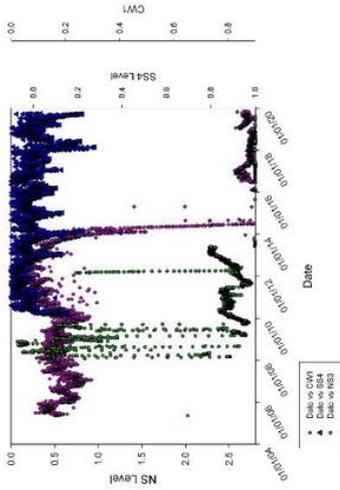


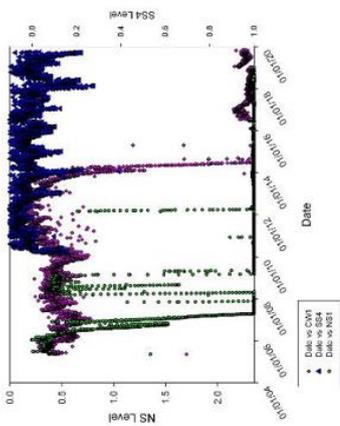
Appendix 1.

Swamp Assessment Figures

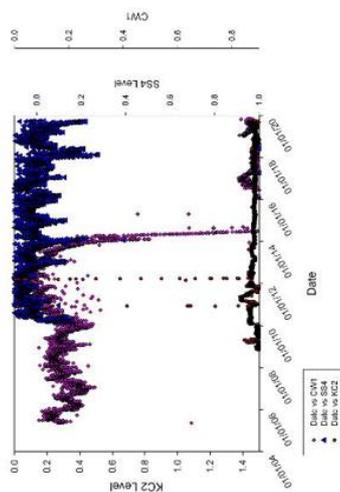
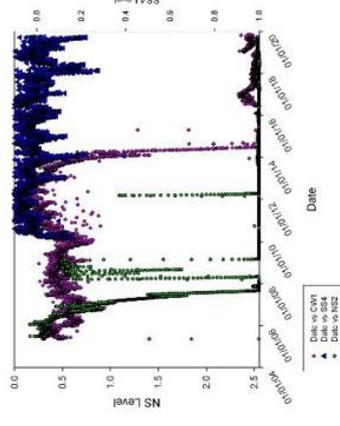
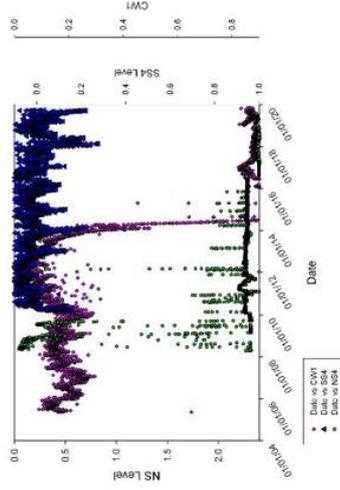
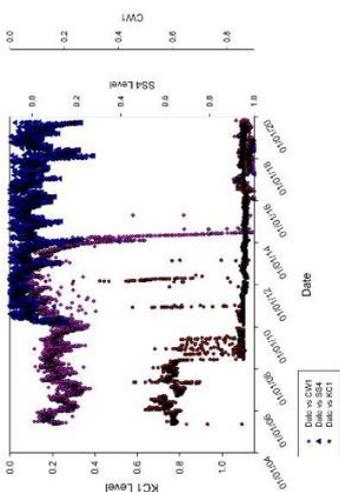
Narrow Swamp – NS3 & NS4



Narrow Swamp – NS1 & NS2

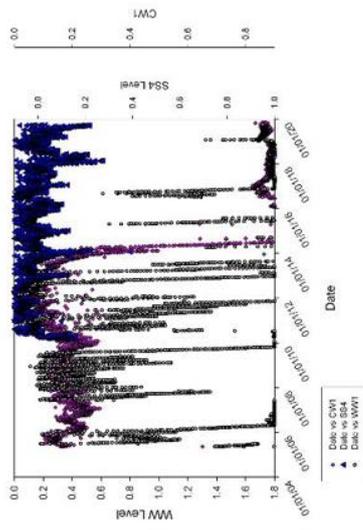


Kangaroo Creek Swamp – KC1 & KC2

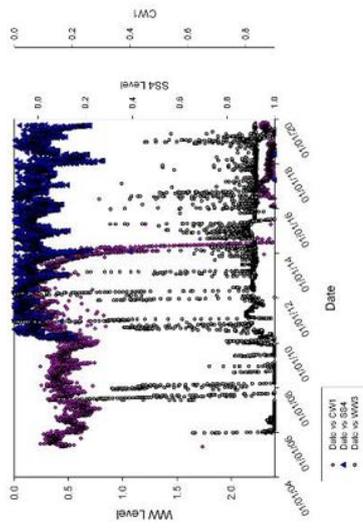


Reference Swamps – Sunnyside Swamp (SS4) & Carne West Swamp (CWI prior to 2014 impacts)

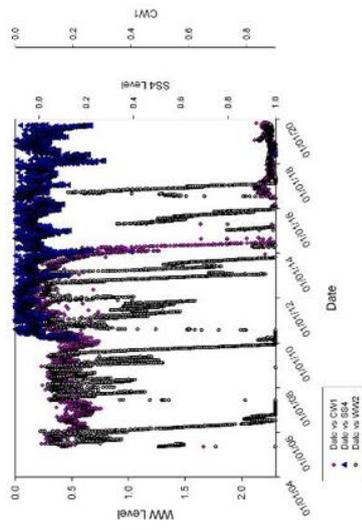
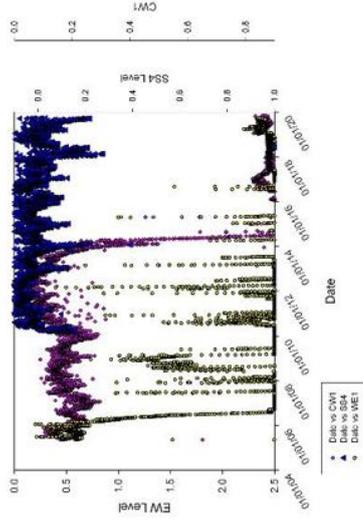
West Wolgan Swamp – WW1 & WW2



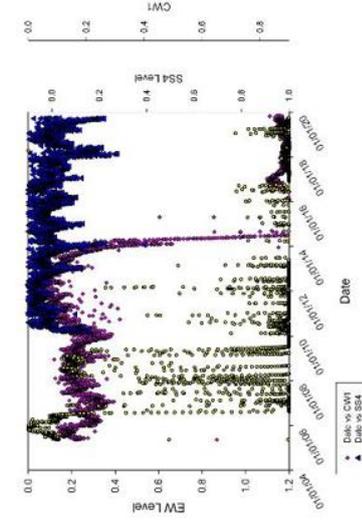
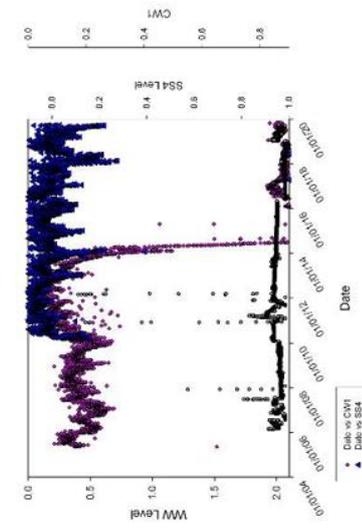
West Wolgan Swamp – WW3 & WW4



