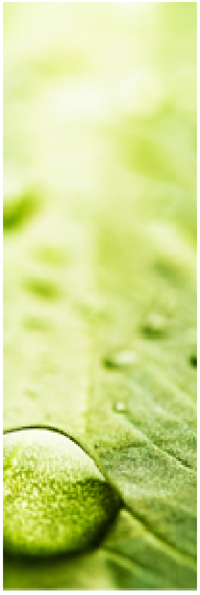
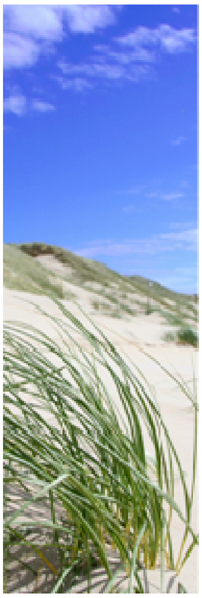
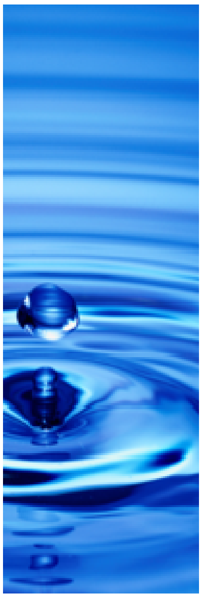
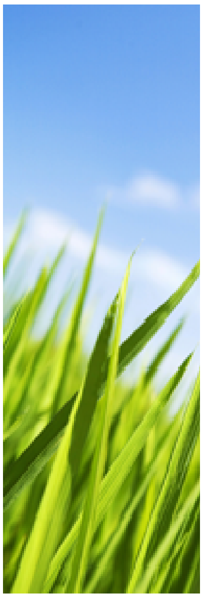
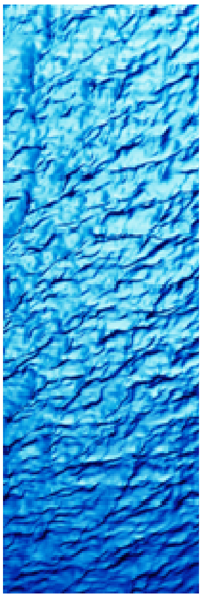
Victorian Desalination Project

Tracer Modelling Addendum
for
DP1-0003: Hydrodynamic Modelling

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Figures and Tables

1 Introduction

This report provides further hydrodynamic modelling (by way of an addendum), required in the design process for the Victorian Desalination Project. The design is being undertaken by the Parsons Brinckerhoff Beca Joint Venture (PBB) on behalf of the Thiess Degrémont Joint Venture (TDJV). Cardno Lawson Treloar is providing hydrodynamic modelling services to PBB.

This addendum is intended to provide further information regarding the potential for entrainment of biological material in both the intake flow and density currents which result from mixing of the discharged brine with the ambient water. The analysis uses the same locations considered in optimising the outlet location for elevated salinity.

2 Previous Studies

The basis for this addendum is the modelling carried out and reported in report RP-PBB-HS-1-A-102-0210-F-01 (Hydrodynamic Modelling Report). The report considered the potential for entrainment of biological material, in particular larvae and gametes, in the density flow resulting from the discharge of brine from the project outlets. As the brine mixes with ambient water and flows offshore as a density current, there is the possibility that larvae and gametes will be entrained from the coastal waters and carried offshore, thus affecting the settling and recruitment of organisms living in the near-shore area. In the previous work, this process has been investigated using passive tracers. A conservative, passive tracer was introduced into the model at different levels in the water column at six locations and the model run for 15 days for both the existing conditions (no project) and for the proposed intake and outlet running at average flow and discharge salinity conditions. Details of the model-result analysis are presented in Section 5.4 of the above-mentioned report.

