Appendix E
Summary of water quality objectives, key water quality indicators and guideline values

Appendix F
Preliminary RUSLE calculations

Appendix E

Summary of water quality objectives, key water quality indicators and guideline values

Heading	Where objectives apply	Relevance	Indicators and guideline values
Aquatic Ecosystems: Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long-term	• All natural waterways. • High level protection of aquatic ecosystems applies to waters in and immediately upstream of national parks, nature reserves, state forests, drinking water catchments and high-conservation-value areas. This reflects their largely unmodified aquatic ecosystems, value in providing natural sources of high-quality drinking water, and high levels of recreational use. • Even in areas greatly affected by human use, continuing improvement is needed towards healthier, more diverse aquatic ecosystems. • Water quality in artificial watercourses (e.g. drainage channels) should ideally be adequate to protect native species that may use them, as well as being adequate for the desired human uses. However, full protection of aquatic ecosystems may not be achievable in the short-term in some artificial watercourses. • Artificial watercourses should meet the objectives (including protection of aquatic ecosystems) applying to natural waterways at any point where water from	High	• Total phosphorous: 25 µg/L • Total nitrogen: 350 µg/L • Chlorophyll-a: 5 µg/L • Turbidity: 6–50 NTU • Salinity: 125–2200 µS/cm • Dissolved oxygen: 85–110% • pH: 6.5–8.5 • Temperature: See ANZECC 2000 Guidelines, table 3.3.1. • Chemical contaminants or toxicants: See ANZECC 2000 Guidelines, chapter 3.4 and table 3.4.1. • Biological assessment indicators: This form of assessment directly evaluates whether management goals for ecosystem protection are being achieved (e.g. maintenance of a certain level of species diversity, control of nuisance algae below a certain level, protection of key species, etc). Many potential indicators exist and these may relate to single species, multiple species or whole communities. Recognised protocols using diatoms and algae, macrophytes, macroinvertebrates, and fish populations and/or communities may be used in NSW and interstate (e.g. AusRivAS).

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	the artificial watercourse flows into a natural waterway		
Visual Amenity:	• All waters, particularly those used for aquatic recreation and where scenic qualities are important.	High	• Visual clarity and colour: Natural visual clarity should not be reduced by more than 20%.Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. • The natural reflectance of the water should not be changed by more than 50%. • Surface films and debris: Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter. • Nuisance organisms: Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.
Secondary Contact Recreation:	• All waters but may not be achievable for some time in some areas. • Secondary contact recreation applies in waterways where communities do not require water quality of a level suited to primary contact recreation, or where primary contact recreation will be possible only in the future.	High	• Faecal coliforms: Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). • Enterococci: Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL). • Algae & blue-green: algae < 15 000 cells/mL • Nuisance organisms: Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.

Heading	Where objectives apply	Relevance	Indicators and guideline values
			• Chemical contaminants: Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. Toxic substances should not exceed values in tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines. • Visual clarity and colour: Use visual amenity guidelines. • Surface films:Use visual amenity guidelines.
Primary Contact Recreation:	• In the immediate future to waters within and immediately upstream of recognised recreation sites. For many other waters, this is a long-term objective. • Secondary contact recreation levels should apply in areas where primary contact recreation, such as swimming, is unlikely to be achieved in the immediate future, owing to pollution	High	• Turbidity: A 200 mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU). • Faecal coliforms Beachwatch considers waters are unsuitable for swimming if: the median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100mL) for five samples taken at regular intervals not exceeding one month, or the second highest sample contains equal to or greater than 600 cfu/100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines recommend median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month). • Enterococci Beachwatch considers waters are unsuitable for swimming if: the median enterococci density exceeds 35 cfu/100mL for five samples taken at regular intervals not exceeding one month, or the second highest sample contains equal to or greater than 100 cfu/100mL (enterococci) for five samples taken at regular intervals not exceeding one month. ANZECC 2000 Guidelines

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			recommend median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60-100 organisms/100 mL).
			• Protozoans: Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note, it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
			• Algae & blue-green: algae < 15 000 cells/mL
			• Nuisance organisms: Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
			• pH: 5.0-9.0 (see supporting information)
			• Temperature:15°-35°C for prolonged exposure.
			• Chemical contaminants: Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed the concentrations provided in tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines 2000.
			• Visual clarity and colour: Use visual amenity guidelines
			• Surface films: Use visual amenity guidelines
Irrigation Water Supply:	• All current and potential areas of irrigated crops, both small and large-scale.	High	• Algae & blue-green algae: Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
			• Salinity (electrical conductivity): To assess the salinity and sodicity of water for irrigation use, a number of interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate,