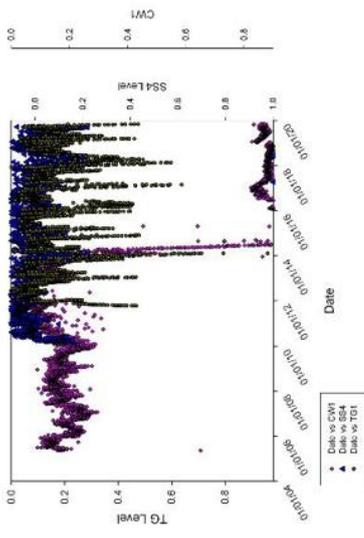
East Wolgan Swamp – WE1 & WE2



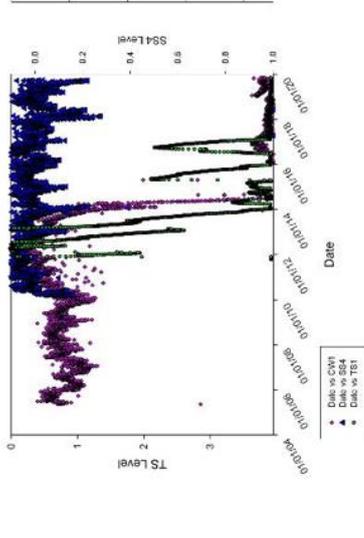
Reference Swamps – Sunnyside Swamp (SS4) & Carne West Swamp (CWI prior to 2014 impacts)



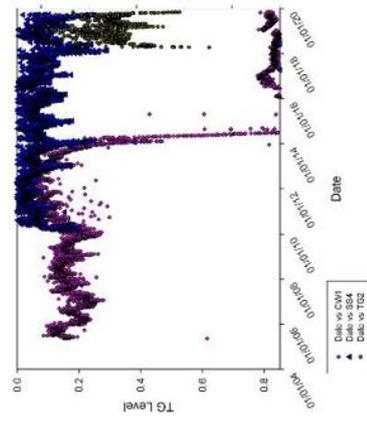
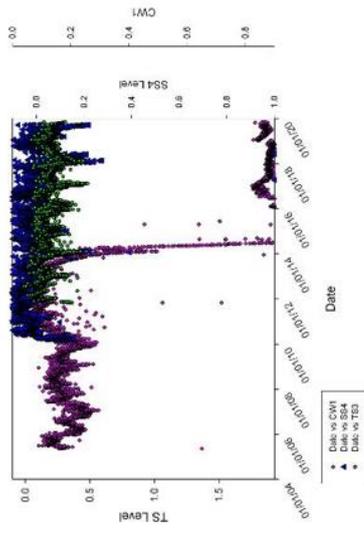
Twin Gully Swamp – TG1 & TG2



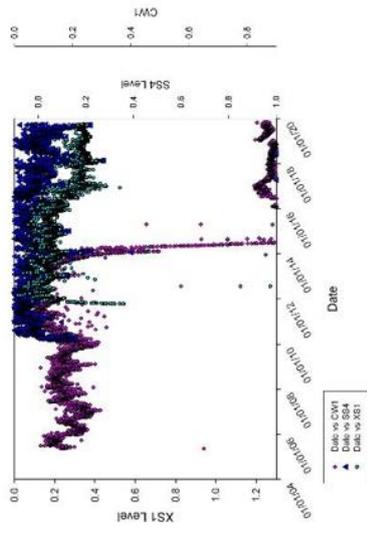
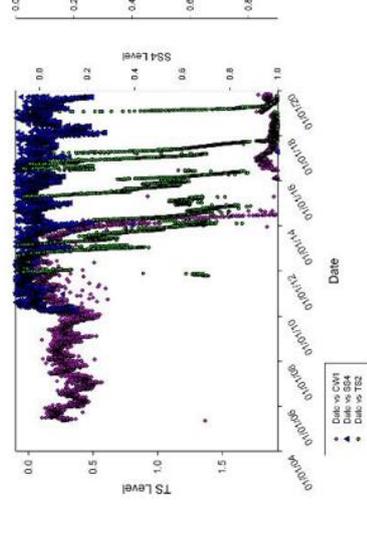
Tri Star Swamp – TS1 & TS2



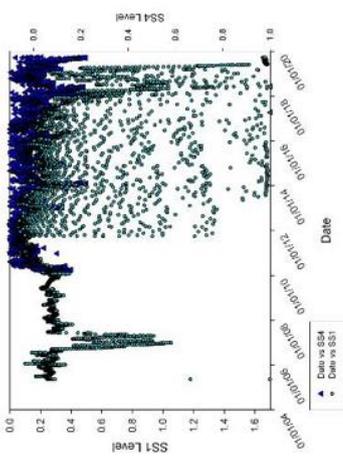
Tri Star & Trail 6 Swamp – TS3 & XS1



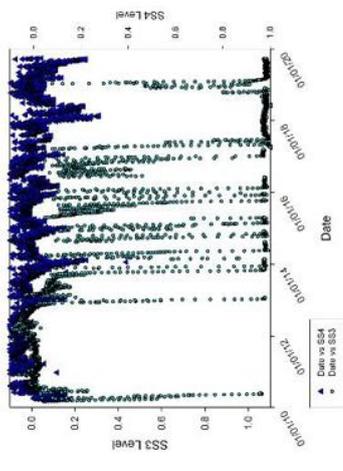
Reference Swamps – Sunnyside Swamp (SS4) & Carne West Swamp (CWI prior to 2014 impacts)



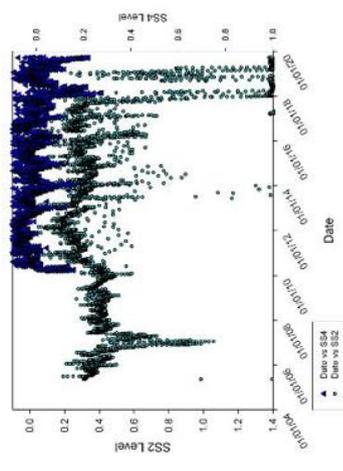
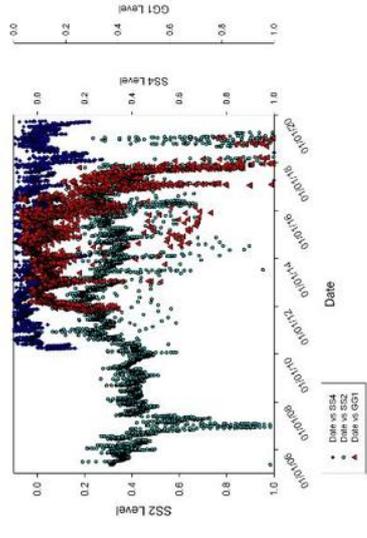
Sunnyside Swamp – SS1 & SS2