3 Requirement for additional modelling

The tracer modelling referred to in the previous section considered release of tracers at six locations in the surface layer and at mid-depth, and from the bottom layer the one location closest to the intake. This modelling only considered the entrainment for the proposed location of the project diffuser. As part of the requirements to fulfil PR218, it is required to investigate the entrainment for other potential sites for the outlet.

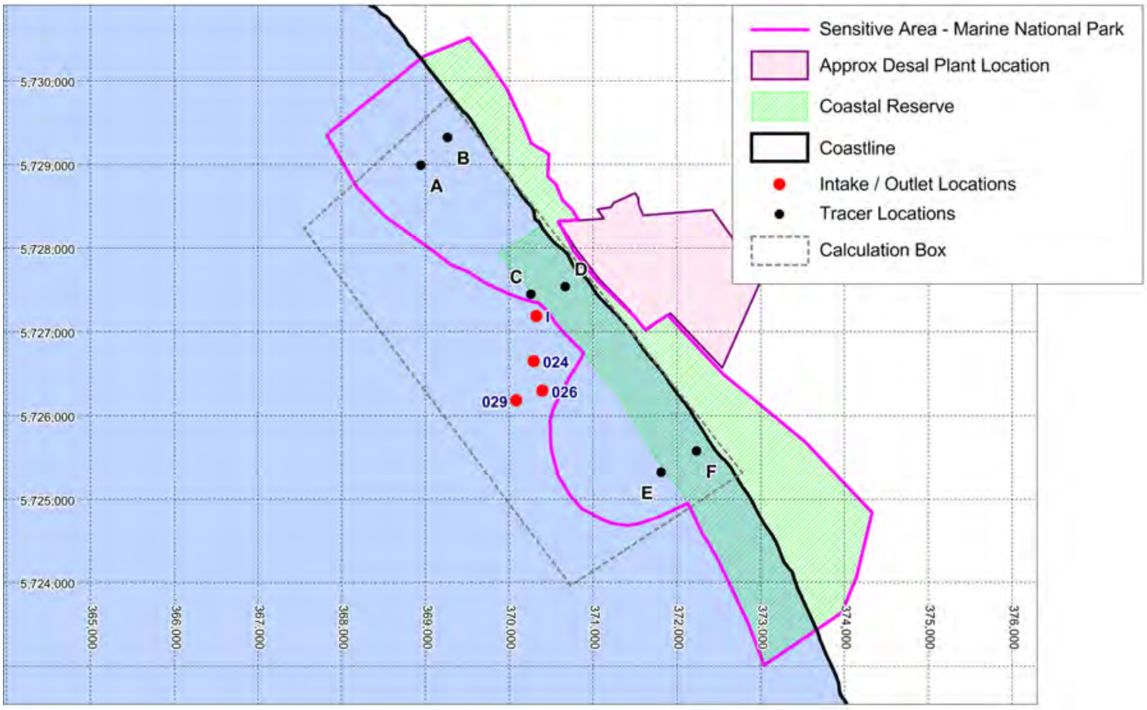
4 Modelling

4.1 Model set up

Modelling of tracers was undertaken as described in the Hydrodynamic Modelling Report, but with the outlet in two other locations. These are designated O26 and O29 to indicate the water depth for each (26 and 29 m respectively). The project location is designated O24 for the purposes of this exercise. These sites are shown in Figure 4.1 along with the locations of the tracer release (labelled A-F). The same project intake and outlet flows and salinity as used in the original modelling were used. The outlet flows were introduced to the model in the same way as described in the Hydrodynamic Modelling Report; that is, the correct volume of water and mass of salt was

distributed over all ten layers of the model cell representing the outlet. The distribution was linear in the vertical, as described in 4.3 of the report.

Figure 4.1 Locations used in the modelling



4.2 Model results

The model results, based on a 15-day simulation for each outlet configuration, are shown in Table 4.1. The values in the table represent the percentage of the total tracer introduced which crosses each of the north, south and offshore boundaries as well as the percentage remaining in the indicated area ("Calculation Box") and taken in by the intake. The final row in each case indicates the "Mass Balance Error" and is the difference between the tracer introduced into the model and that counted in the analysis. For each outlet configuration, the net transport (as a percentage) and the difference between that transport and the value for the existing (no project) case is presented. The final columns indicate the difference, as indicated, between the impacts of each configuration.

