus dallasae*.

Cook *et al* (2008) recorded a number of species that could be used as in indicator species of river health including *Symphitoneuria wheeleri*, the mussel, *Fluviolanatus subtorta* and the Common Jollytail Fish *Galaxias maculatus.* Under the present water levels and low levels of salinity, the suite of macroinvertebrate found in this sampling time are what you would expect for a secondarily salinised river system. The intactness of riparian vegetation along the pol CRK-007, the lower salinity levels and the ease of access suggested this pool would make a good reference pool. However, the low number of macroinvertebrates collected from the pool would counter this. More sampling in spring and summer, as the water levels recede would be needed to confirm the status of this pool as a reference pool.

REFERENCES

Kingsford, R. T., and J. L. Porter, 1994. Waterbirds on an adjacent freshwater lake and salt lake in arid Australia. Biological Conservation 69: 219–228.

Gomon, Martin R. & Bray, Dianne J. 2011, Eastern Gambusia, Gambusia holbrooki, in Fishes of Australia, accessed 30 Sep 2016, http://fishesofaustralia.net.au:8084/home/species/3636

Halse, S. A., Ruprech, J. K. and Pinder, A. M., 2003, Salinisation and prospects for biodiversity in rivers and wetlands of south-west Western Australia. Australian Journal of Botany, 51, 673-688.

Janicke, S. (2003). The State of the Lort River, Department of Environment.

Pinder, A. M., Halse, S. A., McRae, J. M. and Shiel. R. J., 2004. Aquatic invertebrate assemblages of wetlands and rivers in the wheatbelt region of Western Australia. Records of the Western Australian Museum Supplement No. 67: 7-37

Raper, GP, Speed, RJ, Simons, JA, Killen, AL, Blake, AI, Ryder, AT, Smith, RH, Stainer, GS and Bourke, L 2014, 'Groundwater trend analysis for south-west Western Australia 2007–12', Resource management technical report 388, Department of Agriculture and Food, Western Australia, Perth.

Timms, B. V., 2007. The biology of the saline lakes of central and eastern inland of Australia: a review with special reference to their biogeographical affinities. Hydrobiologia 576:27–37

APPENDIX 1 - CATCHMENT FACTS

The Corackerup Creek is a tributary of the lower Pallinup River and extends northward for 25 kilometres before it branches north-west from the main channel and extending another 21 kilometres. The main channel changes name several times and continues for 42 kilometres to the Jerramungup town site some 67 kilometres upstream from the Pallinup River;

- Pallinup River confluence to 25 Km - Corackerup Creek (lower)
- 25 to 46.6 Km - Peniup Creek
- 46.6 to 58.2 Km - Hegarty Creek
- 58.2 to 67 Km (Jerramungup) - Chittowurup Creek

Chingarrup Brook is a tributary of the lower Corackerup Creek and trends 22 Kilometres in a north-east direction from 2.8 Kilometres upstream of the Pallinup River.

The catchment area of the Corackerup (including all creeks) is approximately 900 square kilometres. The entire Pallinup catchment area by comparison is approximately 5000 square kilometres.

The Corackerup – Chittowurup Creek main channel is well endowed with river pools and 104 larger discrete pools were identified using aerial imagery. These pools lengths vary up to 1260 metres with an average length of 224 metres. This represents 39% of the main channel length. Pool widths vary considerable up to 60 metres, but are typically 10 - 20 metres wide.

The Chingarrup Brook, despite its short length of 22 kilometres, has 38 identifiable pools with a mean length of 155 metres. These span 27 % of the main trunk length.