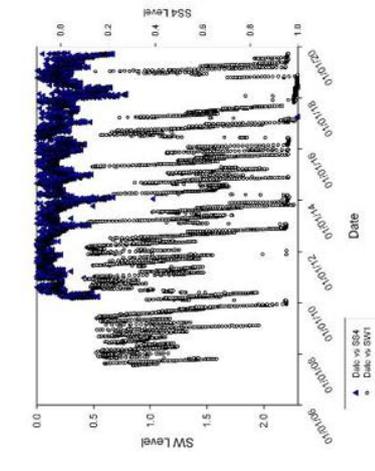
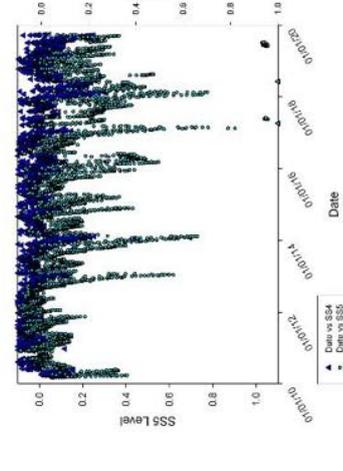
Sunnyside Swamp – SS3 & SS5



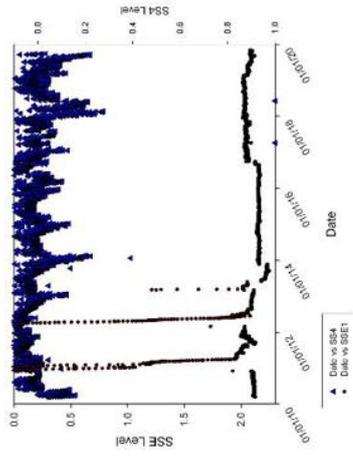
Gang Gang East & Sunnyside West Swamp – GG1 & SW1



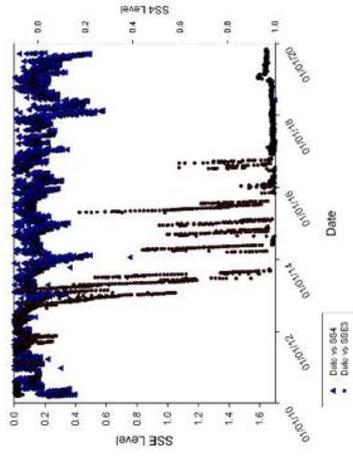
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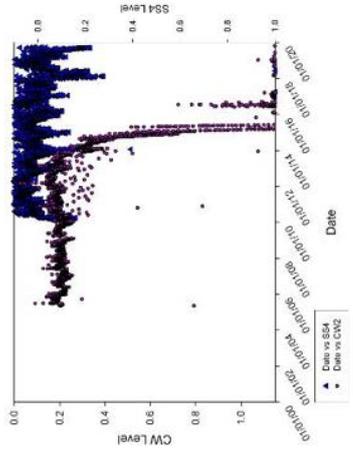
Sunnyside East Swamp – SSE1 & SSE2



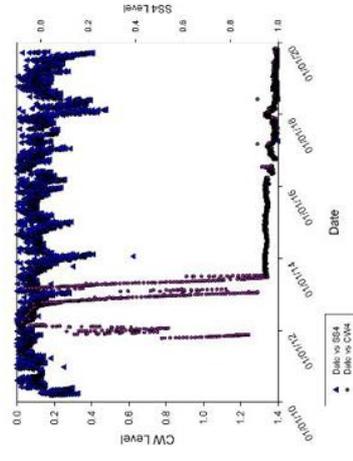
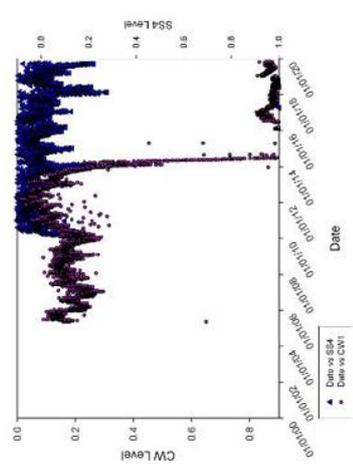
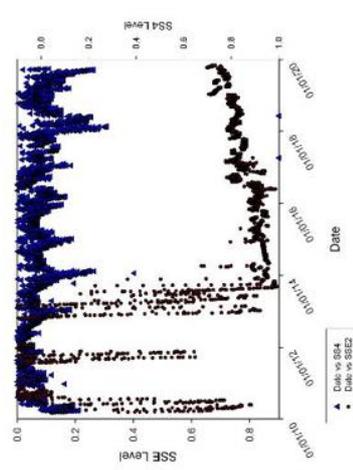
Sunnyside East and Carne West Swamp – SSE3 & CW1



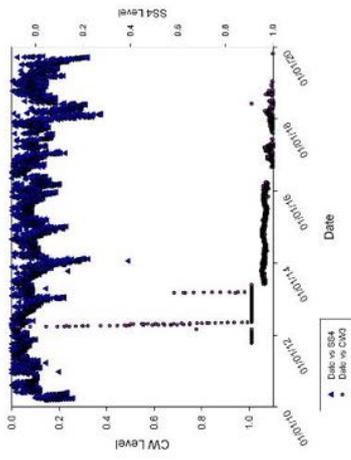
Carne West Swamp – CW2 & CW4



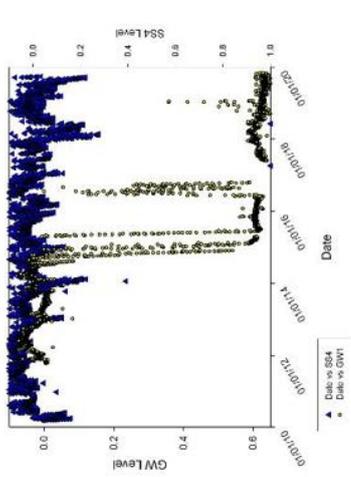
Reference Swamp – Sunnyside Swamp (SS4)



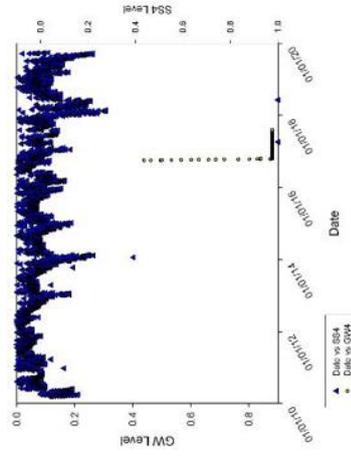
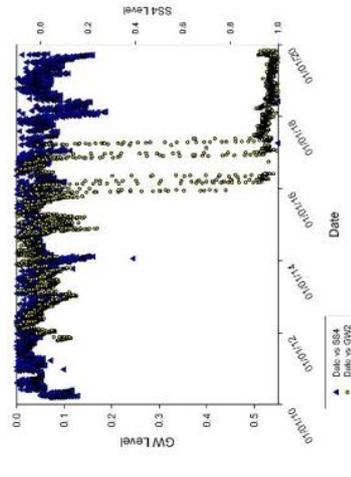
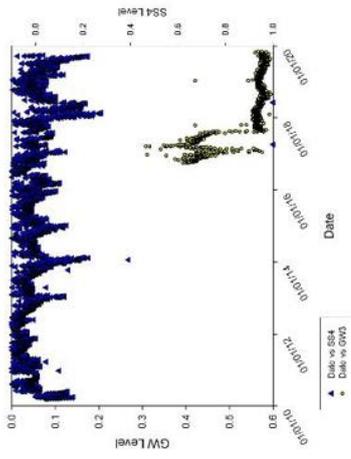
Carne West Swamp – CW3