Table 4.1 Results of tracer calculations over a 15-day period, % of total tracer quantity

Tracer Input		Calculation Boundary	Net Transport	Net Transport	Project Impact	Net Transport	Project Impact	Net Transport	Project Impact	Impact difference	
Location	Layer		EXISTING	O24	O24	O26	O26	O29	O29	O24-O26	O24-O29
A	Mid Layer	North	-42.7	-32.9	-9.9	-34.4	-8.3	-33.5	-9.3	-1.5	-0.6
		South	-49.3	-46.7	-2.6	-48.2	-1.1	-48.8	-0.5	-1.5	-2.1
		Offshore	-5.9	-16.8	10.8	-14.4	8.5	-14.7	8.8	2.3	2.1
		Area	4.8	4.9	-0.1	4.9	-0.1	5.1	-0.3		
		Intake	-	-0.7	-	-1.0	-	-1.1	-		
		Mass Balance Error	*-2.8*	*-1.9*		*-2.9*		*-3.1*			
	Top Layer	North	-27.6	-24.0	-3.6	-23.7	-3.9	-23.5	-4.0	0.3	0.5
		South	-43.2	-41.4	-1.8	-41.8	-1.4	-40.2	-3.0	-0.4	1.2
		Offshore	-23.1	-28.8	5.8	-28.8	5.7	-31.0	7.9	0.0	-2.1
		Area	4.2	4.1	0.1	4.2	0.0	4.3	-0.2		
		Intake	-	-0.1	-	-0.3	-	-0.3	-		
		Mass Balance Error	*2.0*	*1.5*		*1.3*		*0.7*			
B	Mid Layer	North	-40.3	-32.9	-7.4	-34.3	-6.0	-34.0	-6.3	-1.4	-1.1
		South	-51.0	-48.9	-2.0	-49.3	-1.6	-49.0	-1.9	-0.4	-0.1
		Offshore	-5.5	-14.3	8.8	-12.8	7.2	-13.4	7.9	1.5	0.9
		Area	4.1	4.2	-0.2	4.2	-0.2	4.4	-0.4		
		Intake	-	-0.3	-	-0.4	-	-0.4	-		
		Mass Balance Error	*-0.8*	*-0.6*		*-1.0*		*-1.3*			
	Top Layer	North	-33.5	-28.6	-4.9	-28.9	-4.5	-28.7	-4.8	-0.4	-0.1
		South	-43.6	-40.1	-3.5	-40.6	-3.0	-39.5	-4.2	-0.5	0.6
		Offshore	-19.0	-27.0	8.1	-26.3	7.3	-28.0	9.0	0.8	-0.9
		Area	3.4	3.4	-0.1	3.4	-0.1	3.6	-0.3		
		Intake	-	0.0	-	-0.1	-	-0.1	-		
		Mass Balance Error	*0.5*	*0.8*		*0.6*		*0.1*			

Table 4.1 (cont'd)

