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Waterway Management Consultants

STATEMENT OF EXPERT EVIDENCE

GREATER GEELONG PLANNING SCHEME AMENDMENT C278ggee

MARSHALL PRECINCT STRUCTURE PLAN

DRAINAGE AND FLOODING

For: RE-GROW GEELONG PTY LTD

28 October 2024

*Director **Neil McKinnon Craigie** BE(Civil), MEngSci, MIEAust, CPEng (Ret)*
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GLOSSARY OF TERMS

AC	Armstrong Creek
ACUGA	Armstrong Creek Urban Growth Area
ACSP	Armstrong Creek South Precinct
AEP	Annual Exceedance Probability
c.	‘circa’ / approximately
DU	Deakin University
ETA	Actual Evapotranspiration (quantity of water removed due to evaporation and transpiration)
HBP	Horseshoe Bend Precinct
MAR	Mean Annual Runoff
MAIR	Mean Annual Impervious Runoff
Marshall PSP	Marshall Precinct Structure Plan July 2023 (Amended March 2024)
MP	Marshall Precinct
NEIP	North East Industrial Precinct
NEIP PSP	North East Industrial Precinct Precinct Structure Plan May 2010
RCB	Reinforced Concrete Boxes
Re-Grow Pty Ltd	Re-Grow
SOR	Standard Operating Rules
SWMS	Storm Water Management Strategy
TSS	Total Suspended Solids
VS	Venant Solutions
WT	Water Technology

1. NAME AND ADDRESS

Neil McKinnon Craigie, 40 Jamieson Court, Cape Schanck, VIC, 3939.

2. QUALIFICATIONS AND EXPERIENCE

B.E. (Civil), Monash University 1975

Grad. Course in Engg. Hydrology, UNSW 1976

M.Eng. Sci., Monash University 1981

After 14 years professional employment with the former Dandenong Valley Authority, I commenced private practice as a waterway management consultant in 1989 and have worked continuously in this role since then. I am a recognised expert in the field of surface water management, waterway management, and stormwater quality and quantity control measures. I have advised on such issues on numerous rural, semi-urban and urban developments throughout Victoria. A Statement of Qualifications and Experience is attached as Appendix A.

3. INSTRUCTIONS

1. This statement has been prepared on the instruction of Maddocks on behalf of Re-Grow Geelong Pty Ltd (Re-Grow).

2. I was instructed to prepare an opinion in the form of an expert witness report and in the form required by PPV.

3. In the report I should address the key issues associated with the following matters:
    - the original intent for Sparrovale,
    - the capacity of Sparrovale to receive stormwater,
    - how Sparrovale was intended to and now operates from a hydrological perspective,
    - identify any potential solutions to reported operational issues with Sparrovale (without costing),
    - provide an opinion on the impact of development being required to store the required volume of stormwater within either Marshall Precinct (MP) or the North East Industrial

Precinct (NEIP) areas to satisfy EPA publication 1739.1 which seeks to significantly reduce the volume of stormwater flowing from developed areas into waterways.

4. Appear on Re-Grow's behalf at the Panel hearing as an expert and participate in any conclave that may be required.

4. INFORMATION USED AND RELIED UPON

5. In responding to my instructions, I have relied on:

- the documents provided with my instructions,
- those stormwater management strategy (SWMS) reports generated by myself for all precincts across the Armstrong Creek Urban Growth Area (ACUGA) since 2009,
- documents provided as part of my current commission under the initial RFI process,
- documents received in September 2024 via the RFI 2 process,
- site survey, aerial photography, detailed design plans for assets in and around Sparrovale including the Balog Channel (also sometimes referred to as the Southern Diversion Channel) which connected Armstrong Creek dry season flows into Sparrovale, site inspection and contemporary urban stormwater best management practice documents including EPA Guideline 1739.1.

6. The documents provided with my instructions were:

- Marshall Precinct Structure Plan, SWMS Report for City of Greater Geelong, Rev B, Spiire Australia, December 2022.
- Drainage Technical Report, North East Industrial Precinct for Armstrong Creek Industrial Pty Ltd, Water Technology August 2009.
- Armstrong Creek North East Industrial Precinct, Review of Drainage Technical Report, Neil M Craigie P/L, Version V2, October 2009.
- Greater Geelong City Council 28 August 2024, Amendment C278ggee Delegated Authority Report.
- Submissions Redacted Final C278.

7. Stormwater Management Strategy (SWMS) reports generated by myself which are relevant to Sparrovale, Marshall and NEIP were:

- Armstrong Creek East Precinct SWMS Update October 2010.
- Armstrong Creek West Precinct SWMS August 2012.
- Armstrong Creek Town Centre Precinct Review of SWMS October 2013
- Armstrong Creek Horseshoe Bend Precinct SWMS October 2013.
- Armstrong Creek South Precinct (ACSP) Amendment C301 SWMS June 2017.
- Armstrong Creek Marshall Precinct SWMS Draft July 2017.

The HBP SWMS incorporated the recommendations to purchase the Sparrovale properties (DCP project DI LA 22 and 23 (Sparrovale and Cold Winds)), and to construct all internal stormwater management assets (DCP Project DI_DR_12 – Sparrovale Wetland-Construction). Concept designs were included. These were subsequently detailed for construction by SMEC P/L in August 2019. I was provided with copies for the inlet linear wetland works only, in May 2020.

The ACSP SWMS incorporated the recommendations to construct the Balog Channel between the Armstrong Creek linear wetland system and Sparrovale and included concept design for same. The DCP included PAO12 to cover purchase of the land for the channel and construction. The design was subsequently detailed by SMEC P/L with my signoff in April 2020.

8. Other reports generated by myself and others or were supplied to me which dealt specifically with Sparrovale Wetlands, its hydrology and its input hydraulic systems including the Balog Channel were:

- "*An Assessment of The Sustainability of The Proposed Sparrovale Wetlands and Assessment of the Associated Social, Economic and Environmental Risks*", for City of Greater Geelong, Pat Condina and Neil Craigie May 2014.

  (Part of HBP DCP Project DR 13 Sparrovale Wetland – Management Plan and 10 year Implementation Works)

- "*Implementation Table for the Sparrovale Wetlands Project, Part 1 of Preparation of Wetlands Master Plan and Wetlands Management Plan*", for City of Greater Geelong, Pat Condina and Neil Craigie September 2016.

- "*Armstrong Creek Urban Growth Area Sparrovale Wetland Hydrology Draft Report"*, for City of Greater Geelong, Venant Solutions August 2018.

9. As part of my current commission with Re-Grow I was provided access to:

- "*Sparrovale, Ngubitj Yoorree Wetlands Master Plan*", City of Greater Geelong, June 2021 (sourced in September 2023),

- The complete set of endorsed design plans for Sparrovale by SMEC P/L including the outlet works dated 22/11/2019 (provided in June 2024).