Gang Gang West Swamp – GW1 & GW2

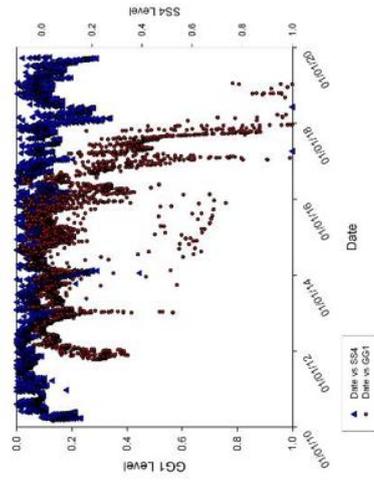


Gang Gang West Swamp – GW3 & GW4

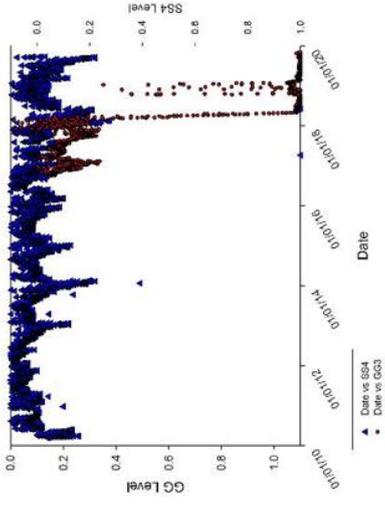


Reference Swamp – Sunnyside Swamp (SS4)

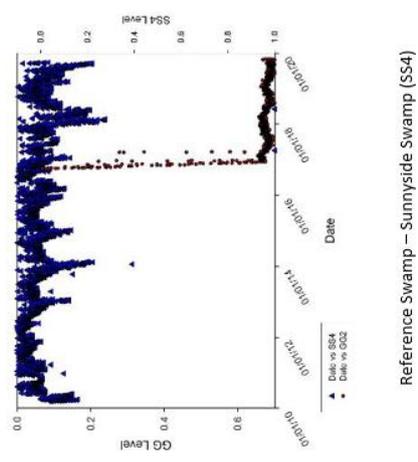
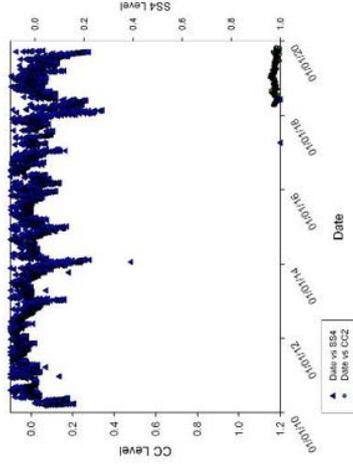
Gang Gang East Swamp – GG1 & GG2



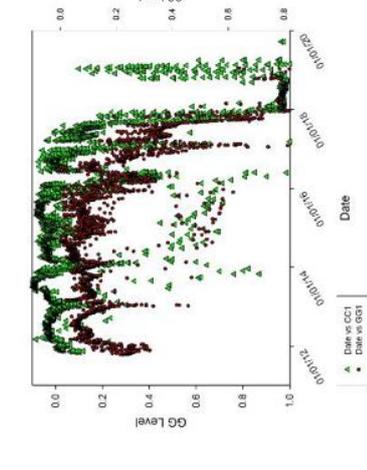
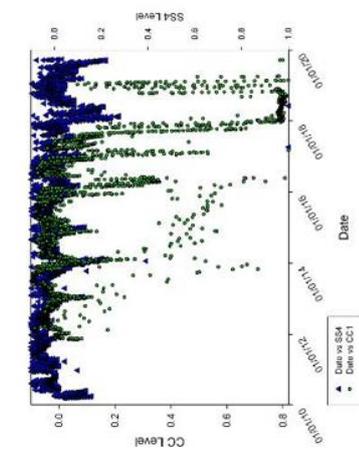
Gang Gang East & Carne Central Swamp – GG3 & CC1



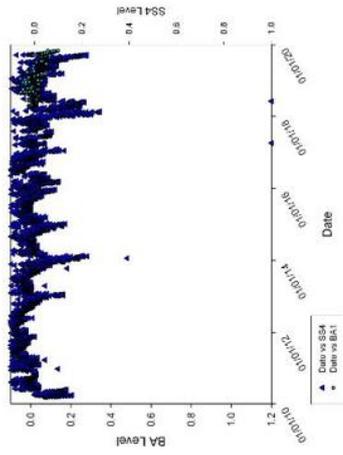
Carne Central Swamp – CC1 & CC2



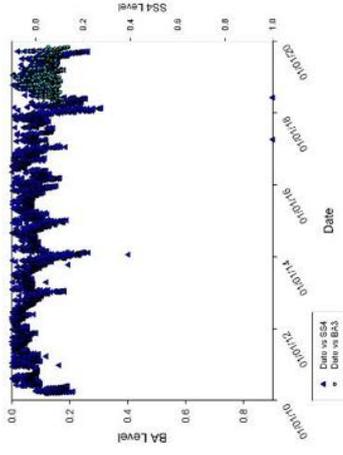
Reference Swamp – Sunnyside Swamp (SS4)



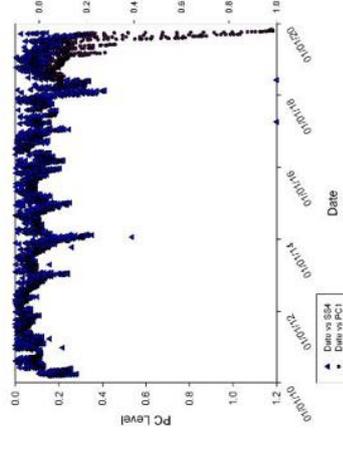
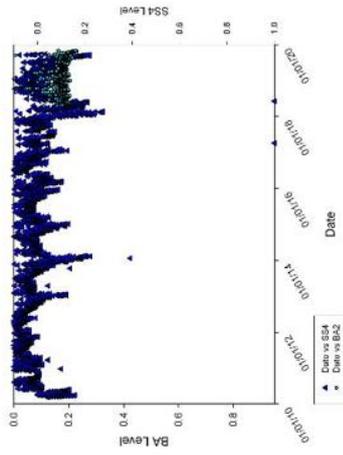
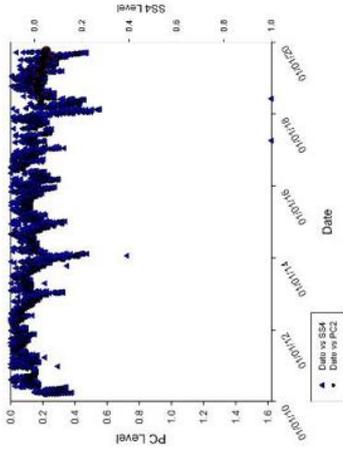
Broad Swamp – BA1 & BA2