Tracer Input		Calculation Boundary	Net Transport	Net Transport	Project Impact	Net Transport	Project Impact	Net Transport	Project Impact	Impact difference	
Location	layer		EXISTING	O24	O24	O26	O26	O29	O29	O24-O26	O24-O29
C	Bottom Layer	North	-27.8	-9.8	-18.0	-10.3	-17.5	-10.5	-17.4	-0.5	-0.7
		South	-63.5	-47.6	-15.9	-50.3	-13.1	-49.8	-13.7	-2.7	-2.2
		Offshore	-8.6	-39.6	30.9	-36.2	27.6	-37.8	29.2	3.4	1.7
		Remaining in box	2.8	2.9	-0.1	2.9	0.0	3.0	-0.2		
		Intake	-	-1.2	-	-1.4	-	-2.4	-		
		Mass Balance Error	-2.8	-1.1		-1.1		-3.5			
	Mid Layer	North	-28.1	-10.7	-17.4	-11.1	-17.0	-10.9	-17.2	-0.4	-0.2
		South	-63.9	-48.2	-15.7	-51.2	-12.7	-50.0	-13.9	-3.1	-1.8
		Offshore	-8.1	-37.7	29.5	-35.8	27.6	-37.4	29.2	1.9	0.3
		Area	2.8	2.9	-0.1	2.9	-0.1	3.0	-0.2		
		Intake	-	-1.5	-	-2.9	-	-2.9	-		
		Mass Balance Error	-3.0	-1.0		-3.9		-4.2			
	Top Layer	North	-8.9	-7.5	-1.3	-7.3	-1.6	-7.4	-1.5	0.3	0.1
		South	-46.2	-44.4	-1.8	-44.8	-1.4	-43.2	-3.0	-0.4	1.3
		Offshore	-42.3	-44.4	2.1	-44.2	2.0	-46.5	4.2	0.2	-2.1
		Area	2.8	2.9	-0.1	2.9	-0.1	3.1	-0.2		
		Intake	-	-0.1	-	-0.4	-	-0.4	-		
		Mass Balance Error	-0.1	0.6		0.4		-0.5			

Table 4.1 (cont'd)

Tracer Input		Calculation Boundary	Net Transport	Net Transport	Project Impact	Net Transport	Project Impact	Net Transport	Project Impact	Impact difference	
Location	layer		EXISTING	O24	O24	O26	O26	O29	O29	O24-O26	O24-O29
D	Mid Layer	North	-26.8	-12.3	-14.5	-12.9	-13.9	-12.9	-13.9	-0.6	-0.6
		South	-64.5	-54.1	-10.4	-55.8	-8.7	-53.4	-11.1	-1.7	0.7
		Offshore	-8.5	-31.9	23.3	-30.0	21.4	-32.4	23.9	1.9	-0.6
		Area	2.9	3.0	-0.1	3.0	-0.1	3.1	-0.3		
		Intake	-	-0.4	-	-0.6	-	-0.7	-		
		Mass Balance Error	-2.7	-1.7		-2.3		-2.5			
	Top Layer	North	-13.5	-10.0	-3.5	-9.9	-3.6	-10.0	-3.4	0.1	0.0
		South	-46.6	-45.6	-0.9	-46.2	-0.4	-44.6	-2.0	-0.6	1.1
		Offshore	-37.2	-40.8	3.6	-40.3	3.0	-42.5	5.2	0.5	-1.6
		Area	2.6	2.7	-0.1	2.7	-0.1	2.9	-0.3		
		Intake	-	-0.1	-	-0.2	-	-0.2	-		
		Mass Balance Error	0.1	0.7		0.7		-0.2			

Table 4.1 (cont'd)

