

Tootgarook Wetland/Boneo Swamp – Conceptual Model Summary Information Template

Ref.	Theme	Sub-Theme	Data Components, Information Sources To be populated in workshop, provide reference of contact for data sources	Description
1.1	Ecosystem Type	Type		Wetland
1.2		Location, Name, Area	Wetlands_1994	Boneo Swamp (Tootgarook Wetland) 298 ha (includes a 22ha island) Lat/Long: 38° 23' 35" S, 144° 52' 22" E Situated between Boneo and Tootgarook in Rosebud West, on the Nepean Peninsula, 65km south of Melbourne
1.3		Classification	GIS	Shallow marsh - Reed dominated
1.4		Site history	Wetlands_1788 Wetlands_1994 Southern Peninsula Indigenous Flora & Fauna Assoc. Tootgarook Swamp. http://www.spiffa.org/tootgarook-swamp.html . Accessed 6/03/2012 Condina (2011)	Was originally a shallow freshwater marsh of 475 ha. Drainage commenced in 1878, to prevent flooding and create arable land, and continued into the mid 1900's. Marl and limestone were mined from the site with a tramway running down Truemans Road to the bay. Marks lime kiln was situated on the original course of Chinamans Creek in the northwest of the site. Vegetation, limestone and peat removal was extensive in the mid to late 1800's. Dairy farming began in 1850 near Borneo and increased vegetation clearance. There is evidence of in-filled former swampland for development purposes. Infilling and vegetation clearing still occurs. Chinamans Creek was realigned and channelised in 1911. The swamp remains largely in private ownership (80%). MW is considering a buyback program.
1.5		Value	GDE Biodiversity Value layer EVC_2005 Southern Peninsula Indigenous Flora	GDE biodiversity values are high-very high. The swamp represents the largest remnant of natural freshwater marsh in the Melbourne Water region.

			<p>& Fauna Assoc. Tootgarook Swamp. http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012</p> <p>MW Tootgarook Swamp Business Case MW flora/fauna spreadsheet</p>	<p>The majority of the site is recognised by DSE as a biosite of state significance for its biodiversity and natural values.</p> <p>Supports endangered and vulnerable EVCs (Coastal Alkaline Scrub – EVC 858, Freshwater Wetland Formation – EVC 74, Riparian or Swampy Scrub Woodlands – EVC 53, Damp Sands Herb-rich Woodland – EVC 3, Coast Banksia Woodland – EVC 2). Endangered wetland specific EVCs include: Aquatic Herbland (EVC 653), Brackish Grassland (EVC 934), Brackish Sedgeland (EVC 13), Brackish Wetland (EVC 656), South Gippsland Plains Grassland (EVC 132), Sedge Wetland/Calcareous Wet Herbland Complex (EVC 200), Tall Marsh (EVC 821), Swamp Scrub (EVC 53) and Reed Swamp (EVC 300).</p> <p>The site also supports several threatened flora and fauna species. Threatened wetland birds and/or those listed under JAMBA/CAMBA include: Eastern Great Egret, Latham’s Snipe, Musk Duck, Australasian Bittern, Royal Spoonbill, Pacific Gull, Hardhead, Australasian shoveler, Lewin’s Rail, Nankeen Night Heron, White-throated Needletail, Sharp-tailed Sandpiper, Greenshank, Glossy Ibis, Cattle Egret, Baillon’s Crake. Threatened reptiles include: Glossy Grass Skink and Swamp Skink. White-bellied Sea-eagle, Grey-crowned Babbler and White-footed Dunnart have also been recorded at or near the site.</p> <p>Threatened aquatic flora includes Water Parsnip, Leafy Twig-sedge and Large River Buttercup. Coast Bitterbush, Coast Wirilda, Common Morel and two species of Leafy Greenhood have also been recorded. Large stands of Ghania filum (Chaffy Saw-sedge) exist and remnant Moonah Woodland is considered a threatened community.</p> <p>The following fish species have also been recorded from the site: Short-finned Eel, Common Galaxid, Spotted Galaxid, Tupong, Tench and Mosquito Fish.</p> <p>Tootgarook Swamp has been identified in the Healthy Waterways Strategy as a priority area for the following “focal values:” Vegetation, Birds and Frogs.</p> <p>Aboriginal cultural heritage artefacts have also been found along swamp edges and within Moonah Woodland (shell middens and artefact scatters). Historical values remaining from the marl and limestone kiln are also important to conserve. The site maintains a high level of community interest and involvement.</p> <p>The site also acts as a retarding basin which helps to control flooding of adjacent areas</p>
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				and provides flood protection for Rosebud and northern urban areas. Stormwater treatment. Potential application for Ramsar listing currently being negotiated with local government (likely addresses 4 criteria).