Broad and Paddys Swamp – BA3 & PC1

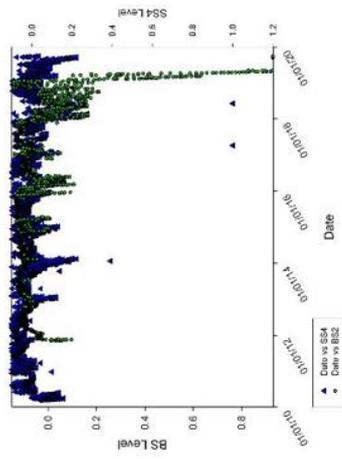


Paddys Swamp – PC2

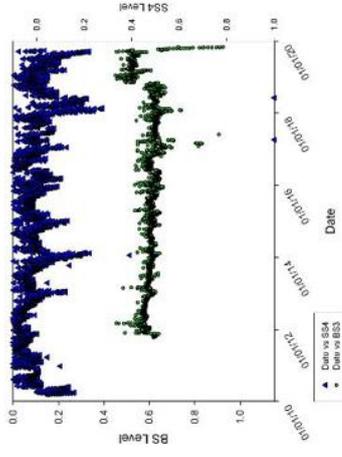


Reference Swamp – Sunnyside Swamp (SS4)

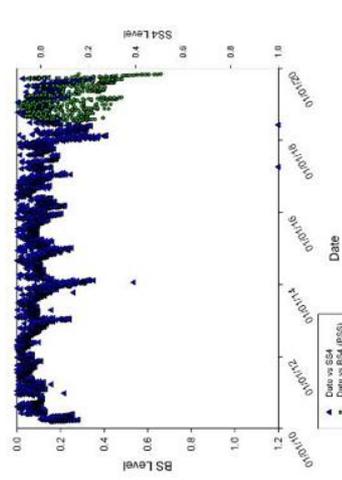
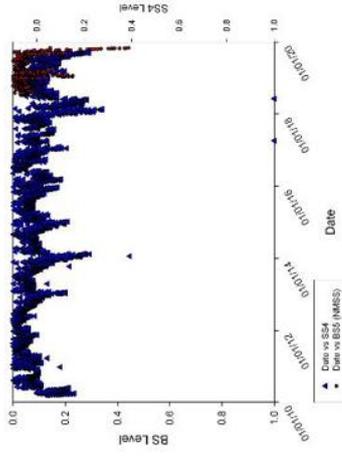
Pine Swamp - BS2 & BS4



Pine Swamp - BS3

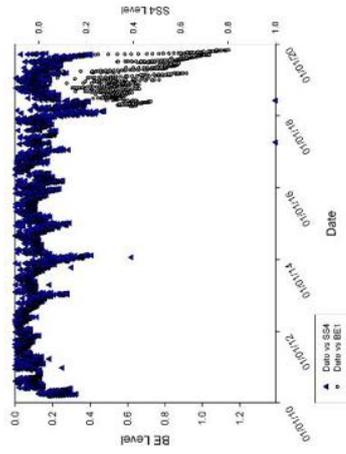


Nine Mile Swamp - BS1 & BS5

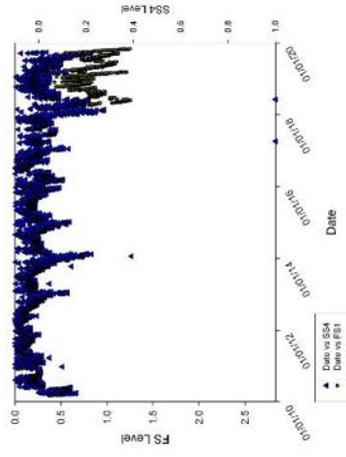


Reference Swamp - Sunnyside Swamp (SS4)

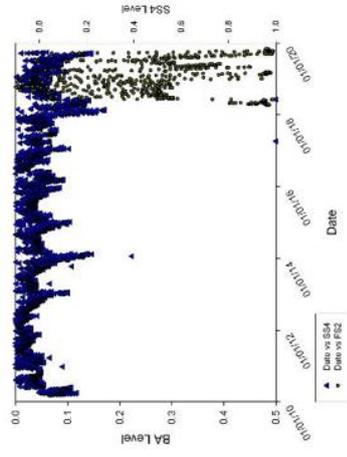
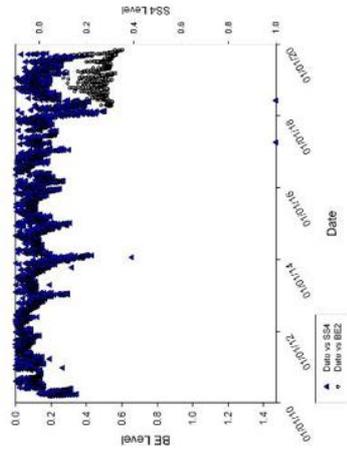
Budgaty Creek (Best) Swamp – BE1 & BE2



Nayook Creek (Firetail) Swamp – FS1 & FS2

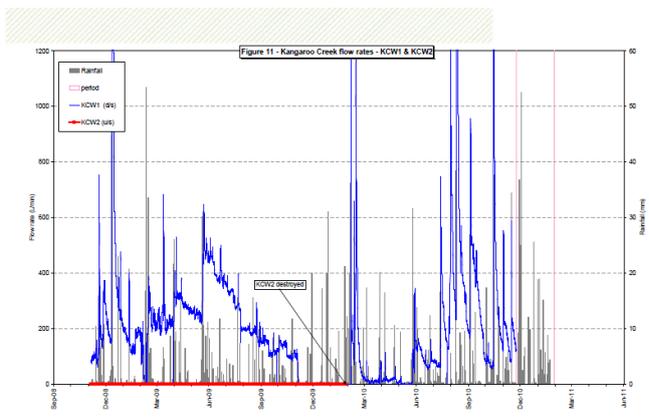
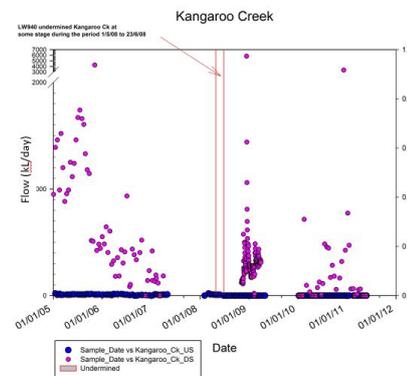
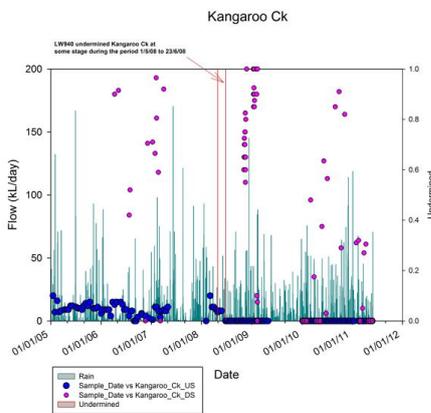
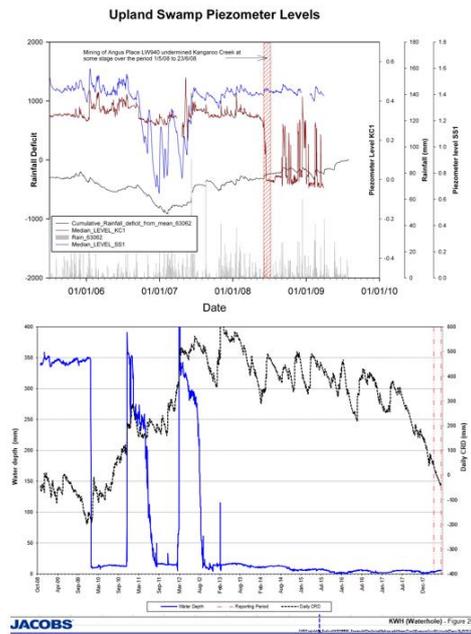
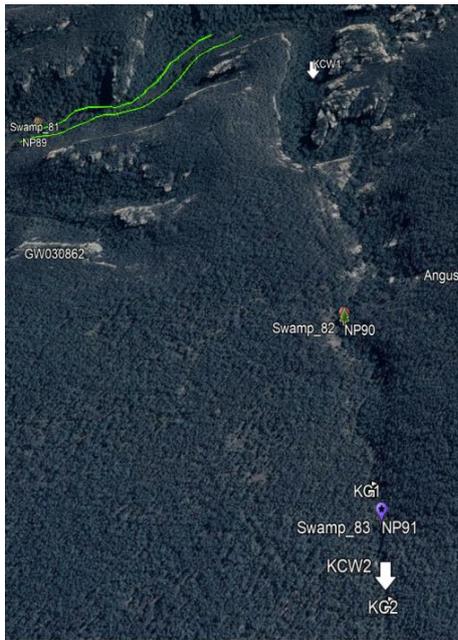