Tracer Input		Calculation Boundary	Net Transport	Net Transport	Project Impact	Net Transport	Project Impact	Net Transport	Project Impact	Impact difference	
Location	layer		EXISTING	O24	O24	O26	O26	O29	O29	O24-O26	O24-O29
E	Mid Layer	North	-9.1	-5.0	-4.1	-3.9	-5.2	-4.0	-5.1	1.1	1.0
		South	-73.3	-54.2	-19.2	-56.4	-17.0	-55.3	-18.0	-2.2	-1.2
		Offshore	-16.9	-38.5	21.6	-37.6	20.7	-38.9	22.0	0.9	-0.4
		Area	1.8	1.9	-0.1	1.9	0.0	1.9	-0.1		
		Intake	-	-0.2	-	-0.3	-	-0.3	-		
		Mass Balance Error	-1.2	0.2		-0.1		-0.5			
	Top Layer	North	-4.8	-5.4	0.5	-4.8	-0.1	-5.0	0.2	0.6	0.4
		South	-53.4	-51.5	-1.8	-53.7	0.3	-53.2	-0.2	-2.1	-1.7
		Offshore	-40.7	-41.7	1.0	-40.2	-0.5	-40.8	0.1	1.5	0.9
		Area	2.0	2.1	-0.1	2.1	-0.1	2.2	-0.2		
		Intake	-	-0.1	-	-0.2	-	-0.2	-		
		Mass Balance Error	-0.9	-0.8		-1.0		-1.5			
F	Mid Layer	North	-7.1	-5.9	-1.2	-5.2	-1.9	-5.6	-1.5	0.7	0.3
		South	-59.3	-59.9	0.5	-62.3	3.0	-61.3	2.0	-2.5	-1.5
		Offshore	-33.0	-32.5	-0.6	-31.3	-1.7	-32.2	-0.9	1.1	0.3
		Area	1.9	1.9	-0.1	1.9	-0.1	2.0	-0.1		
		Intake	-	-0.1	-	-0.4	-	-0.4	-		
		Mass Balance Error	-1.3	-0.3		-1.2		-1.4			
	Top Layer	North	-7.8	-7.7	-0.1	-7.0	-0.7	-7.3	-0.4	0.6	0.3
		South	-54.7	-54.4	-0.3	-56.5	1.9	-55.2	0.5	-2.1	-0.8
		Offshore	-36.3	-36.0	-0.3	-35.0	-1.3	-36.1	-0.1	1.0	-0.2
		Area	2.0	2.1	-0.1	2.1	-0.1	2.2	-0.2		
		Intake	-	-0.1	-	-0.2	-	-0.2	-		
		Mass Balance Error	-0.8	-0.3		-0.9		-1.2			

5 Discussion

The model results shown in Table 4.1 indicate very little change in the movement of tracer when comparing the three outlet locations. In other words, the performance of the outlets at the three locations is very similar. There are a number of factors which are thought to contribute to this result.

One significant factor is that the dominant transport of tracer is along shore. In every case, the transport across one of the long shore boundaries, generally to the south, is greater than the transport offshore. Changes in the offshore transport do not alter this dominant flow.

Another factor is that the volume and concentration of brine is the same in each case. This means that the density and volume of the diluted brine which makes up the density current is very similar from each of the outlet locations and, similarly, the volume of ambient water, and therefore tracer, which is entrained is very similar at the three locations.

The final factor worth mentioning in this context is the spatial separation of the outlets. When viewed in relation to the scale of the current patterns, there is not a large distance between the outlet sites. The major features of the current patterns are such that all the outlet locations experience similar flow patterns and hence their impact on the tracer distribution are similar.

6 Relation to PR218

PR218 States: *Prior to the construction of the diffuser the Project Company (AquaSure) must demonstrate to the EPA, following examination by the Independent Reviewer and Environmental Auditor, that the diffuser has been designed, and will be located and operated, in a manner that minimises the size of the mixing zone to the extent practicable and minimises the environmental risks outside the mixing zone.*

As part of the process of optimising the outlet design and its final proposed location, the direct performance of the final Project Design was compared to the Reference Design. This comparison clearly demonstrates that the Project Design and location results in improved mixing and a smaller area enclosed by the 1 psu salinity-rise contour, and that this area is located farther away from the Sensitive Area than for the Reference Design.

A further comparison was undertaken in this addendum to compare the impact of density currents from the preferred 24 m depth location and further locations at 26 m and 29 m depth. This comparison demonstrates that, for the modelled locations investigated (refer to Figure 4.1), there is little difference in the outlet performance at the 24 m, 26 m, and 29 m deep locations in terms of entrainment by the density current.

7 Conclusion

Tracer modelling using the same methodology as in the Hydrodynamics Modelling Report applied to three locations for the outlet indicates that there is little, if any, difference in performance of the three outlets in terms of entrainment, as any variability in performance is very close to the levels of uncertainty in the model.