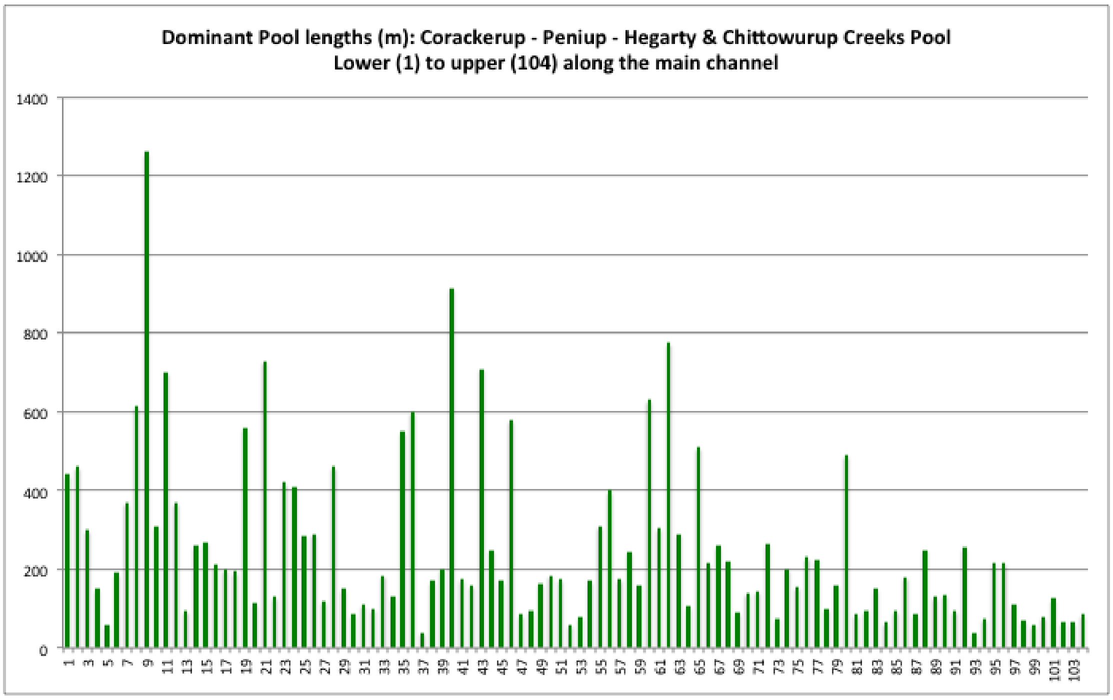

Figure 16: Shows the dominant pool lengths in the upstream direction (L to R) of the main trunk of the Corackerup - Chittowurup Creek system.

It can be seen that the length of the longer pools decreases in the upstream direction as might be expected with decreasing catchment area. The pools are nevertheless reasonably distributed along the Corackerup, Peniup and Hegarty Creeks with only a few in the Chittowurup.

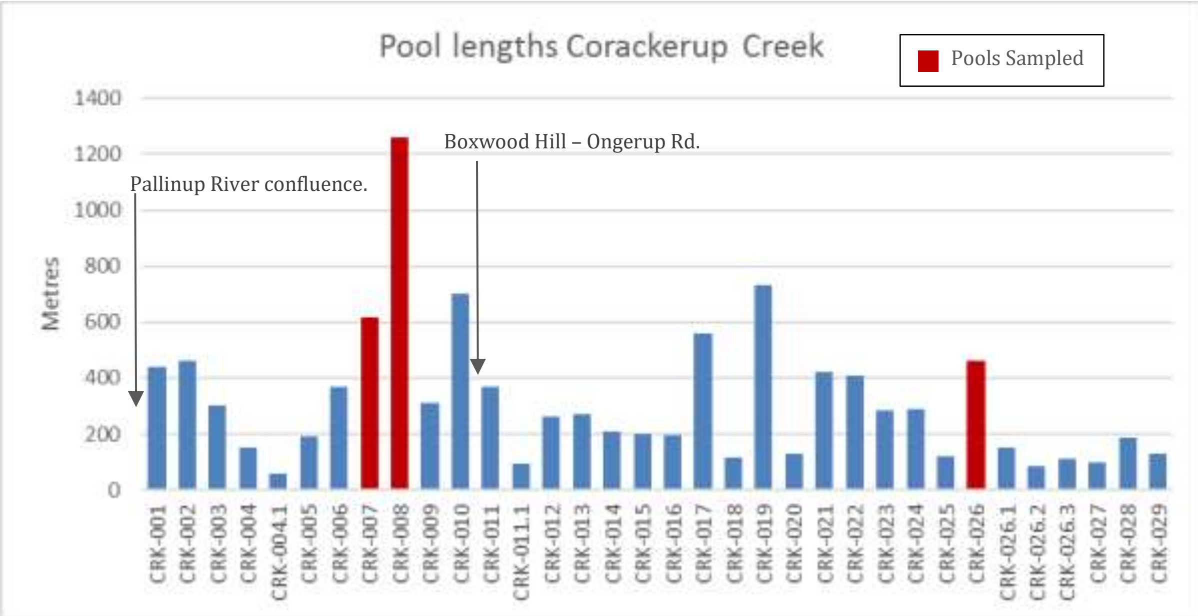

Figure 17: The distribution of pool lengths for Corackerup Creek in the upstream direction to the start of Peniup Creek.