1.6		Condition	Watercourses DSE Interactive Maps	The site is heavily degraded, primarily through drainage. Channelised Chinamans Creek runs north-south through the wetland. Also several other major and minor east-west running drains including Drum Drum Alloc Creek and Browns Road drains. Drum Drum Alloc Creek enters in the northeast of the swamp and drains into Chinamans Creek. Chinamans Creek was rated poor in the Index of Stream condition. Vegetation quality is moderate to good where intact remnants exist.
1.7		Geomorphic description	Geomorphic Unit Geomorphic Landsystems Darling (1992)	Gippsland Plain Bioregion. Quaternary barrier complexes (Discovery Bay and Gippsland Lakes) (<1.4myo). The Cups ridges of Aeolian calcareous sand dunes occur immediately to the west of the swamp (up to 30m asl). Boneo Plain occurs to the east of the swamp. The land is flat and low lying (approx. 2m asl). The ground slopes gently to the west (1.4m asl on western side of swamp).
1.8	Climate	Rainfall	Condina (2011)	Mean average rainfall is 815mm (based on available data 1928 – 2010). Rainfall is greatest May – August and lowest December – March. Rainfall was below average for the period 1997-2010. Runoff is low due the high permeability of sands and lack of surface water drainage. Runoff only occurs in very wet years when subsoils are saturated.
1.9		Evaporation / Aridity	EHZ Description (FS01_Zone28 Portsea)	The aridity index in the zone is approximately 0.55, i.e. rainfall is 55% of evaporation.
1.10	Ecosystem Type	Type		Wetland
1.12		Location, Name, Area	Wetlands_1994	Boneo Swamp (Tootgarook Wetland) 298 ha (includes a 22ha island) Lat/Long: 38° 23' 35" S, 144° 52' 22" E Situated between Boneo and Tootgarook in Rosebud West, on the Nepean Peninsula, 65km south of Melbourne

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1.13		Classification	GIS	Shallow marsh - Reed dominated
1.14		Site history	<p>Wetlands_1788</p> <p>Wetlands_1994</p> <p>Southern Peninsula Indigenous Flora & Fauna Assoc. Tootgarook Swamp.</p> <p>http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012</p> <p>Condina (2011)</p>	<p>Was originally a shallow freshwater marsh of 475 ha. Drainage commenced in 1878, to prevent flooding and create arable land, and continued into the mid 1900's. Marl and limestone were mined from the site with a tramway running down Truemans Road to the bay. Marks lime kiln was situated on the original course of Chinamans Creek in the northwest of the site. Vegetation, limestone and peat removal was extensive in the mid to late 1800's. Dairy farming began in 1850 near Borneo and increased vegetation clearance.</p> <p>There is evidence of in-filled former swampland for development purposes. Infilling and vegetation clearing still occurs.</p> <p>Chinamans Creek was realigned and channelised in 1911.</p> <p>The swamp remains largely in private ownership (80%). MW is considering a buyback program.</p>
1.15		Value	<p>GDE Biodiversity Value layer</p> <p>EVC_2005</p> <p>Southern Peninsula Indigenous Flora & Fauna Assoc. Tootgarook Swamp.</p> <p>http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012</p> <p>MW Tootgarook Swamp Business Case</p> <p>MW flora/fauna spreadsheet</p>	<p>GDE biodiversity values are high-very high.</p> <p>The swamp represents the largest remnant of natural freshwater marsh in the Melbourne Water region.</p> <p>The majority of the site is recognised by DSE as a biosite of state significance for its biodiversity and natural values.</p> <p>Supports endangered and vulnerable EVCs (Coastal Alkaline Scrub – EVC 858, Freshwater Wetland Formation – EVC 74, Riparian or Swampy Scrub Woodlands – EVC 53, Damp Sands Herb-rich Woodland – EVC 3, Coast Banksia Woodland – EVC 2).</p> <p>Endangered wetland specific EVCs include: Aquatic Herbland (EVC 653), Brackish Grassland (EVC 934), Brackish Sedgeland (EVC 13), Brackish Wetland (EVC 656), South Gippsland Plains Grassland (EVC 132), Sedge Wetland/Calcareous Wet Herbland Complex (EVC 200), Tall Marsh (EVC 821), Swamp Scrub (EVC 53) and Reed Swamp (EVC 300).</p> <p>The site also supports several threatened flora and fauna species. Threatened wetland birds and/or those listed under JAMBA/CAMBA include: Eastern Great Egret, Latham's Snipe, Musk Duck, Australasian Bittern, Royal Spoonbill, Pacific Gull, Hardhead, Australasian shoveler, Lewin's Rail, Nankeen Night Heron, White-throated Needletail,</p>