Reference Swamp – Sunnyside Swamp (SS4)



Flow Assessment Figures

Kangaroo Creek Swamp



Kangaroo Creek Monitoring Sites (Top Left), KC1 Levels (Top Right), KWH Levels (Middle) & Kangaroo Creek Flow (Bottom). Source: EES SD unpublished, DECCW 2010 & Centennial datafiles supplied to OEH.

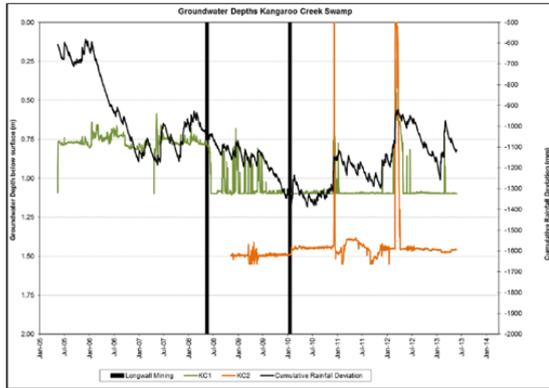
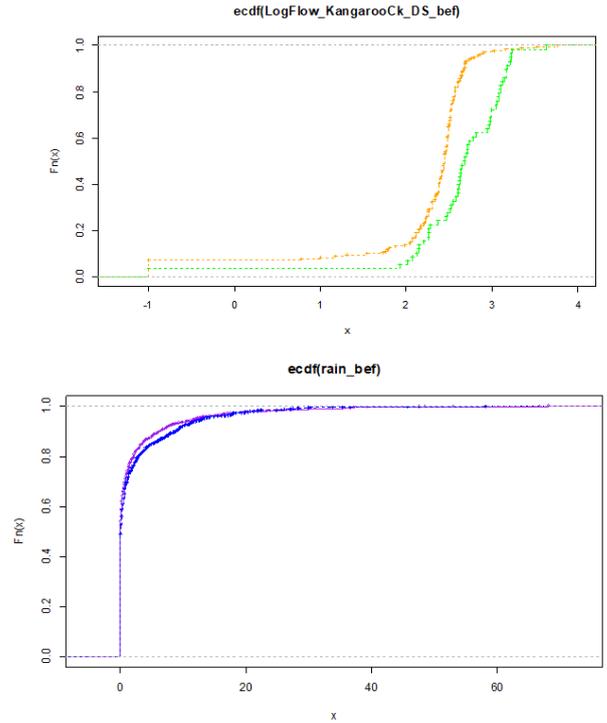
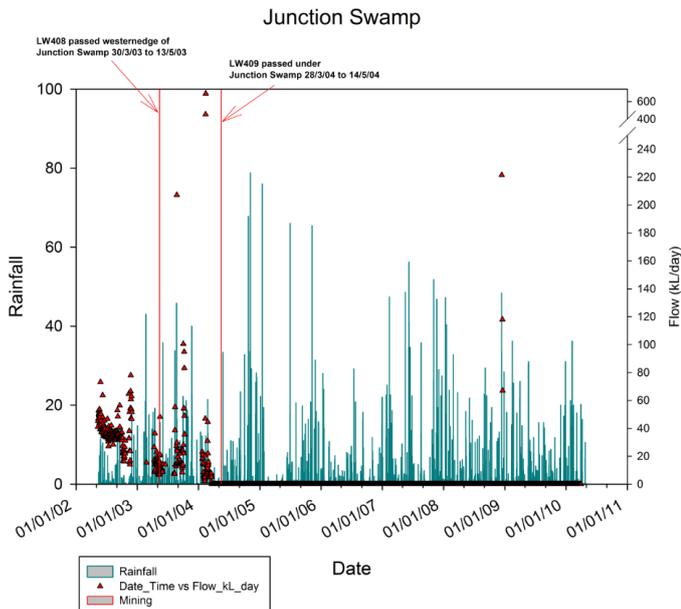


Figure 2.27: Hydrographs of the swamp piezometers installed at Kangaroo Creek Swamp showing timing of longwall mining and cumulative rainfall deviation



Flow (Left) and Flow exceedance kL/day (empirical cumulative distribution function) for Kangaroo DS before (green) and after (orange) LW940 impacts (Above Right). Rainfall exceedance for Newnes Plateau before (purple) and after (blue) LW940 impacts (Below Right). Source: EES SD unpublished & Centennial datafiles supplied to OEH.

Junction Swamp



Junction Swamp Flow. Source: EES SD unpublished.

Wolgan River

Table 4.2: Flow Gauging Summary – Wolgan River, Tri Star and Twin Gully

	Wolgan River Downstream	East Wolgan D/S Junction	Tri Star Swamp	Twin Gully Swamp
Mean (kL/day)	3477.4	649.1	422.7	243.1
90 th Percentile (kL/day)	8657.5	1194.2	742.2	592.8
Median (kL/day)	1576.5	348.5	298.0	183.0
10 th Percentile (kL/day)	228.5	74.0	164.2	38.8
Count	296	260	69	55
Zero Flow Observations	3	10	0	1

Table 5.4: Summary SAPSWBM Model Output (WR05a) – Wolgan River Swamp

Flow Percentile	U10 Results (Flow ML/day)			U90 Results (Flow ML/day)		
	PROPD	NULL	% ¹	PROPD	NULL	% ¹
Min	0.55	0.54	2	0.54	0.78	-30
5%	1.1	1.1	1	1.1	1.2	-10
10%	1.4	1.3	3	1.3	1.4	-11
20%	1.7	1.6	4	1.5	1.7	-9
50%	2.2	2.2	2	2.1	2.2	-7
80%	4.2	4.1	1	4.0	4.2	-4
90%	8.9	8.8	1	8.7	8.8	-2
95%	17	17	0	17	17	-1
Max	1081	1081	0	1080	1081	0

Notes. 1. %Δ is percent change between Proposed (PROPD) and Null Case (NULL) prior to rounding.