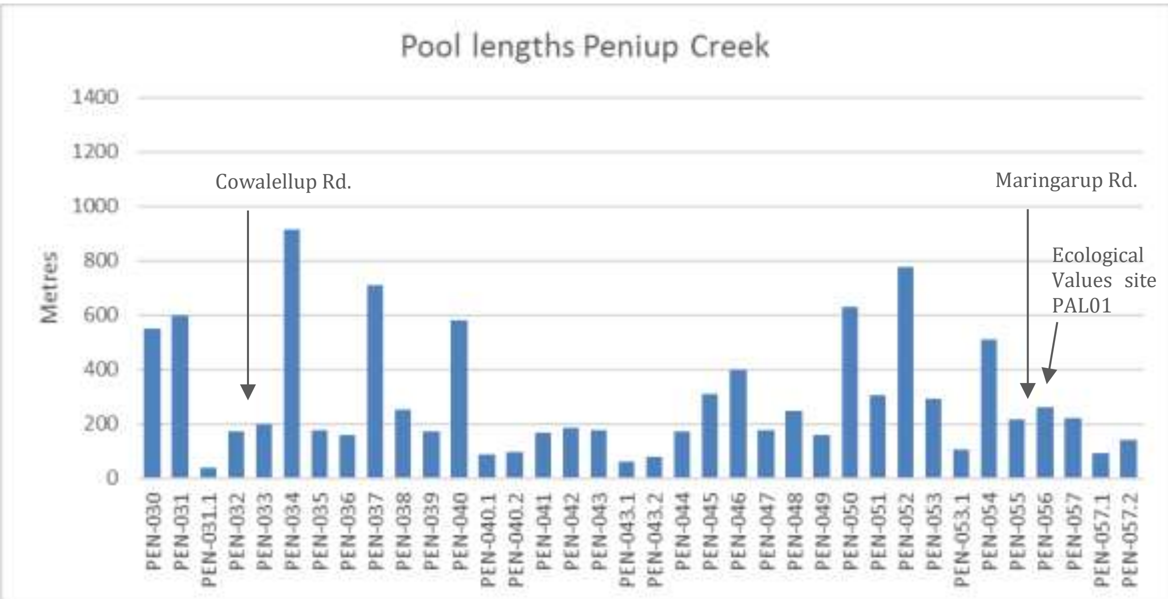

Figure 18: The distribution of pool lengths for Peniup Creek in the upstream direction to the start of Hegarty Creek.