				<p>Sharp-tailed Sandpiper, Greenshank, Glossy Ibis, Cattle Egret, Baillon’s Crake. Threatened reptiles include: Glossy Grass Skink and Swamp Skink. White-bellied Sea-eagle, Grey-crowned Babbler and White-footed Dunnart have also been recorded at or near the site.</p> <p>Threatened aquatic flora includes Water Parsnip, Leafy Twig-sedge and Large River Buttercup. Coast Bitterbush, Coast Wirilda, Common Morel and two species of Leafy Greenhood have also been recorded. Large stands of Ghania filum (Chaffy Saw-sedge) exist and remnant Moonah Woodland is considered a threatened community.</p> <p>The following fish species have also been recorded from the site: Short-finned Eel, Common Galaxid, Spotted Galaxid, Tupong, Tench and Mosquito Fish.</p> <p>Tootgarook Swamp has been identified in the Healthy Waterways Strategy as a priority area for the following “focal values:” Vegetation, Birds and Frogs.</p> <p>Aboriginal cultural heritage artefacts have also been found along swamp edges and within Moonah Woodland (shell middens and artefact scatters). Historical values remaining from the marl and limestone kiln are also important to conserve. The site maintains a high level of community interest and involvement.</p> <p>The site also acts as a retarding basin which helps to control flooding of adjacent areas and provides flood protection for Rosebud and northern urban areas.</p> <p>Stormwater treatment.</p> <p>Potential application for Ramsar listing currently being negotiated with local government (likely addresses 4 criteria).</p>
1.16	Hydrogeology	GMA, other	GMA layer	Nepean GMA
1.17		Aquifer(s)	EHZ Description (FS01_Zone28 Portsea) SKM (2010)	<p>Approximately 4,000 ML of groundwater is currently extracted per year (estimated) from the Nepean GMA Quaternary aquifer.</p> <p>The watertable aquifer in this zone is contained within the Quaternary Aquifer which underlies the area. The watertable is between sea level and 2m asl.</p> <p>On the Nepean Peninsula the Brighton group is overlain by the Wannaeue Formation (consists of shelly sand, mud and clay – up to 90m thick). Overlying this is the Bridgewater Formation (fine to medium grained dune sand – 80m thick). In total the Quaternary aquifer is approximately 200m thick.</p>

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1.18		Hydrogeo. unit / GFS	<p>EHZ Description (FS01_Zone28 Portsea)</p> <p>Darling (1992)</p> <p>O'Rourke (1991)</p> <p>JLCS (2007)</p> <p>Condina (2011)</p>	<p>The aquifer is part of a local and intermediate groundwater flow system in Aeolian dunes and plains. It is saturated below the watertable.</p> <p>The groundwater level appears to slope towards the wetland and in particular Chinamans Creek. This Creek seems to be draining the groundwater from the swamp to Port Phillip Bay, in line with the regional groundwater flow. Flow is permanent in this Creek; further evidence for groundwater discharge.</p> <p>There evidence of a perched watertable or near surface impermeable stratum, remains open to conjecture. There is some evidence of low permeability palaeosol horizons in the sequence which may cause localised perched watertables or groundwater confinement. Groundwater may also be perched above near surface peat and clay beneath the swamp. These aquitards are leaky but may confine groundwater in the underlying Bridgewater Formation aquifer. The permeability of semi-confining peat layers may be in the order of 0.41m/day.</p> <p>The watertable is above or near surface across the low-lying areas of the swamp (0.36 agl – 0.32m bgl).</p>