Table 5.5: Summary SAPSWBM Model Output (WR10) – Wolgan River Swamp Upper Swamp

Flow Percentile	U10 Results (Flow ML/day)			U90 Results (Flow ML/day)		
	PROPD	NULL	% ¹	PROPD	NULL	% ¹
Min	0.25	0.25	3	0.25	0.34	-26
5%	0.55	0.54	2	0.52	0.54	-3
10%	0.70	0.65	7	0.63	0.64	-1
20%	0.86	0.81	6	0.77	0.79	-2
50%	1.16	1.12	4	1.08	1.09	-1
80%	2.18	2.15	1	2.10	2.16	-3
90%	4.77	4.74	1	4.69	4.71	0
95%	9.4	9.3	1	9.2	9.3	0
Max	615	615	0	615	615	0

Notes. 1. %Δ is percent change between Proposed (PROPD) and Null Case (NULL) prior to rounding.

Table 5.12: Summary of SAPSWBM Model Output (WR02) – Wolgan River below Carne Creek

Flow Percentile	U10 Results (Flow ML/day)			U90 Results (Flow ML/day)		
	PROPD	NULL	% ¹	PROPD	NULL	% ¹
Min	4.5	4.3	5	4.8	5.2	-7
5%	9.1	8.9	2	9.7	10.0	-3
10%	11	11	2	12	12	-4
20%	13	13	2	14	14	-4
50%	20	20	1	21	22	-3
80%	52	52	0	54	54	-1
90%	90	90	0	91	92	-1
95%	177	177	0	178	179	0
Max	9517	9516	0	9518	9518	0

Notes. 1. %Δ is percent change between Proposed (PROPD) and Null Case (NULL) prior to rounding.

Table 5.13: Summary of SAPSWBM Model Output (WR03) – Wolgan River above Carne Creek

Flow Percentile	U10 Results (Flow ML/day)			U90 Results (Flow ML/day)		
	PROPD	NULL	% ¹	PROPD	NULL	% ¹
Min	1.6	1.5	5	1.8	2.0	-12
5%	3.5	3.4	3	3.7	3.9	-4
10%	4.4	4.3	3	4.6	4.8	-4
20%	5.2	5.1	2	5.5	5.7	-3
50%	7.9	7.8	1	8.3	8.5	-2
80%	25	24	1	25	25	-1
90%	48	48	0	48	48	0
95%	60	60	0	60	60	0
Max	3774	3774	0	3774	3774	0

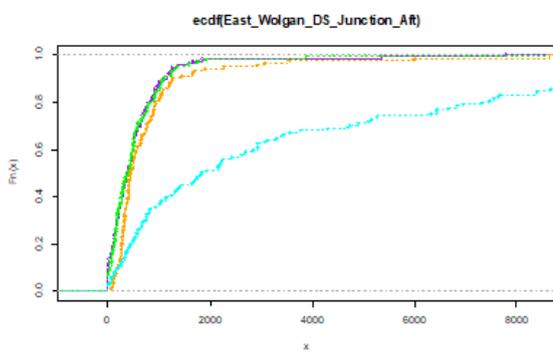
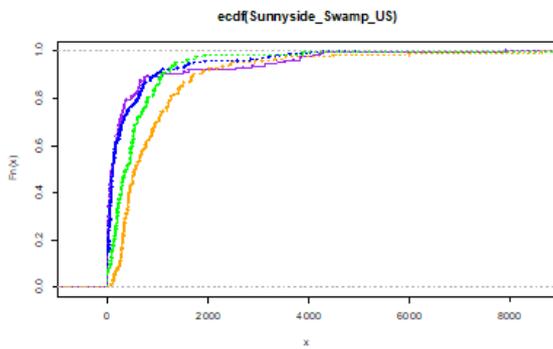
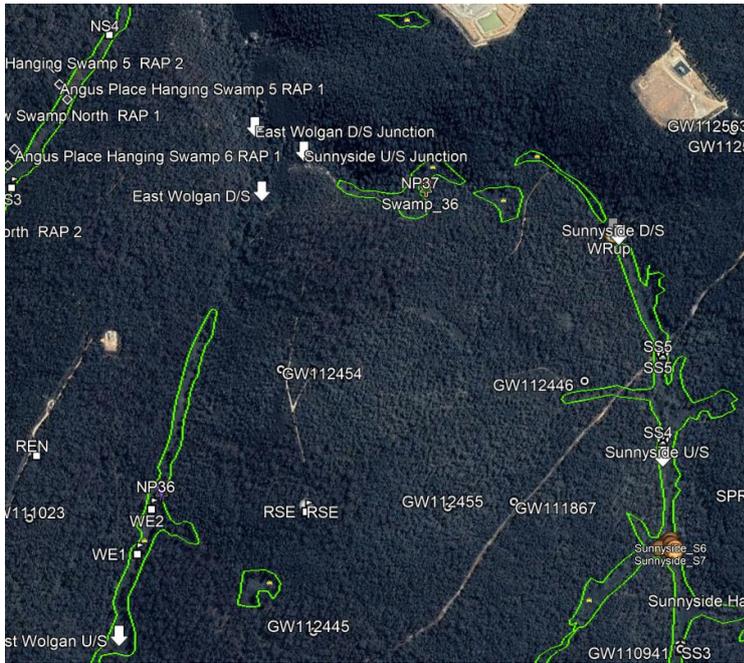
Notes. 1. %Δ is percent change between Proposed (PROPD) and Null Case (NULL) prior to rounding.

Table 5.14: Summary of SAPSWBM Model Output (WR04) – Wolgan River west of 1000 panel area

Flow Percentile	U10 Results (Flow ML/day)			U90 Results (Flow ML/day)		
	PROPD	NULL	% ¹	PROPD	NULL	% ¹
Min	1.1	1.0	7	1.1	1.4	-19
5%	2.4	2.3	4	2.4	2.6	-7
10%	3.0	2.9	4	3.0	3.1	-5
20%	3.6	3.5	3	3.5	3.7	-5
50%	5.4	5.3	2	5.3	5.5	-4
80%	16	16	1	16	16	-1
90%	31	31	0	31	31	-1
95%	38	38	0	38	38	-1
Max	1990	1990	0	1990	1990	0

Notes. 1. %Δ is percent change between Proposed (PROPD) and Null Case (NULL) prior to rounding.

Wolgan River Flow and Predictions - Tables 4.2, 5.4, 5.5 & 5.12-5.14 from Jacobs (2019).



East Wolgan and Sunnyside Monitoring Locations – Above; Flow exceedance kL/day (empirical cumulative distribution function) for Sunnyside Upstream of Junction (green), Sunnyside Downstream (blue), Sunnyside Upstream (purple) and Carne West (orange) – Middle; Flow exceedance kL/day (empirical cumulative distribution function) after impacts to East Wolgan Swamp for Sunnyside Upstream of Junction (green), Sunnyside Downstream (blue), East Wolgan Downstream Junction (purple), Carne West (orange) and East Wolgan Downstream (light blue) – Bottom. Source: EES SD unpublished