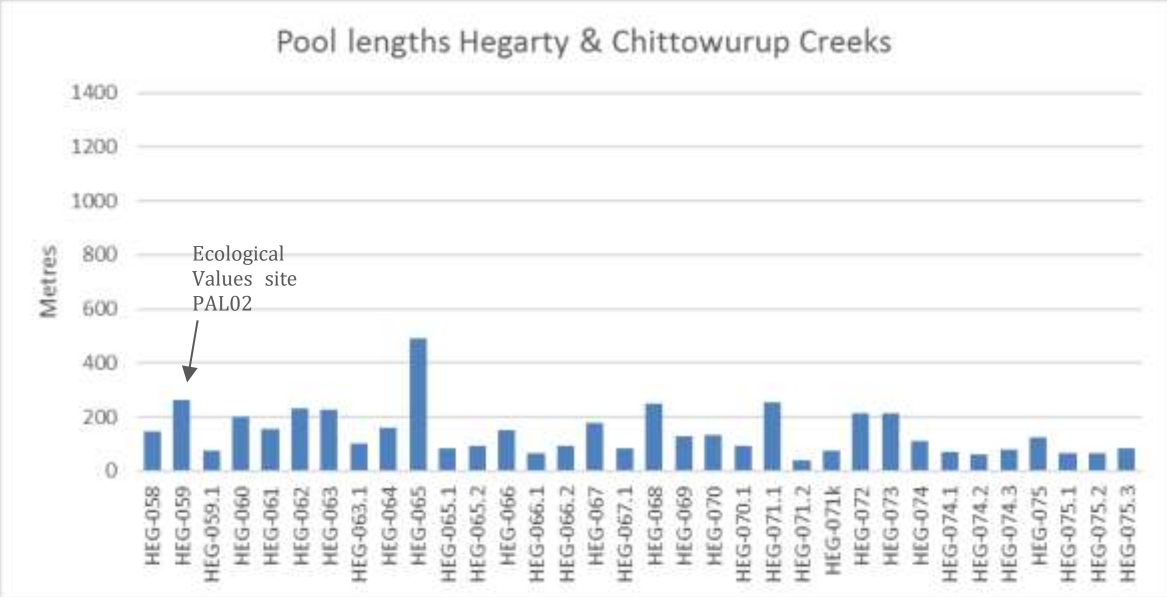

Figure 19: The distribution of pool lengths for Hegarty and Chittowurup Creeks in the upstream direction.

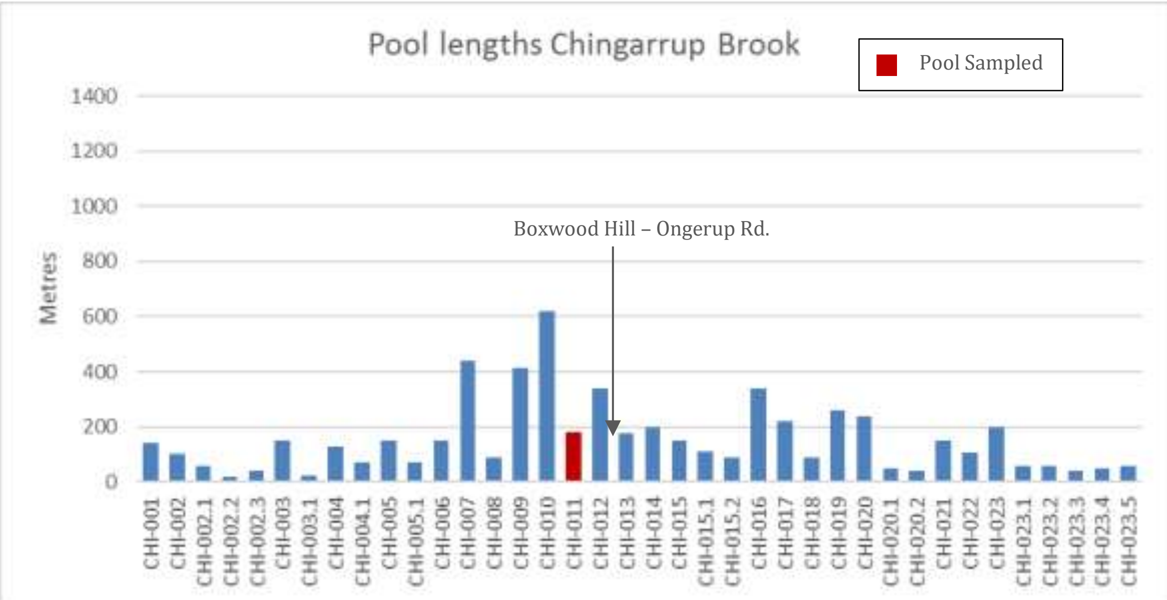

Figure 20: The distribution of pool lengths for Chingarrup Brook in the upstream direction.

APPENDIX 2 – MACROINVERTEBRATES AND FISH

Macroinvertebrate composition in four pools on the Corackerup Creek and Chingarrup Brook, sampled on the 26th and 27th of September 2016.

* = introduced species.	Lower Corackerup CRK-007	Middle Corackerup CRK-008	Corackerup Nowanup CRK-026	Chingarrup pool CHI-011
Fish				
Gobiidae, Pseudogobius olorum	y	y	y	y
Poeciliidae, * Gambusia holbrookii	y	y		
Annelida				
Oligochaeta, Paranais sp.			y	
Arachnida				
Orbatidia, Orbatidid sp.		y		
Trombidiodiea, Trombid sp.				y
, Tetragnatha sp.				y
Crustacea				
Ceinidae, Austrochiltonia subtenuis		y	y	y
Palaemonidae, Palaemonetes australis	y	y	y	
Copepoda/Calanoida, Calanoid sp.	y	y	y	y
Copepoda/Harpacticoid, Harpacticoid sp.		y	y	
Cyprididae, Cypretta sp.				y
Cyprididae, Cypricersus sp.				y
Cyprididae, Ilyodromus sp.			y	
Cyprididae, Mytilocypris mytiloides/henricae		y		
Cyprididae, unknown Cypridid sp.		y		
Insecta				
Dytiscidae, Necterosoma penicilatus			y	y
Hydrophyllidae, Berosus dallasae		y	y	