1.19		Geology	<p>Geology_polygon_250k</p> <p>Southern Peninsula Indigenous Flora & Fauna Assoc. Tootgarook Swamp. http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012</p> <p>Darling (1992)</p> <p>O'Rourke (1991)</p> <p>JLCS (2007)</p>	<p>Quaternary dune deposits (Qd2)</p> <p>Aeolian dune deposits, sand, clay, calcareous sand.</p> <p>Geology comprises lagoonal deposits and sandy and concretionary limestone deposits overlain by calcareous and ligneous clay peat. Limestone is approx 2.6m bgl in some areas of the swamp however it seems to be a non-continuous near surface stratum.</p> <p>High level irregular dunes consisting of siliceous and calcareous sand occur to the west of the swamp. East of the swamp, are older dunes and sheet sands consisting of siliceous sand and aeolianite.</p> <p>The Selwyn Fault occurs to the east of the site and runs parallel in a north-south direction. The Bellarine Fault occurs to the west of the Peninsula. The Peninsula overlies a downthrown geological structure known as the Sorrento Graben between the upthrown blocks east and west of these faults.</p> <p>The site is of geological interest for peat, limestone and marl.</p>
1.20		Soils	<p>DSE_Geomorphic Unit</p> <p>DSE_Geomorphic Landsystems</p>	<p>The Peninsula has Aeolian lithology, pale sands, podosols with low compaction, high leaching, moderate drainage, <5.5 pH, low water erosion and moderate wind erosion.</p>

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			<p>Victorian Resources Online – Port Phillip and Westernport</p> <p>O'Rourke (1991)</p> <p>JLCS (2007)</p>	<p>Mid-north and north-east of the wetland supports Aeolian and Alluvium lithology and dermosols. The surface soils in the swamp largely consist of peat (up to 7m but typically 0.5-4m deep and 0.2-4m thick) derived from reeds, rushes and paperbark. The peat is dark grey to black and becomes slightly sandy with depth. These soils are fibric organosols. The peat layer extends under most of the swamp.</p> <p>The pH of peats and sands was neutral to slightly alkaline (7.5-8.5), due to alkaline groundwater moving through the area and soil carbonates.</p> <p>Groundwater helps to buffer the likely PASS. Soils are mostly waterlogged. The swamp is mapped as having high probability of acid sulphate soil occurrence – alkaline groundwater is likely to neutralise and maintains saturation, avoiding acidification.</p>
1.21		Groundwater movement	JLCS (2007)	<p>A regional groundwater divide trends northwest-southeast along the spine of the Peninsula. From this divide groundwater moves north towards Port Phillip Bay and southwards towards Bass Strait, whereas regional groundwater flow is typically and east to west. Groundwater has a hydraulic gradient towards Chinamans Creek.</p> <p>Predominately unconfined aquifer.</p> <p>Seasonal watertable fluctuation of 0.5-1m.</p>
1.22		Temporal classification of GW connection with the site	Site specific	<p>Residence time, saturation regime:</p> <p>Permanent, near permanent</p>
1.23		Water quality, chemistry	EHZ Description (FS01_Zone28 Portsea) JLCS (2007)	<p>Groundwater salinity is typically <500 mg/L TDS (ranges from 300-1,200 mg/L) in the freshwater lens of the Bridgewater Formation. Salinity increases with depth (there's a saltwater wedge under the Peninsula). There are some reports of higher salinities in shallow bores within the swamp – most likely due to the evaporitic concentration of salts.</p> <p>Nitrate contamination has been reported in several instances in the Bridgewater Formation (peaks in September-October and potentially related to fertiliser application). Faecal coliforms and faecal streptococci were also recorded in bores adjacent the catchment.</p> <p>Neutral to slightly alkaline water quality may be buffered by groundwater.</p>