Carne West Swamp

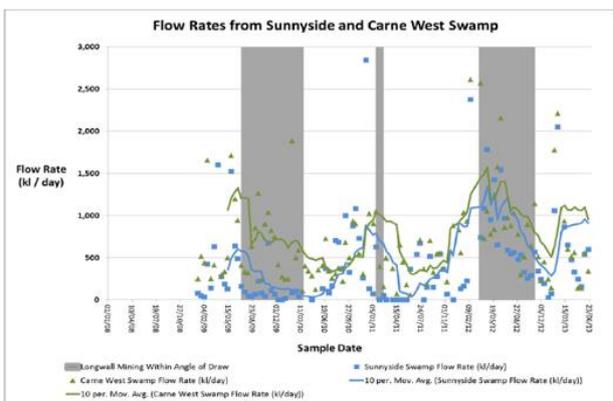
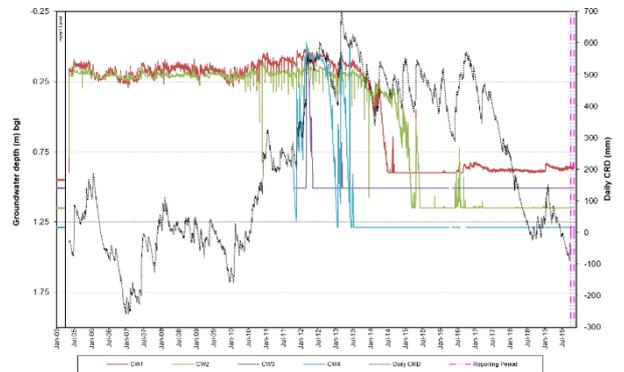
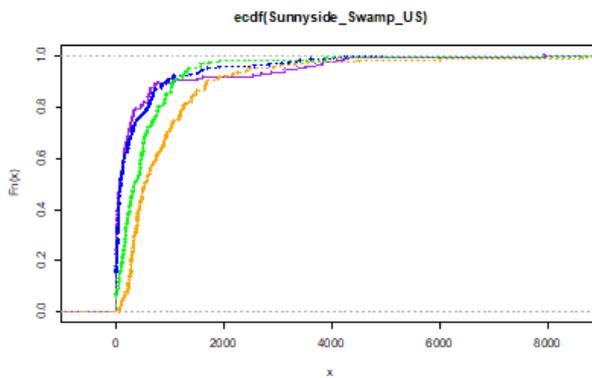
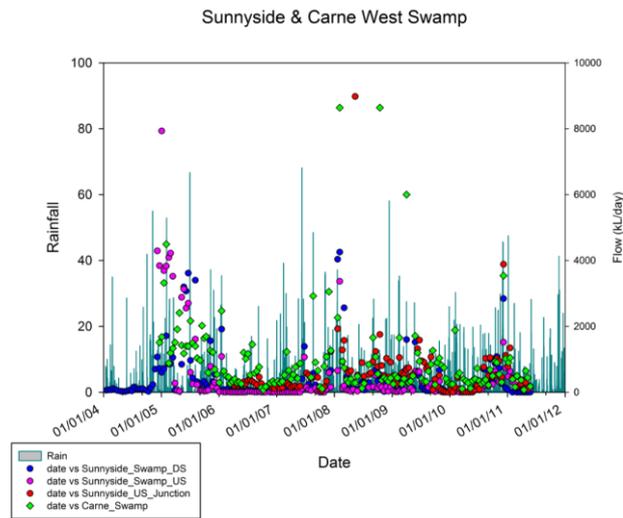


Figure 2.18: Surface Water Flows from Sunnyside and Carne West Swamps

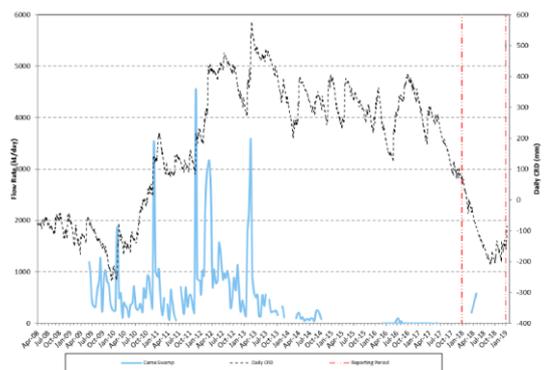
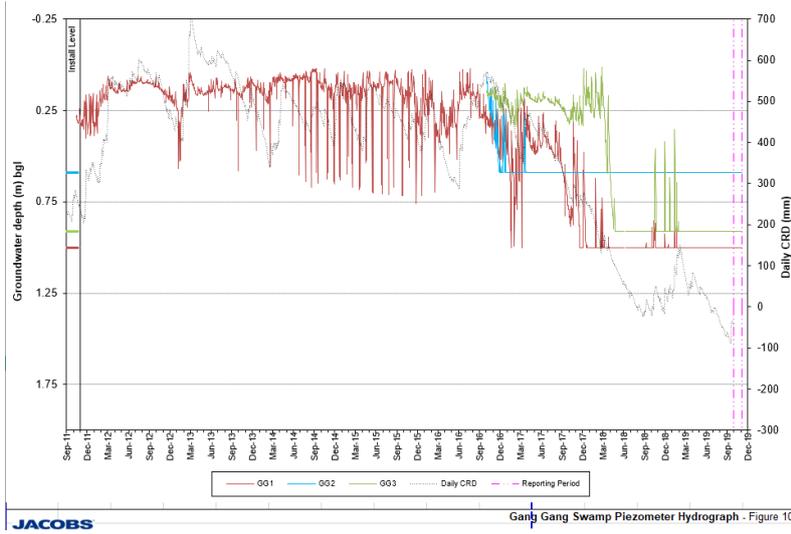


Figure 21 Carne West Flow Monitoring Results June 2009 to 2018

Carne West and Sunnyside Flow Monitoring – Above; Flow exceedance kL/day (empirical cumulative distribution function) for Sunnyside Upstream of Junction (green), Sunnyside Downstream (blue), Sunnyside Upstream (purple) and Carne West (orange) - Middle Left; Carne West Swamp Piezometer levels – Middle Right; Later Carne West Flow plots - Below. Source: EES SD unpublished & Centennial data files supplied to OEH.

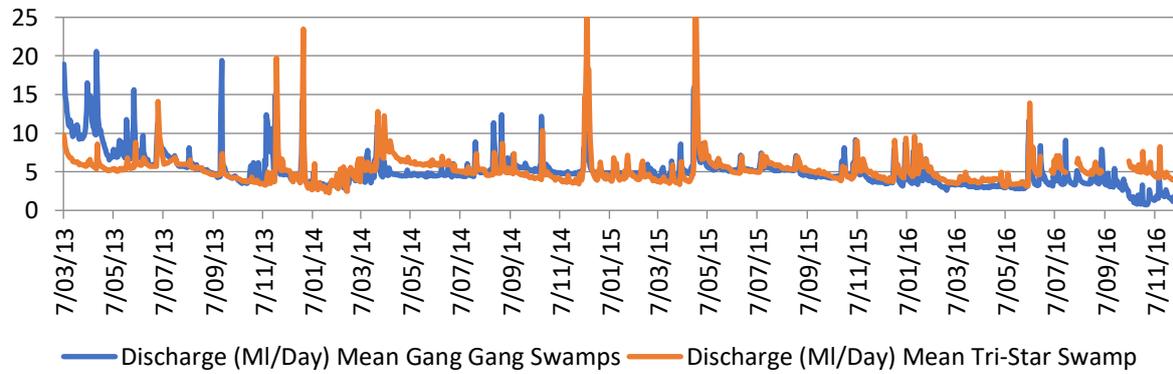
Gang Gang East Swamps



JACOBS

Gang Gang Swamp Piezometer Hydrograph - Figure 10

Surface Water Flows Gang Gang and Tri-Star Swamps



Gang Gang East Piezometer Levels – Above; Gang Gang and Tri Star gauged Flow (ML/day) below. Source: Centennial data files supplied to OEH.