10. In September 2024 through the RFI 2 process I have been provided access to the following reports and plans:

- "*Armstrong Creek Urban Growth Area Sparrovale Wetland Hydrology Final Report"*, for City of Greater Geelong, Venant Solutions, September 2018.

- "*Operating Rules, Balog Channel / Sparrovale Wetland*", for City of Greater Geelong, Water Technology, 22 December 2022.

- *"Technical Report, Sparrovale Wetland Operating Rules"*, for City of Greater Geelong, 22 December 2022.

- "*Summary Report, Sparrovale Wetland Monitoring, Years 1-3*", for City of Greater Geelong, Deakin University and Water Insites, July 2024.

- "*Water Salt Balance Model for the Lower Barwon Wetlands, Summary Report"*, for CCMA, Alluvium December 2022.

- "*Water Salt Balance Model for the Lower Barwon Wetlands, Findings Summary*", for CCMA, Alluvium December 2022.

5. THE ORIGINAL DESIGN INTENT FOR SPARROVALE

11. Figure 1 is a locality plan showing the Armstrong Creek Urban Growth Area (ACUGA) precincts, main drainage lines, Sparrovale Ngubitj yoorree constructed wetlands (Sparrovale Wetlands) and the lower Barwon floodplain area features.

12. Sparrovale Wetlands were established to manage stormwater from the ACUGA, so as to protect the downstream Ramsar Wetlands (Hospital Swamps) from excess fresh water volumes associated with urban development in the summer/autumn periods (Dec-Apr). Freshwater volumes from ACUGA were not of concern in winter/spring periods (May-Nov) when far larger volumes have normally been transferred into Hospital Swamps from the Barwon River barrage pondage to achieve desired watering. Treated urban stormwater from the ACUGA thus becomes a positive in winter/spring periods by reducing volumes needed to be diverted in from the Barwon barrage pondage.

13. The design intent was reflected in the wording for Amendment C357 which stated that the two farm properties purchased under PAO12 were "*to be used as a freshwater wetland and stormwater detention system (Sparrovale Wetlands) to appropriately treat the increased volume and rate of flow of stormwater from ….the Horseshoe Bend Precinct (HBP) prior to discharge into the Barwon River. The Sparrovale Wetlands will provide a number of environmental benefits beyond those associated with the treatment and control of storm water from the future residential areas. These include protection of the adjacent Hospital Swamp and saline Ramsar wetlands from effects of increased freshwater inputs, extension of the Barwon River Parklands, maintenance of the significant biodiversity values of the Sparrovale and Ramsar sites, etc.*" (Greater Geelong Planning Scheme Amendments C357/C360 Panel Report, 12 October 2017, P15 of 23).

14. Referring to Figure 1, inflow catchments to the Sparrovale Wetlands included the HBP, parts of the MP and NEIP areas, and diversion flows from Armstrong Creek (AC) via the Balog Channel. Land for the Balog Channel was also included in PAO12.

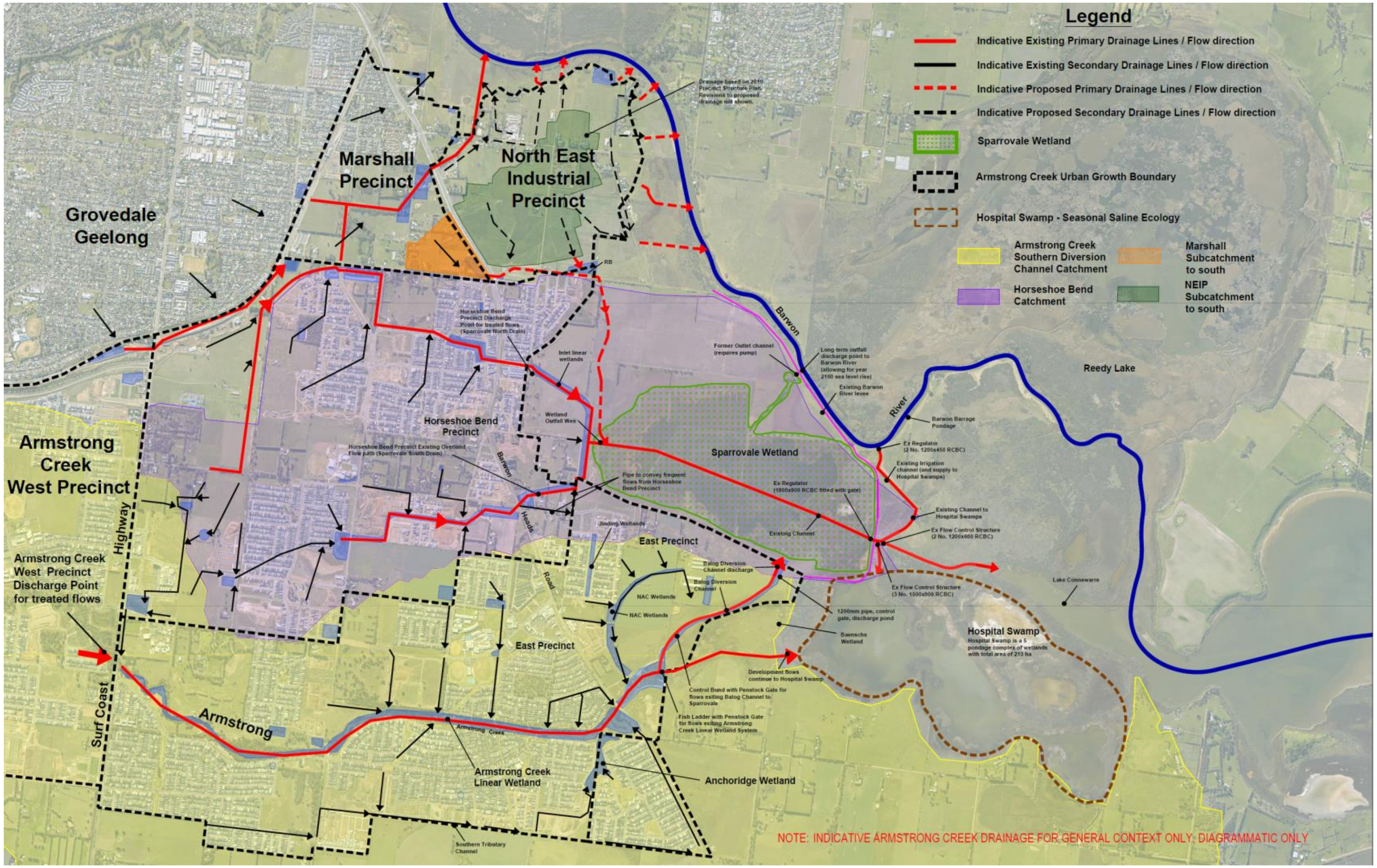


Figure 1 Locality Plan showing ACUGA precincts, main drainage lines, Sparrovale and lower Barwon floodplain area/Lake Connewarre (SMEC Rev F, 11 Oct 2024)

15. I am not aware of ecological offset sites being located within or around the Sparrovale Wetlands behind (ie., west of) the Barwon River levee (shown in pink on Figure 1).