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1.24		GW flow dynamics Recharge area to discharge site	Dave Carew pers comm. Workshop O'Rourke (1991) Graham (2010) SKM (2010) JLCS (2007)	<p>Groundwater recharge across the aquifer is direct via infiltration of rainfall and regionally dominant. Recharge is rapid due to the highly permeable sands and lack of surface water drainage. Recharge estimates vary from 10mm/yr (1997-2009 and 220mm/yr (1970-1996). Approximately 17-25% of average annual rainfall results in recharge. Up to 3,000 ML/yr may be recharged to groundwater via septic tank systems on the Nepean Peninsula.</p> <p>Drum Drum Alloc Creek appears to lose across the plain and recharge the sands. A portion of this creek does not have flow at any time of year.</p> <p>Permeability is moderate to high and typical for clean sands (4.7x10⁻⁵m/sec for 1-3m depth). Hydraulic conductivities are approximately 20m/day in the Quaternary aquifers of the Peninsula. Borehole yields are generally 0.6L/s to >5L/s.</p> <p>Discharge is to Port Phillip Bay and from local flow systems into the swamp. The upward vertical gradient indicates that the swamp area is a groundwater discharge zone. Recharge occurs in the elevated areas along the spine of the Peninsula and to the east and west.</p> <p>Groundwater level trends across the area or show slight declines since the late 1990s, potentially in response to both climate and groundwater extraction.</p>
1.25	GW service	Critical GW process	Site specific	<p>Site hydrology and water regime.</p> <p>Maintenance of subsurface saturation and hence surface water runoff.</p> <p>Maintain saturation of potential acid sulphate soils (PASS).</p> <p>GDE maintenance including terrestrial vegetation.</p>
1.26		EWRs. Relative GW contribution to other water sources	Site specific	<p>The site has limited surface water inputs due to poorly developed surface drainage and highly permeable soils. Surface water input comes from Drum Drum Alloc Creek which drains the east of the catchment. This creek is known to flow underground for a length of its reach. The other input is Chinamans Creek which has largely been modified to act as a drainage channel which shifts water from the south to the north of the swamp and out to Port Phillip Bay. This drain intersects the groundwater table. Groundwater is critical to the water regime of this site. The watertable is at, above or just below the surface throughout the swamp.</p>
1.27	Key Threat Summary	Water extraction and development	<p>Pumping Sensitivity layer</p> <p>Southern Peninsula Indigenous Flora</p>	<p>Hydrological change – swamp drainage and lowering of the groundwater table.</p> <p>Blockage and siltation of drains which affects flood flow</p>

			<p>& Fauna Assoc. Tootgarook Swamp. http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012</p> <p>Graham (2010)</p>	<p>Site is within an area sensitive to groundwater extraction. Declining groundwater levels may impact the groundwater dependence of the site and hence water regime. Numerous S&D bore development in last 5-10 years. Irrigation for golf courses and market gardens as well. The water budget for Nepean is estimated to be in deficit by approximately 1.3 GL/yr which may explain declining groundwater levels since 1997 (up to 2m).</p> <p>Urban encroachment in north from Rye, Rosebud and Tootgarook. Several golf courses and driving ranges border the site and include Eagle Ridge and Rosebud Country Club Golf Course. Grazing and irrigated market garden crops are landuses which occur adjacent the swamp. Cropping is significant in the east.</p> <p>Old landfill and transfer station in the northeast of the swamp, closed in late 1980's and now Truemans Road recreation Reserve. New landfill site – Rye Waste Disposal and Recycling Centre (Browns Road), 1km west of the wetland. Boneo sewerage treatment works occur adjacent the wetland in the southeast.</p> <p>20% of bores across the northern coast and in proximity to Chinamans Creek are likely to intercept the saline-freshwater interface. Any increase in groundwater extraction in these areas is likely to lead to further impacts and saline intrusion to shallow bores. Predominately private land tenure. Land in the northern end is zoned residential or industrial and continues to be developed.</p> <p>Potential for chemical and recycled water runoff from adjacent agricultural areas. Point source pollution – septic tanks, etc.