	* = introduced species.	Lower Corackerup CRK-007	Middle Corackerup CRK-008	Corackerup Nowanup CRK-026	Chingarrup pool CHI-011
	Hydrophyllidae, Berosus sp. Larvae				y
	Hypogastruridae, Hypogastrurid sp.		y		y
	Ceratopogonidae, Undetermined sp.		y		
	Chironominae, Chironomus alternans affin.		y		
	Chironominae, Cladopelma curtivalva		y		
	Chironominae, Dicrotendipes conjunctus	y	y	y	y
	Chironominae, Tanytarsus barbitarsus		y	y	y
	Culicidae, Aedes (Ochtlerotatus) camptorhynchus				y
	Ephydridae, Ephydridae sp.		y	y Early instar	y Pupal case
	Stratiomyidae, Stratiomyid sp.		y		
	Tanypodinae, Procladius paludicola		y	y	y
	Leptoceridae, Symphitoneura wheeleri	y	y	y	y
Mollusca					
	Trapeziidae , Fluviolanatus subtorta	y	y	y	
	Pomatiopsidae, Coxiella sp.	y		y	
Aquatic plants					
	Algae, Filamentous enteromorpha		y	y	
	Ruppiaceae, Ruppia megacarpa		y		

APPENDIX 3 - WATER QUALITY INSTRUMENTATION AND DATA ACCURACY

- Electrical conductivity / temperature ADWA AD32 (0 - 20 mS/cm)
- Optical Salinometer (0 - 250 ppt)
- pH ADWA AD11
- Turbidity Turbidity tube
- Bathymetry Lead line +/- 0.1 m

Table 3: Control checks in the field

Parameter	Date	Standard	Meter reading	Discrepancy
EC	26.09.2016	12.88 mS/cm	12.72 mS/cm	1.25%
pH	26.09.2016	7	7.2	2.8%
pH	26.09.2016	4.01	4.2	4.7%

APPENDIX 4 - CHANNEL LENGTHS BETWEEN RURAL ROAD CROSSINGS

- Jerramungup to Maringarup Rd 21.4 Km
- Maringarup Rd to Cowellelup Rd 16 Km
- Cowellelup Rd to Boxwood Hill-Ongerup Rd 14.7 Km
- Boxwood Hill-Ongerup Rd to Boxwood Hill-Bremer Bay Rd 13 Km
- Boxwood Hill-Bremer Bay Rd to Pallinup River 0.7 Km

APPENDIX 5 - SOUTH COAST RIVER POOLS - A CODING SYSTEM

Aerial photo interpretation of river systems along the South Coast suggests that the significant river pools vary in length up to 2000 metres with an average length of approximately 340 metres. The authors define a significant pool as any pool greater than 100 metres in length. This does not mean that pools under 100 metres long are not important components of the systems, but that they are less easily identified. Pools that are in a reasonably natural condition are bounded at either end by densely vegetated barriers and these act as riffles. The stream narrows at the riffles to a shallow dominant channel (run) that will often be dry over the summer months. Higher flows may be divided into multiple pathways by in-stream vegetation and deposits of coarse sand from previous flood events.

Aerial photography is often taken in Spring when pools have been topped up by winter flows and this enables the pools to be more easily discerned on the images. The upstream and downstream ends of many pools are indistinct as they are partly hidden by vegetation, but the central location of the pool and its approximate extent can be reasonably inferred.

Figure 21: Intermediate pools are labelled using a decimal point.

A pool audit is done as a desktop exercise and pools longer than 100 metres are numbered starting at the lowest in the catchment or sub-catchment. The authors have employed an alpha-numeric code to identify pools, with the first three letters representing the name of the river or creek, followed by 3 digits. The first pool upstream of the river or streams downstream end point is 001. For example, CRK-001 and CRK-004 are the first and fourth pool on the Corackerup Creek, upstream of the Pallinup River confluence. Pools that are under 100 metres in length can be included in the audit by using a decimal point. Thus CRK-004.1 is an intermediate pool between CRK-004 and CRK-005 (Figure 21). This also allows smaller pools to be added to the coding system without changing the basic numerical sequence.

APPENDIX 6 – NOWANUP POOL – CRK-026

Steve & Geraldine Janicke