16. In regard to inflows from Armstrong Creek, full best practice water quality treatment is achieved within the various AC precinct boundaries-that is prior to conveyance along the Balog Channel to Sparrovale Wetlands.

17. The HBP DCP provided for lesser standards (70%TSS removal and (partial) peak flow management) within the PSP boundaries and for the balance of quality treatment, peak flow management and volume management to be achieved in Sparrovale Wetlands. As this released additional developable land within the precinct, the HBP DCP logically included acquisition of the Sparrovale and Cold Winds properties and construction of works therein to create the Sparrovale Wetlands.

18. The Armstrong Creek South Precinct (ACSP) DCP provided for the Balog Channel to be constructed to divert development-related stormwater volumes from Armstrong Creek into Sparrovale Wetlands during the summer/autumn periods. No diversion was intended in winter/spring periods when all treated stormwater in Armstrong Creek would normally continue east into Baenschs Wetland and thence into Hospital Swamps, offsetting in part the annual transfer of water from the Barwon barrage pondage to Hospital Swamps.

<u>Location and Use of Water Regulating Structures</u>

19. Table 1 numbers and lists the various hydraulic control structures (regulators) used to manage water flows out of the Barwon River, Armstrong Creek and Sparrovale Wetlands into Hospital Swamps and Lake Connewarre, as well as management responsibilities. Figure 2 provides this information on a current aerial photo.

20. For Armstrong Creek and the Balog Channel there are 4 hydraulic control structures (6-9 inclusive) which control flow of water across to Sparrovale Wetlands and/or east into Baenschs Wetland and thence Hospital Swamps.

21. In the summer/autumn period treated stormwater is diverted across to Sparrovale via the Balog Channel when water levels in the Armstrong Creek linear wetland rise above 1.0 m AHD. Regulator gates 6 and 7 are open during this period whilst the fishway gates 8 are closed.

22. Gates 6 and 7 would normally be closed in winter/spring periods or when maintenance needs dictate. All treated water in Armstrong Creek should go to Hospital Swamps during this time. When closed, gate 7 prevents any diversion of flow into Sparrovale Wetlands from Armstrong Creek. The fishway gates 8 are open during this period. The linear wetland outlet channel 9 is engaged during high flows in Armstrong Creek.

Table 1 Water regulator/hydraulic control structures (derived from WT 2022)

Item	Control Structure Name	Location	Responsible Authority	Secondary Parties
1	Barwon River Offtake	N 272488.6 E 5766577.0	CCMA	CoGG, Parks Victoria
2	Hospital Swamp Inlet	N 272496.2 E 5765862.5	CCMA	Parks Victoria
3	Hospital Swamp Outlet	N 274380.0 E 5764676.0	CCMA	Parks Victoria
4	Baenschs Wetland Outlet	N 271691.0 E 5764995.9	CCMA	Parks Vic, Field and Game
5	Blind Channel Outlet	N 272520.0 E 5765857.2	CCMA, CoGG	CCMA
6	Balog Channel Inlet	N 271019.8 E 5765210.3	CoGG	CCMA
7	Balog Channel Outlet	N 271720.9 E 5765582.8	CoGG	CCMA
8	Balog Fishway	N 270879.6 E 5764939.1	CoGG	CCMA
9	Linear Wetland Outlet Channel	N 270885.5 E 5764949.0	CoGG	CCMA
10	Sparrovale Outlet	N 272440.6 E 5765881.7	CoGG	CCMA

23. Drainage outfall from Sparrovale Wetlands is via the regulator structure 10 under the Barwon River levee.

24. In the summer/autumn period regulator 10 outflows (if any) would bypass Hospital Swamps and go direct into Lake Connewarre via the Blind Channel and regulator 5. Regulator 2 would remain closed during this period.

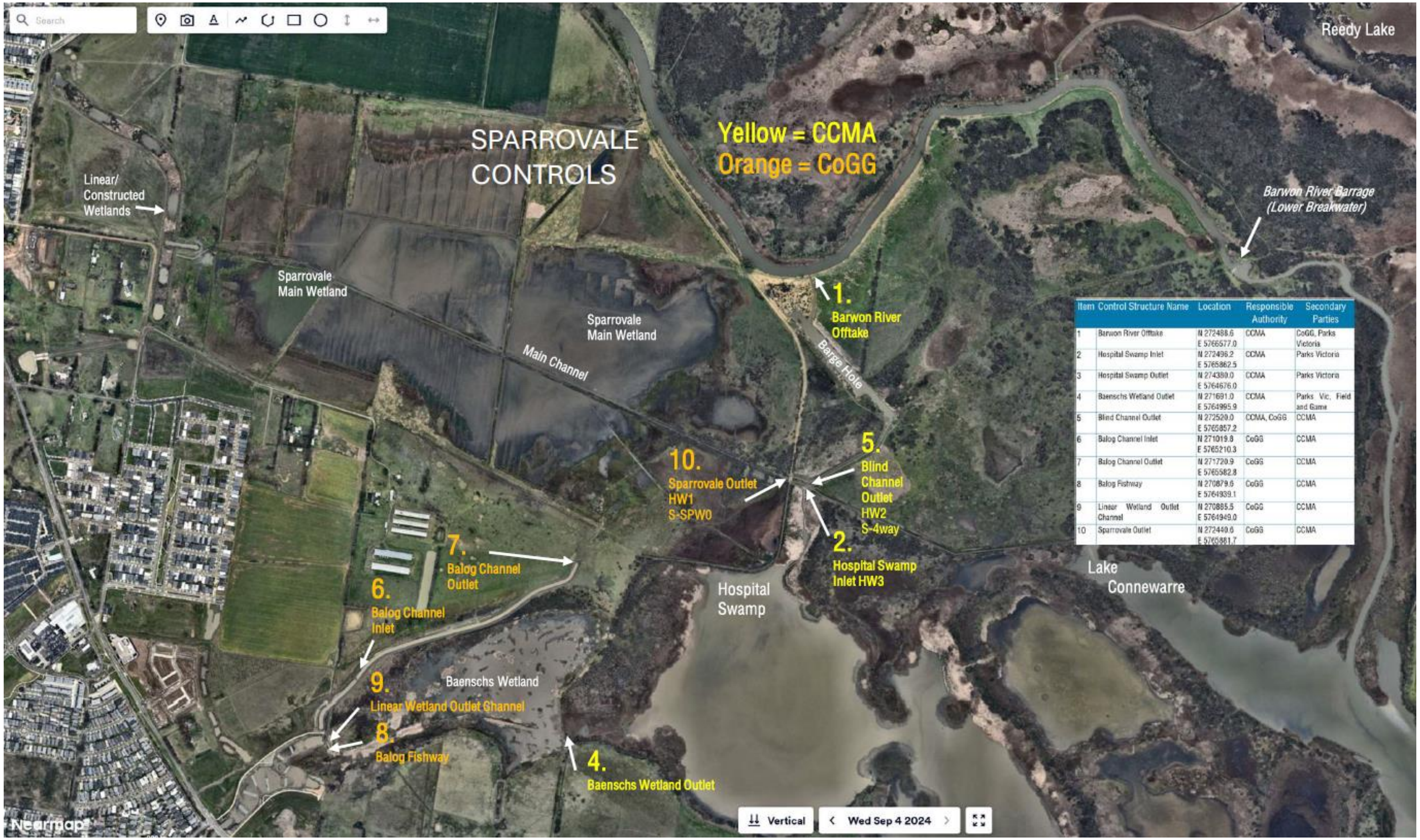
25. For the rest of the year regulator 10 outflows would be directed south into Hospital Swamps with regulator 5 being closed and regulator 2 opened. If additional water was required to satisfy Hospital Swamps needs then regulator 1 on the diversion channel from the Barwon River barrage pondage would be opened, at least in part, to allow river water to also be directed south into Hospital Swamps.