</p> <p>Vegetation clearance and land reclamation continue today to facilitate development on the swamp margins</p> <p>Multi-agency management arrangements</p> <p>Water quality, stormwater runoff, urban and agricultural runoff. Surface water and groundwater point source and diffuse pollution</p> <p>Fire</p> <p>Weed encroachment and pest animals (e.g. Blackberry, Typha, Watercress, and Phragmites, cats and foxes). Cinnamon fungus.</p> <p>Proposed Mornington Peninsula freeway extension alignment may impact on biodiversity values as well as the hydrology through bisecting the swamp with a major embankment.</p>
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1.28		Climate change	Brooke and Kinrade (2006)	<p>Temperature increase of 0.2-1.4oC by 2030 and 0.7-4.3oC by 2070. Warming is greatest in summer. Increases in daily maximum and minimum temperatures will be similar to changes in average temperatures.</p> <p>Average rainfall is likely to decrease and will be greatest in spring (-2-20% by 2030 and -5-60% by 2070).</p> <p>Increases in drought in spring-summer. Increases in the number of hot summer days (>35oC).</p> <p>Increased number of days with very high-extreme Forest Fire Danger Index. Higher fire danger in spring, summer and autumn.</p> <p>Increased evaporation, drier soils, decreased runoff and recharge. Increased winds in coastal areas.</p> <p>Sea level rise (0.03-0.17m by 2030 and 0.07- 0.49m by 2070)</p>
1.29		Mechanism to manage threat	What is the potential to address the threat to the significant site	<p>Licensing, Allocation requirements – inclusion/estimation of S&D use. Some analysis of water budget show a budget deficit for the Peninsula aquifer which needs to be addressed by integrated water management and appropriate licensing and allocation.</p> <p>Improved planning overlays to ensure further development is in line with site preservation objectives. New developments should not further impact on the site hydrology.</p> <p>Raising site profile through Ramsar or DIWA listing, etc to provide leverage for funding and conservation.</p>
1.30		<i>Others?</i> List key threats to site	Site specific?	
1.31	Site resilience/sensitivity	GW flow system	Description of the likely impacts the threat may have on the GW system associated with the significant site	<p>The swamp is likely connected to local and regional groundwater systems in the underlying Quaternary aquifers. Groundwater levels in this region have been falling for the past decade. Small changes in the water budget may have significant impacts on the site and its current hydrology.</p> <p>Impacts from dropping groundwater levels are expected to have fairly short lag times due to the highly permeable sand aquifer.</p> <p>Saltwater intrusion may also be an increasing issue in future.</p>

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1.32		Climate, and Climate change	Brooke and Kinrade (2006)	Impacts of predicted climate change on water resources and the swamp: water quality decline, changes in peak streamflow timing, decreased recharge which will impact on watertable levels and ultimately the water regime in the swamp. There will be increased competition for water users; decreased streamflow and runoff; increased risk of fire and inappropriate burning regimes and impacts on the peat bed. A decline in GDE health including terrestrial vegetation (Moonah Woodlands) would be expected. Potentially increased saline intrusion and potential sea water impacts in the north of the swamp from storm surges/sea level rise.
1.33		Ecosystem resilience	GDEs in Sensitive Areas layer	GDE sensitivity is high-very high Ecosystem has and will continue to shift due to competition from the surrounding landscape. Fragmented remnant vegetation remains at the site. Current hydrological regime is largely dependent on groundwater discharge. The site is in a groundwater pumping sensitivity zone. Groundwater extraction for S&D has significantly increased in the last 5-10 years in surrounding areas. Groundwater levels are currently declining.