Heading	Where objectives apply	Relevance	Indicators and guideline values
			landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines. • Thermotolerant coliforms (faecal coliforms): Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in table 4.2.2 of the ANZECC Guidelines • Heavy metals and metalloids: Long-term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in table 4.2.10 of the ANZECC 2000 Guidelines.
Drinking water • Disinfection only • Clarification and disinfection • Groundwater	• All current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objective also applies to sub-catchments or groundwaters used for town water supplies.	Low	• Blue-green algae: Recommend twice weekly inspections during danger period for storages with history of algal blooms. • >500 algal cells/mL - increase monitoring. • < 2000 algal cells/mL - water may be used for potable supply. • >2000 algal cells/mL - immediate action indicated; seek expert advice. • >6500 algal cells/mL - seek advice from health authority. • >15 000 algal cells/mL - may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon. Source: *Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).* • Turbidity: Site-specific determinant. • Salinity (electrical conductivity) <1500 µS/cm • > 800 µS/cm causes a deterioration in taste.

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			• Faecal coliforms: 0 faecal coliforms per 100 mL (0/100 mL) • Total coliforms: 95% of samples should be 0 coliforms/ 100 mL throughout the year. • Up to 10 coliform organisms may be accepted occasionally in 100 mL. • Coliform organisms should not be detected in 100 mL in any two consecutive samples. • Dissolved oxygen: > 6.5 mg/L (> 80% saturation) • pH: 6.5-8.5 • Chemical contaminants: See ANZECC 2000 guidelines, section 6.2.2.
Aquatic Foods (Cooked):	• All waters where aquatic foods are taken for non-commercial and commercial harvesting.	High	• Algae & blue-green algae: No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms. • Faecal coliforms: Guideline in water for shellfish: The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100 mL. • Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli /g of flesh with a standard plate count of 100,000 organisms /g. • Toxicants (as applied to aquaculture activities) Metals: Copper: less than 5 µgm/L. Mercury: less than 1 µgm/L. Zinc: less than 5 µgm/L. Organochlorines: Chlordane: less than 0.004 µgm/L (saltwater production) PCBs: less than 2 µgm/L.

Heading	Where objectives apply	Relevance	Indicators and guideline values
			• Physico-chemical indicators (as applied to aquaculture activities): Suspended solids: less than 40 micrograms per litre (freshwater): Temperature: less than 2 degrees Celsius change over one hour.
Industrial Water Supply:	• The high economic value of water taken from rivers and lakes for use by industry needs recognition in water quality planning and management. It has been identified as an important environmental value through community consultation. • As industry water supply needs are diverse, relevant water quality criteria are not summarised here and the ANZECC 2000 Guidelines do not provide guidance on the water quality needed for various industries. Sources of water used for industry invariably have other environmental values, which mostly need water of a higher quality than that needed by industry. Further, individual industries generally have the capacity to monitor and treat the available water resources to meet their own needs.	Low	N/A

Appendix F

Preliminary RUSLE calculations

Preliminary RUSLE calculations

A preliminary review has been undertaken to assess the overall erosion risk within the proposal area of disturbance comprising the access track between Heathcote Road and the Woronora River from the northern bridge approach.

Factors affecting soil erosion by water include:

- rainfall droplet size and rainfall intensity
- soil characteristics (erodibility)
- topographic characteristics (slope gradient and length)
- soil conservation practices (e.g. surface roughness)
- ground cover (protection of soils from wind and water erosion).

The computed soil loss and erosion hazard for a site may be defined through the Revised Universal Soil Loss Equation (RUSLE). This equation considers five key factors in determining erosion hazard, namely:

- **Rainfall Erosivity Factor (R-Factor):** A measure of rainfall erosivity based on intensity, duration, and droplet size from average annual rainfall data (adopts two year, six hour storm event intensity)
- **Soil Erodibility Factor (K-Factor):** A measure of soil erodibility determined soil properties including soil texture, organic matter content, soil structure, soil permeability
- **Slope Length and Gradient Factor (LS Factor):** An analysis of slope and gradient to determine topographic induced erodibility
- **Soil Conservation Practice Factor (P-Factor):** Based on surface condition of soils (e.g. compacted, loose)
- **Ground Cover Factor (C-Factor):** A measure of the effectiveness of ground cover.

It should be noted that the RUSLE equation applies only to erosion risks from non-channelized flows (e.g. sheet erosion, rill erosion) and ignores soil dispersibility.

Table B1 presents RUSLE inputs and factor values for the purpose of assessing soil loss and erosion hazard of construction access tracks from Heathcote Road down to the Woronora River.

Table B1 RUSLE Input Value

Factor	Input Value	Factor Value
R Factor	10.4 mm/hr	2,370
K Factor	Hawkesbury	0.033
LS Factor	Assume 100m with 30% gradient	13.85
P Factor	Assume compacted and smooth soil	1.3
C Factor	Assumes no grass cover (bare earth)	1.0

Based on the above factor values the calculated soil loss for the access track to the Woronora River is approximately 1408 tonnes per hectare per year. This is equivalent to a Soil Loss Class 6 classification.