26. Regulator 10 could normally be open or closed during the Dec-March (inclusive) period and open at all other times except when tailwater levels may be elevated (eg., during Barwon River diversion flows or floods, and/or during periods of high (saline) tailwater levels in Lake Conneware).

27. Approximately 200 ha of the Sparrovale Wetlands (land below nominal Normal Top Water Level (NTWL) 0.95 m AHD) is required for the urban stormwater management/Hospital Swamps protection roles. As expressed in the 2014 report by Pat Condina and myself, the design intent was for the wetlands to evolve as a brackish to freshwater ephemeral wetland area, drying out each year on average.

28. The NTWL of 0.95 m AHD was adopted for the long term to maintain security against saltwater intrusion under the year 2100 sea level rise scenario (predicted to rise to a mean of ~0.80 m AHD by 2100). This scenario would preclude gravity outfall from Sparrovale at lower levels. Under current sea level conditions such levels are rarely reached at the Sparrovale outlet.

29. Under present day conditions Sparrovale water levels are highly variable and would rarely reach 0.95 m AHD.



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10	Sparrovale Outlet	N 272440.6 E 5765881.7	CoGG	CCMA

Figure 2 **Main hydraulic controls on inflow and outflow to/from Sparrovale Wetlands**

6. THE CAPACITY OF SPARROVALE (ORIGINAL INTENT) TO MANAGE STORMWATER

30. As part of the EPBC approval process, Venant Solutions were engaged by CoGG to complete hydrologic modelling of the Sparrovale/AC SDC system and its impacts on Hospital Swamps. Key output Tables 3.3, 3.4, 4.1 and 5.1 from the Final report of September 2018 are listed below.

Table 3-3Proposed Sparrovale Wetland Storage Relationship

Level (m AHD)	Area (m^2)	Incremental Volume (m^3)	Cumulative Volume (m^3)
0.2	0	0	0
0.4	666,830	66,683	66,683
0.6	1,273,040	193,987	260,670
0.8	1,587,610	286,065	546,735
1.0	2,008,700	359,631	906,366
1.2	2,229,900	423,860	1,330,226
1.4	2,469,100	469,900	1,800,126
1.6	3,130,980	560,008	2,360,134
1.8	3,209,600	634,058	2,994,192
2.0	3,350,000	655,960	3,650,152

Table 3-4Sparrovale Wetland Modelling Scenarios

	Scenario				
	1	2	3	4	5
AC Diversion@1mAHD	✓		✓	✓	
AC Diversion@0.9mAHD		✓			
AC Catchment 100% Ultimate Development	✓	✓	✓	✓	
HBP Catchment 100% Ultimate Development	✓	✓			
HBP Catchment 50% Ultimate Development			✓		
HBP Catchment Existing Development				✓	✓

Table 4-1 Statistical Analysis of Sparrovale Wetland Hydrology – All Seasons

Water Level Statistics (m AHD)[1]	Scenario				
	1	2	3	4	5
Maximum	1.51	1.51	1.50	1.48	0.85
Minimum	0.20	0.20	0.20	0.20	0.20
Mean	0.35	0.35	0.32	0.30	0.23
Median	0.28	0.28	0.25	0.23	0.21
25th percentile	0.21	0.21	0.20	0.20	0.20
75th percentile	0.41	0.47	0.37	0.33	0.24
95th percentile	0.74	0.77	0.67	0.60	0.33
No. years wetland dries out	125	125	125	125	125

[1]The depth of water can be calculated by subtracting 0.20 m from the water level reported in this table

Table 5-1 Statistical Analysis of Existing and Proposed Outflows

Outflow Statistics	Outflow (ML/day)	
	Scenario 1	Scenario 5
Maximum	145	139
Minimum	0	0
Mean	4.8	0.3
25th percentile	0	0
75th percentile	6.8	0
95th percentile	21	1.3

31. In regard to volume management, modelling of 125 years of daily rainfall data with the assumed hydraulic controls and operating rules showed that after full development was complete in the HBP and AC catchments (not including MP or NEIP):

- The volume of water entering the wetland from Armstrong Creek (ultimate development) is about double that entering from the HBP (ultimate development).
- Total mean annual inflow volume to the Sparrovale Wetlands would be c. 4,850 ML/year.

- Mean annual discharge from the Sparrovale Wetlands would be about 1,750 ML/yr.
- This implies up to ~65% of fully developed mean annual inflow would be removed via evaporation and some seepage.

  As shown in Section 11, such volume reduction exceeds the intent of the "Reasonably Practicable" guidance in EPA Guideline 1739.1, given the constraints imposed by the Barwon Water recycle supply mandate which effectively prevents reuse of the vast quantities of roofwater generated within the precincts.

- The Balog Channel diversion would achieve its primary objective of matching as closely as possible the pre-development inflow regime from Armstrong Creek to Hospital Swamps.

32. The VS 2018 modelling did not quantify the impact on monthly water levels inside Sparrovale itself. The report lists maximum and minimum and various %ile water levels over the 125 years modelled but not monthly average water levels. It did identify monthly and mean daily outflows from Sparrovale.

33. In terms of <u>stormwater quality treatment</u> Sparrovale Wetlands are far larger in area than required to meet normal best practice standards. Modelling for the HBP SWMS showed that a hypothetical wetland treatment area of 7.5 ha would have been required to meet best practice for HBP outflows. Inflows from Armstrong Creek via the Balog Channel are already pre-treated to best practice. With c. 200 ha wetland area available in Sparrovale with NTWL of 0.95 m AHD, water quality treatment potential thus far exceeds best practice in the longer term before discharge.