1.34	Rating of sensitivity Summary discussion to compliment conceptual model descriptions	Groundwater connection, Climate other	Site specific	High sensitivity to changes in hydrology including groundwater levels – groundwater is at, near or above the swamp floor and there is poor surface runoff/drainage due to permeable sandy soils. Edge developments are also impacting on site hydrology (reclamation of land, filling, banking, road development, etc.). High sensitivity to surrounding land uses – pollutants, encroachment, reclamation, market gardens and grazing, vegetation clearance, weeds, etc. Remnants have high sensitivity to surrounding land uses and climate change. Climate change will increase the sensitivity of the site, particularly in relation to impacts on hydrology through decreased runoff, recharge and increased water extraction.
1.35	Monitoring and Indicators	Current Programs, infrastructure, data,	DSE Interactive Maps Literature	Friends of Tootgarook Swamp(?) BOCA bird records Groundwater monitoring bores ISC site on Chinamans Creek IWC sites(?) Rosebud Country Club rainfall observations since 1984.

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				<p>MW Water Quality Monitoring Program (site at Chinamans Creek at Eastbourne Rd – sampled monthly since 1994)</p> <p>Shallow and deep monitoring bores adjacent downstream of Chinamans Creek at Eastbourne Rd (500m inland from the coast).</p> <p>3 monitoring bores in the northeast of the swamp. 1 west of the swamp on Browns Rd and 3 east of the swamp along Borneo Rd and adjacent the treatment plant. All are monitored quarterly by SRW. All are water level monitoring bores.</p>
1.36		Trends in data (natural variation). Trajectory	Condina (2011)	<p>DO has decreased slightly, whilst turbidity, <i>E.coli</i>, and Total P increased in average from 1993-2004 to 2005-2010.</p>
1.37	References	Key info sources		<p>Southern Peninsula Indigenous Flora & Fauna Assoc. (2012). <i>Tootgarook Swamp</i>. URL: http://www.spiffa.org/tootgarook-swamp.html. Accessed 6/03/2012.</p> <p>DSE Interactive Maps</p>
				<p>Broke, C. and Kinrade, P. (2006). <i>Climate Change Impacts in Western Port</i>. Report prepared for the Western Port Greenhouse Alliance. CSIRO and Marsden Jacob Associates, Victoria.</p> <p>Condina, P. (2011). <i>Tootgarook Swamp, Rosebud: Literature Review and Directions Report</i>. Report for Waterways group, Melbourne Water. Pat Condina and Associates, Deon Meadows, Victoria.</p> <p>Darling, D.B. (1992). <i>Rosebud – Rye Pipeline Stage 1: Tootgarook Swamp. Melbourne Water</i> (M2317/AB). Coffee Partners International Pty Ltd, Melbourne.</p> <p>Goh, S.P. (1994). <i>Tootgarook Drainage Study: Shire of Flinders</i>. S.P. Goh and Associates, Aspendale, Victoria.</p> <p>Graham, M. (2010). <i>Groundwater Resource Appraisal for Southeast Melbourne</i>. Report</p>

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				<p>for Southern Rural Water. Parsons Brinckerhoff, Southbank, Victoria.</p> <p>JLCS (2007). <i>McNaught Wetland Hydrogeological Assessment (GW-07/006)</i>. John Leonard Consulting Services, Carnegie, Victoria.</p> <p>O'Rourke, M.F. (1991). <i>Rosebud – Rye Pipeline Stage 1: Tootgarook Wetland Investigation</i>. Geotechnical Services Section, (GT 0851/01-01), Melbourne Water, Melbourne.</p> <p>SKM (2010). <i>South East Region of Melbourne, Groundwater Opportunities: Groundwater Opportunities and Considerations in the Bunyip Basin Catchment</i>. Report for South East Water. Sinclair Knight Merz, Melbourne.</p>
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