34. <u>In regard to peak flow mitigation</u> the HBP SWMS modelling identified that an additional retarding storage volume of c.100 ML would be needed in Sparrovale to fully mitigate the impact of increased peak flow discharges from the HBP under full development conditions.

    Scenario 1 (fully developed HBP+AC) results in Table 4.1 show:

- The Sparrovale Wetlands rising to a 95%ile level of 0.75 m AHD and up to a maximum of 1.5 m AHD and drying out completely each year. Mean water levels were 0.35 m AHD (0.15 m depth).

Scenario 5 results in Table 4.1 (existing (pre-developed) conditions HBP, no Balog Channel) show:

- The Sparrovale Wetlands rising to a 95%ile level of 0.33 m AHD and up to a maximum of 0.85 m AHD and drying out completely each year. Mean water levels were ~0.25 m AHD (0.05 m depth).

From Table 3.3 the flood storage volume available above mean water level of 0.35 m AHD NTWL and below the maximum level of 1.5 m AHD is some 2000 ML. As would therefore be expected with such massive storage capacity the maximum mean daily outflow in Table 5.1 shows no significant change from undeveloped conditions.

Conclusions

35. As originally intended and modelled, the Sparrovale Wetlands would have the capacity to:
    - treat input stormwater to far greater than best practice standards,
    - ensure peak flood flows discharged from the HBP are maintained at or below those for existing conditions,
    - protect Hospital Swamps from the impacts of increased freshwater runoff from the ACUGA during the summer/autumn periods,
    - achieve as far as practically possible the intent of EPA Guideline 1739.1 for the total catchment, including Armstrong Creek.

7. ORIGINAL INTENT VERSUS CURRENT DESIGN AND OPERATION

36. After very recently gaining access to the SMEC design plans for Regulator 10 and ancillary controls 2 and 5, the WT 2022 reports, the DU monitoring report of July 2024, and detailed field survey, I am now aware that:

- the hydraulic capacity of the Sparrovale outlet 10 has been reduced by blocking one of the two RCB culverts. The VS modelling assumed 2 No. 2.44*1.22 RCB were in place. The same sizing was assumed in the WT and DU modelling with one blocked.
- Detailed survey has revealed that outlet 10 is 1.8*0.9 m in size so that hydraulic capacity when fully opened is actually 73% of that assumed in the VS modelling.
- The available reports do not indicate that any sensitivity testing was ever carried out beforehand to justify the decision to block one of the RCB culverts.
- The Standard Operating Rules (SOR) currently applied differ significantly from those assumed in the VS 2018 modelling studies.
- The current SOR for the Sparrovale outlet 10 is for the gate over the single culvert to be closed all year except if circumstances dictate otherwise. VS assumed the gates over the 2 culverts would be closed Dec-April inclusive and opened for the rest of the year except if circumstances dictated otherwise.
- Although not modelled by VS the current watering plan for the Barwon regulator 1 is for it to be open between May and November. The original intent was for treated stormwater from Sparrovale to replace the untreated water from the Barwon being diverted into Hospital Swamps during this period as far as practicable in the future. Hence the assumption by VS that Sparrovale outlet 10 would be open unless circumstances dictated otherwise. Keeping gate 1 open over the wet seasons (May-Nov) virtually precludes water being discharged from Sparrovale via gate 10 due to high tailwater levels.

37. These are major changes from the original system hydraulic and operational design so it is to be expected that differences in modelling and monitoring results would occur between

the VS and WT/DU reports. First and foremost, water levels in Sparrovale must be expected to be retained at higher levels and for longer periods than those modelled by VS, exacerbating issues with access track flooding.

38. The WT 2022 modelling tested different watering plans as listed in their Table 6.6 (below).

TABLE 6-6 MODEL SCENARIOS

Option	Scenario	Balog	Fishway/Spillway Armstrong Creek Wetland	Sparrovale Outlet	Barwon to Hospital
Existing	Existing	N/A	N/A	Close	Open (May - Nov)
Option 1	WP1 (water plan 1)	Open (Dec - Apr)	Close	Close	Open (May - Nov)
Option 2	WP2 (water plan 2)	Open (Dec - Apr)	Open (Dec - April)	Close	Open (May - Nov)
Option 3	WP3 (water plan 3)	Open (Full year)	Open (Full year)	Close	Open (May - Nov)
Option 4	Dev_ND (No Diversion)	Close	Close	Close	Open (May - Nov)

39. WP1 and WP2 were the favoured options with mean water level results for ultimate conditions as listed in their Table 6.11 (below).

TABLE 6-11 SPARROVALE WATER LEVEL

Scenario	Summer	Winter
Option 1 – WP1	0.525 m	0.725 m
Option 2 – WP2	0.463 m	0.667 m

40. Under the listed operating rules the WT 2022 modelling is actually reflective of the longer term 2100 scenario that was originally envisaged under full development conditions. Sea level rise would prevent gravity outflow from Sparrovale below water levels of 0.80 m AHD at all times. This effectively matches the current SOR.

41. The WT 2022 modelling thus confirms with certainty that Sparrovale will continue to achieve its original intent for stormwater management under current sea level rise predictions to the year 2100.

8. MONITORING RESULTS AND REPORTED OPERATIONAL ISSUES

42. With all Sparrovale and AC/Balog Channel works now complete, the hydrologic inflow regime within Sparrovale Wetlands is effectively in place now, with volumes increasing as expected each year as development expands in the connected catchments.

43. The Deakin University (DU) monitoring results over the last 3 years are showing:

- Reasonable agreement on levels between recorded and modelled conditions after accounting for Non-Standard control gate interventions (details of which are not reported).
- Reasonable agreement with water level variability trends estimated in the Water Technology (WT) 2022 modelling results.
- Similar runoff volume distribution between AC/Balog Channel and Sparrovale/HBP inputs (accounting for current extents of development) as estimated in the WT 2022 work.
- Regular variation in water levels over a range of 0.2-0.3 m on a 4-6 day cycle at the 4-way intersection immediately downstream of the Sparrovale outlet. This may be linked to Non-Standard gate interventions and possibly tidal influences from Lake Connewarre.
- Water balances as summarised in their Table 3 (below). Note that the last row Total Volume Loss figures are in ML.

Table 3: Water balance analysis for 2022 and 2023

	Oct 21 to Sep 2022	Jan 2023 to Dec 2023
Total Rainfall (mm)	596	430
Total Catchment Run-off (ML), Horseshoe Bend	864.6	342.8
Total Catchment Run-off (ML), Armstrong Creek	3377.6	1617
Total Catchment Run-off (ML)	**4242**	**1960**
Total Flow into Sparrovale (ML)	2063	1893
Total Flow into Baensch's Wetland (ML)	2551	346.7
Total Outflow from Sparrovale at outlet gate to 4-Way interchange (ML)	760.6	527
Total Volume Loss in Sparrovale to groundwater and ETA	**990**	**1003**

44. The water balance results in DU Table 3 also show that:

- In the wet year (Oct 2021-Sep 2022) total inflow into Sparrovale was 2063 ML and total outflow was 761 ML with volume lost to ETA and groundwater of 990 ML. That would imply an increase in storage over that period of about 312 ML. The stage-storage relation used is not given but the water level plots show water level rose from ~0.48 to ~0.73 m AHD over the period. The VS 2018 stage-storage relation shows a gain of 310 ML which is good agreement. The ETA+groundwater loss implies a volume reduction of 48% in Mean Annual Runoff (MAR) over the wet year period.

- In the dry year (calendar year 2023) total inflow into Sparrovale was 1893 ML, total outflow was 527 ML and the volume lost to ETA and groundwater was 1003 ML. This implies an increase in storage over that period of 363 ML. The level plots show water level actually rose from ~0.57 to ~0.66 m AHD over the period. This is an increase of only 130 ML which is not good agreement. The listed ETA+groundwater loss of 1003 ML implies a volume reduction of 53% in MAR over the dry year period.

  (Note: To balance the inflow/outflow figures with recorded water level changes, the ETA+groundwater loss would have needed to be up to 1236 ML which would imply a volume reduction of 60-65%.)

45. Regardless of whether or not any errors exist in DU Table 3 the figures do indicate about 50% of stormwater inflow to Sparrovale Wetlands is being removed via evapotranspiration and seepage in a wet year. More would be expected to be removed in a dry year.

    (Note: Further stormwater volume reduction occurs through evaporation in Hospital Swamps

46. As the current SOR is for the Sparrovale outlet 10 to be closed all year, the figures in DU Table 3 show that all outflow must be being discharged out of Sparrovale via the Non-Standard gate interventions.

47. The DU monitoring results (Jul 2021-Jul 2024) do confirm that Sparrovale Wetlands:

- Are operating very successfully in meeting the design intent for stormwater management and Ramsar protection as expressed in C357, the HBP SMWS and our subsequent 2014/16 reports.

- Are satisfying the intent of EPA Guideline 1739.1. (This is especially laudable in an urban growth area where reuse of the vast volumes of roofwater is effectively prevented as a consequence of Barwon Water mandated connection of all development to the treated recycle water supply).

- Are experiencing periods of higher than desired (and originally modelled) water levels which may be compromising potential ecological values within the wetlands and exacerbating flooding issues on internal access tracks.

  In part this may have been due to higher rainfalls. For the 3 years after construction of the Balog Channel (2020-2022 inclusive) total annual rainfall was more than 20% higher than average.

9. POTENTIAL SOLUTIONS TO REPORTED OPERATIONAL ISSUES

48. The modelled/monitored situation shows higher ponded water levels in summer/autumn seasons than were originally envisaged. In my opinion this outcome:

    - Is largely due to the above-mentioned changes from original Sparrovale outlet 10 hydraulic capacity and its operating rules,
    - Is not reflective of errors or shortcomings in the VS 2018 modelling,
    - Could also reflect the impact of leaving the Barwon offtake gates 1 open from May-November.

49. It could be reasonably expected that variation of operating rules on the Sparrovale outlet 10 and restoration of its original design capacity, might effectively mitigate these impacts. It is also possible that river diversion flows from the Barwon outlet 1 to Hospital Swamps via regulator 2 could be restricted to reduce backwater effects on the Sparrovale outlet 10.

50. The detail survey shows it is likely that localised flooding issues on lowpoint sections of access tracks will require those sections to be raised. One key access point is at 0.6 m AHD which is below the mean winter water levels modelled by WT under both WP1 and WP2 watering plan options.

51. The DU monitoring studies deal with impacts of emerging development across the catchments, not ultimate development conditions, so the models are probably not ready to be used for full development conditions at present.

52. The WT 2022 work is reflective of current operating rules and actual outlet capacity in Armstrong Creek and it addresses full development conditions. It can easily be adjusted to match the surveyed capacity of the Sparrovale outlet 10. I am satisfied the WT model is robust and is currently best suited to assess the likely impact of potential operational and outlet capacity changes affecting Sparrovale Wetlands.

53. Restoration of outlet capacity of Regulator 10 by unblocking the original culvert and adding an extra gate should be an early trial. Hydraulic capacity is doubled for any gate opening/tailwater level scenario so water will be discharged faster at any headwater level.

54. In the summer/autumn periods trial runs could also examine opening of both Regulators 10 and 5 with Regulator 2 closed (to protect Hospital Swamps). There is a trade-off to be evaluated on volume of water removed by evaporation and seepage (keeping water ponded longer in the warmer weather is a plus for both) against discharging it at controlled rates (to better protect internal seasonal vegetation areas).

55. In the winter/spring periods Regulator 10 and 2 gates should normally be opened with gate 5 closed to pass all treated Sparrovale outlet water to Hospital Swamps. Unlike the current operating rule, the Barwon regulator 1 would only be opened if insufficient water was being discharged from Sparrovale (and Armstrong Creek) to satisfy watering demands in Hospital Swamps. The Barwon water is untreated so should ideally be used as the backup source for Hospital Swamps.

10. ADDITION OF MP AND NEIP STORMWATER TO SPARROVALE

56. The MP SWMS currently proposes to discharge treated and retarded stormwater into Sparrovale via DCP item DI-DR14. There are no requirements for volume reduction over and above the ~10% reduction normally achieved via evaporation from wetland treatment areas in the precinct.

57. Both the MP SWMS and the Sparrovale Ngubitj Yoorree Wetlands Master Plan (at Section 4.2.3) assume inflows from the southern catchment of NEIP will also enter Sparrovale. The MP DCP provides for cost sharing of DI-DR14 between MP and NEIP based on catchment area ratio. The NEIP catchment contributes 85% (97 ha) with the remaining 15% to Marshall SE Catchment K (17 ha).

58. Putting ultimate catchment runoff volumes into context, Figure 3 below shows relative mean annual runoff (MAR) volume contributions to Lake Connewarre from the ACUGA precincts and the wider Barwon catchment. In regard to overall discharge of freshwater to Lake Connewarre it can be noted that when fully developed the ACUGA will discharge just 1.3% of the total. The greater Barwon River catchment contributes 98.7% of the total- the majority of which receives little or no treatment.

    (Note: The MAR figures for the Armstrong Creek precincts and HBP are based on the VS 2018 results (there should be no significant difference with WT 2022 modelling for fully developed catchment inflow volumes). The MP and NEIP figures are derived from current MUSIC modelling.)

59. Given that the MP inflow of 54 ML/yr would increase MAR to Sparrovale from ~4,850 ML/yr to ~4,900 ML/yr (1.0%) in the long term, not requiring further volume reduction for MP water is entirely appropriate in my opinion.

60. Addition of both MP and NEIP stormwater would increase total MAR to Sparrovale from ~4,850 to ~5,200 ML/yr (7.2%) overall and not significantly affect overall volume reduction.

Figure 3 **Mean annual runoff (MAR) volumes-freshwater (fully developed catchments)**

61. On this basis it is my opinion there should be no impediment to adding in the MP and NEIP flows without extra volume reduction. This would offer the most economic, simplest and environmentally friendly solution to meeting EPA 1739.1, whilst avoiding the need for extra drainage outfalls through the sensitive eastern floodplain into the Barwon River barrage pondage, as was proposed in the original NEIP SWMS from 2009.

62. The WT 2022 fully developed modelling setup again offers the quickest and easiest way to confirm any marginal impact in ponding duration and water levels in Sparrovale wetlands associated with adding in MP and NEIP flows.

63. Total MAR from the relevant catchments of MP and NEIP should be discharged into Sparrovale. Diversion of high flows direct to the Barwon along the north side of the main Goodman Road levee is not required primarily because high flows account for only a small percentage of MAR. For example:

- If only treated outflows from a wetland system were to enter Sparrovale south of Goodman Road this would mean 93% of the NEIP MAR volumes would still go into Sparrovale with just 7% going to the river.

- if a 20%AEP flow limit was used (standard urban residential stormwater pipe capacity) then 98% of the NEIP MAR volumes would go into Sparrovale with just 2% going to the river.

The Barwon levee along Goodman Road is subject to overtopping for Barwon River floods rarer than 10%AEP which further invalidates the need for high flows from NEIP to be directed eastwards into the river.

(Note: Detail survey reveals most of the levee is 2.4-2.5 m AHD but a localised lowpoint exists at 2.16 m AHD near the river end. This lowpoint should be raised to at least 2.4 m AHD to maintain flood protection to Sparrovale Wetlands from the Barwon.)

11. ADDRESSING EPA PUBLICATION 1739.1

64. EPA Publication 1739.1 is not a compliance document. It is a guideline setting out guidance to help minimise risks from urban stormwater, so far as is reasonably practicable.

65. EPA Publication 1739.1 sets out volume reduction targets which vary with mean annual rainfall. The volume reduction target is for mean annual impervious runoff (MAIR) and not total mean annual runoff (MAR). MUSIC modelling shows MAIR is 85% of MAR for 70% average catchment imperviousness in this area.

66. For the 500 mm rainfall band which covers Sparrovale the priority target is 77% reduction via harvest/evapotranspiration and 5% via seepage or 82% total MAIR. Hence the 1739.1 target in Sparrovale is 0.85*82=70% of MAR.

67. Roofwater storage and reuse has been modelled in Geelong as achieving up to 20% reduction in MAR from residential development at 70% imperviousness. Given this option

is ruled out by the Barwon Water recycle supply mandate, achieving the priority target (so far as is reasonably practicable) under 1739.1 implies removal of up to 50% of MAR.

68. In Section 6 it was concluded that on the basis of modelling and monitoring records that the intent of EPA Guideline 1739.1 is being achieved now in Sparrovale and this will continue with full catchment development.

12. SUMMARY

69. As originally intended and modelled by VS, the Sparrovale Wetlands would have the capacity to:
    - treat input stormwater to far greater than best practice standards,
    - ensure peak flood flows discharged from the HBP are maintained at or below those for existing conditions,
    - protect Hospital Swamps from the impacts of increased freshwater runoff from the ACUGA during the summer/autumn periods,
    - achieve as far as practically possible the intent of EPA Guideline 1739.1 for the total catchment, including Armstrong Creek.

70. Major changes have been made from the original system hydraulic and operational design so it is to be expected that differences in modelling and monitoring results would occur between the VS and WT/DU reports. Detailed survey also shows that the Sparrovale outlet 10 is smaller in size than assumed in all previous reports. Consequentially, water levels in Sparrovale must be expected to be retained at higher levels and for longer periods than those modelled by VS, exacerbating issues with access track flooding.

71. The DU monitoring results (Jul 2021-Jul 2024) do confirm that Sparrovale Wetlands:

    - Are operating very successfully in meeting the design intent for stormwater management and Ramsar protection as expressed in C357, the HBP SMWS and our subsequent 2014/16 reports.

- Are satisfying the intent of EPA Guideline 1739.1. (This is especially laudable in an urban growth area where reuse of the vast volumes of roofwater is effectively prevented as a consequence of the Barwon Water mandated connection of all development to the treated recycle water supply).

- Are experiencing periods of higher than desired (and originally modelled) water levels which may be compromising potential ecological values within the wetlands and exacerbating flooding issues on internal access tracks.

  In part this may have been due to higher rainfalls. For the 3 years after construction of the SDC (2020-2022 inclusive) total annual rainfall was more than 20% higher than average.

72. It could be reasonably expected that variation of operating rules on the Sparrovale outlet 10 and restoration of its original design capacity, might effectively mitigate these impacts. It is also possible that diversion flows from the Barwon outlet 1 to Hospital Swamps could be restricted to reduce backwater effects on Regulator 10.

73. The WT 2022 work is reflective of current operating rules and outlet capacity in Armstrong Creek and it addresses full development conditions. It can easily be adjusted to reflect the true capacity of Sparrovale outlet 10. I am satisfied the WT model is robust and is currently best suited to quickly assess likely impact of potential operational and outlet capacity changes.

74. Restoration of outlet capacity of Regulator 10 by unblocking the original culvert and adding an extra gate should be an early trial. Hydraulic capacity is doubled for any gate opening/tailwater level scenario so water will be discharged faster at any headwater level.

75. In the summer/autumn periods trial runs could also examine opening of both Regulators 10 and 5 with Regulator 2 closed (to protect Hospital Swamps). There is a trade-off to be evaluated on volume of water removed by evaporation and seepage (keeping water ponded longer is a plus for both) against discharging it at controlled rates (to better protect internal seasonal vegetation values).

76. In the winter/spring periods Regulator 10 and 2 gates should normally be opened with 5 closed to pass all treated Sparrovale outflow water to Hospital Swamps. Unlike the current operating rule, the Barwon regulator 1 would only be opened if insufficient water was being discharged from Sparrovale and Armstrong Creek to satisfy watering demands in Hospital Swamps. The Barwon water is untreated so ideally should be used as the backup source.

77. Addition of both MP and NEIP stormwater would increase total inflow volume to Sparrovale by 7.2% overall and not significantly affect overall volume reduction. On this basis it is my opinion there should be no impediment to adding in these flows without further volume reduction. This would offer the most economic, simplest and environmentally friendly solution to meeting EPA 1739.1 whilst avoiding the need for extra drainage outfalls through the sensitive eastern floodplain into the Barwon River barrage pondage, as was proposed in the original NEIP SWMS from 2009.

78. Total MAR from the relevant catchments of MP and NEIP should be discharged into Sparrovale. There is no need for costly and disruptive high flow diversion east to the Barwon.

79. The WT 2022 fully developed modelling setup again offers the quickest and easiest way to confirm any marginal impact in ponding duration and water levels in Sparrovale wetlands due to adding in MP and NEIP flows.

80. Under the listed operating rules the WT 2022 modelling is actually reflective of the longer term 2100 scenario that was originally envisaged under full development conditions. Sea level rise would prevent gravity outflow from Sparrovale below water levels of 0.80 m AHD at all times. This effectively matches the current SOR.

81. The WT 2022 modelling thus confirms with certainty that Sparrovale will continue to achieve its original intent for stormwater management under current sea level rise predictions in the year 2100.

82. On the basis of modelling and monitoring records, the intent of EPA Guideline 1739.1 is being achieved now in Sparrovale and this will continue with full catchment development.

13. DECLARATION

In preparing this statement I have made all the enquiries that I believe to be desirable and appropriate, and that no matters of significance that I regard as relevant have to my knowledge been withheld from the Panel.

N Craigie

Neil M Craigie

BE Civil, MEngSci, MIEAust, CPEng (Ret)

28 October 2024

Appendix A Statement Of Qualifications And Experience

Name: Neil McKinnon Craigie

Address: 40 Jamieson Court, Cape Schanck, VIC 3939

Business Phone: 0427 510 053 **Email**: nmcraigie@bigpond.com

Professional Qualifications:

B.E. (Civil), Monash University 1975
Grad. Course in Engg. Hydrology, UNSW 1976
M.Eng. Sci., Monash University 1981

Professional Background:

1974 Joined Dandenong Valley Authority (DVA)
1980 Appointed as Design Engineer
1984 Appointed as Design and Investigation Engineer controlling hydrologic and hydraulic investigations, project design and engineering consultancy services
1989 Commenced private practice as a waterway management consultant.

Current Occupation: Waterways Management Consultant
trading as Neil M Craigie Pty Ltd

Affiliations: Member, Institution of Engineers Australia (MIEAust, CPEng (Ret))

Experience:
I have extensive experience in:

- river basin management,
- assessment and design of restoration works for degraded and/or unstable natural waterway systems,
- assessment and design of mitigation works to address the effects of urbanisation on waterway systems,
- investigation and design of drainage and flood management schemes of all forms and sizes in both urban and rural settings,
- troubleshooting and remedial design in urban drainage systems.
- investigation, design and ongoing management of wetland, lake and tidal waterway systems

Whilst with the DVA, I directed all hydrologic and hydraulic investigations, project design and consultancy services. I led the preparation of standards for stream restoration work and developed innovative techniques for evaluation and appraisal of waterway management problems. I have further refined and applied these techniques since commencing private practice, in major studies throughout Victoria and in Far North and South-East Queensland.

In recent years, I have undertaken work in the field of environmental flows, providing hydraulic and waterway management input to multi-disciplinary teams. I was a team member for the Environmental Flow Assessment for the Lower Thomson and Macalister Rivers in Victoria (CRC Freshwater Ecology, 1999). Since 2000, I have assisted Dr Sandra Brizga on the environmental flow studies carried out for the Water Allocation and Management Plans (WAMPs) on the Pioneer and Logan Rivers, for the Water Resource Plans (WRP's) on the Mary and Maroochy Rivers in Queensland, and the River Processes Study on the Mary River. Each of these studies is a major multidisciplinary undertaking involving specialists from a range of disciplines, including hydrology, hydraulics, geomorphology, water quality, and ecology (aquatic and riparian vegetation, macroinvertebrates, fish, and other vertebrates such as turtles, platypus and dugong).

I have carried out and/or directed numerous hydrologic and hydraulic studies, utilising computer based models. I have particular expertise in retarding/retention basin design, several examples of which have featured novel outlet works designed to counteract high debris loads, mitigate sediment discharge, provide water quality treatment, and dissipate very high flow velocities.

In the field of management of natural waterway and floodplain systems, I and my associates have collaborated on a series of complex hydro-geomorphological investigations. These studies involved integration of unsteady-state two dimensional hydraulic modelling and fluvial geomorphology analyses to develop waterway management plans which recognise and address the governing physical processes (for example, the Tambo River at Bruthen, Badger Creek through Healesville Sanctuary, and Glenelg River sand transport studies).

In the urban areas I have been closely involved in the development and preparation of municipal/agency stormwater management plans across the greater Melbourne area.

I and my associates are continuing to play leading roles in conceptual planning and design of stormwater quantity and quality management systems involving open waterways, wetlands and lakes in many of the large residential estates developed in greater Melbourne since the late 1990's (for example, Caroline Springs, The Waterways Estate, Tenterfield Estate, The Boardwalk Estate, Berwick Springs Estate, Beaumont Waters Estate, Torquay Sands, Lakeside at Pakenham, Pt Cook Gardens Estate, Lincoln Heath Estate, Marriott Waters, Martha Cove, Highlands Estate).

I am also active at the regional level with similar water management system planning (for example; Paynesville, Port Fairy, Warrnambool, Bendigo, Geelong/Bellarine Peninsula, Mornington Peninsula, Phillip Island/San Remo, Castlemaine, Traralgon, Warragul, Ballarat).

In conjunction with associates in the field of stormwater and wastewater quality treatment and aquatic biology, I have developed innovative approaches to design of stormwater quality management systems and all aspects of water sensitive urban design, and have applied these in a variety of urban, semi-urban and rural settings.

In the rural areas I have jointly carried out investigations into redesign opportunities for irrigation drainage systems to mitigate sediment and nutrient loads, for Goulburn-Murray

Water. This work culminated in the design and construction of a major artificial wetland system serving the Muckatah Depression Drainage Scheme in Northern Victoria. This project has since won the IEAust Engineering Excellence Award.

In conjunction with my associates, I have won UDIA Awards for Excellence for Water Sensitive Urban Design and Residential Development in 2000, 2002, 2003, 2004, 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2017 and 2018, the SIAV Award for Stormwater Innovation in 2004 and 2005 (2) and the Stormwater Victoria Award for Excellence in Integrated Stormwater Design (2015). I was the recipient of the ALDE Recognition Award in 2012.

Since commencing private practice in 1989 I have also gained considerable experience as an expert witness, preparing and presenting numerous submissions to VCAT and various Planning Panels on drainage, waterway and floodplain management implications of proposed development projects throughout Victoria.

Neil M Craigie