Repairing water quality: what to do at the site
### Strategy 1. Keep the water as cool as possible

Suitability of strategy: Most suitable for small streams with naturally cool water. Most likely to be effective where a small portion of the catchment is impervious and a sizeable tract of the upstream waterway is still relatively intact. Less achievable when the urban area is anticipating marked increases in temperature associated with climate change.

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<tr>
<td><strong>1a. Shade the stream</strong>&lt;br&gt;See Repairing riparian function: what to do at the site factsheet, Strategy 1, all actions</td>
<td>Increasing the shading of the stream will reduce the penetration of UV light into the waterway and reduce water temperature.</td>
<td>Where the stream channel is relatively narrow (&lt; 10 m) and where the natural vegetation is trees rather than grassland. See Repairing riparian function: what to do at the site factsheet, Strategy 1, for the suitability of specific actions.</td>
<td>[1-4]</td>
<td>See associated factsheet</td>
</tr>
<tr>
<td><strong>1b. Relocate stormwater inputs so they run stormwater through vegetated filter strips / riparian land</strong></td>
<td>Stormwater should not be directly piped to waterways, instead it should be allowed to flow through vegetated filter strips or riparian land where it can cool before entering the stream via surface or sub-surface pathways.</td>
<td>Where the riparian land is shaded by trees. Where the vegetated buffer that the stormwater passes through is &gt; 10 m wide.</td>
<td>[5]</td>
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<tr>
<td><strong>1c. Promote groundwater upwelling</strong>&lt;br&gt;See Repairing vertical connectivity: what to do at the site and in the catchment factsheet, all Strategies</td>
<td>Typically groundwater is considerably cooler than surface water, hence actions that improve the flow of groundwater into the waterway help to moderate elevated temperatures.</td>
<td>Where the site would naturally receive a significant proportion of its flow from groundwater – i.e. highly permeable bed sediment (gravel, coarse sand) and has a shallow watertable (&lt; 4 m deep). Not appropriate if the groundwater is contaminated with pollutants (nutrient or non-nutrient).</td>
<td>[4, 6-8]</td>
<td>See associated factsheet</td>
</tr>
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### Strategy 2. Keep oxygen levels high

Suitability of strategy: most suitable where the waterway experiences protracted periods of low flow, particularly during warm months, and where nutrient concentrations are elevated.

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<td>2a. Increase turbulence instream using logs and riffles</td>
<td>Turbulent flow associated with instream structures such as logs and riffles promotes oxygenation of water.</td>
<td>Where the waterway has very little instream habitat complexity.</td>
<td>[9] Riffles [10, 11] LWD [10, 12-18]</td>
<td></td>
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<td>2b. Artificially aerate the waterway</td>
<td>Artificial aeration can either bubble air through the water or inject pure oxygen. In some cases, water low in oxygen is removed from the waterway, oxygenated, and then returned to the river.</td>
<td>In high value locations where the water is deep and prone to stratification, such as the lowland sections of urban rivers. River reaches downstream of flow regulating structures (e.g. weirs) are particularly susceptible to oxygen crashes.</td>
<td>[19] Aerator [20]</td>
<td></td>
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<td>2c. Use pumps to maintain flow</td>
<td>Water can be pumped from the downstream end of a site to the upstream end to maintain constant flow and aeration.</td>
<td>In high value locations where there is a differential in height between the upstream and downstream end of the waterway reach. Most appropriate for constructed or novel living streams in new urban developments.</td>
<td></td>
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</tr>
<tr>
<td>2d. Keep the water as cool as possible – as per Strategy 1</td>
<td>The solubility of oxygen in water decreases as the water temperature increases, therefore efforts to cool instream water will also improve oxygen levels.</td>
<td>Most suitable for small streams with naturally cool water. Most likely to be effective where a small portion of the catchment is impervious and a sizeable tract of the upstream waterway is still relatively intact. Less achievable when the urban area is anticipating marked increases in temperature associated with climate change.</td>
<td>[21] As per Strategy 1 this factsheet</td>
<td></td>
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</table>
Strategy 3. Reduce non-nutrient pollutants (i.e. heavy metals, hydrocarbons, PCBs, pharmaceuticals and other personal care products)

Suitability of strategy: most suitable where the site has large quantities of fine sediments (e.g. mid to lowland river sites), given fine sediments bond to contaminants and increase the exposure of the site to pollutants. Particularly suited to sites adjacent to, or downstream of an industrial area.

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<td>3a. Install gross pollutant traps (GPTs)</td>
<td>GPTs catch plastic and other rubbish in stormwater, preventing it from entering the waterway.</td>
<td>Where stormwater pipes discharge into the site. Care should be taken the GPT’s do not prevent coarse sediment and leaf litter from entering the stream.</td>
<td>WSUD manuals</td>
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<td>3b. Relocate/redesign stormwater inputs</td>
<td>Direct piping of stormwater into the stream bypasses riparian filtration. Stormwater outputs should be allowed to filter through riparian soils so that biogeochemical processes can transform pollutants. Flush road kerbing or kerbless roads should be used on the side of the road that drains to riparian land. Where stormwater pipes exist they should terminate at swales/filter strips/biofilters on the distal (road side) edge of the riparian buffer.</td>
<td>Sites where stormwater pipes or subsurface drainage pipes are present and where a road borders the riparian land.</td>
<td>[22]</td>
<td>[23, 24] See WSUD manuals</td>
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<td>3c. Promote hyporheic exchange</td>
<td>The hyporheic zone is an active area of pollutant breakdown. Actions that increase downwelling and upwelling at the site, such as removing channel hard-lining, increasing channel sinuosity, adding logs, creating pool-riffle sequences or adding gravel will promote pollutant biodegradation.</td>
<td>Most effective where a large portion of flow occurs through the hyporheic zone – i.e. streams that experience protracted low flows and where bed permeability is moderate to high (sand, gravel). Less effective where high-volume scouring urban flows persist year round and where bed permeability is low (e.g. clay). See associated factsheet for additional advice on specific actions.</td>
<td>[9]</td>
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<td>3d. Keep oxygen levels high – see Strategy 2 this factsheet</td>
<td>The biodegradation of many pharmaceuticals and most trace organic contaminants is accelerated under aerobic conditions.</td>
<td>Where oxygen levels are prone to fall below 4 mg/L.</td>
<td>[9]</td>
<td>As per Strategy 2 this factsheet</td>
</tr>
<tr>
<td>3e. Use aquatic macrophytes to stabilise fine sediment</td>
<td>Most metals and hydrophobic pollutants bind more readily to fine sediments than large sediments. Macrophyte roots are effective in stabilising these fine polluted sediments and preventing them from entering the water column where they can create stress for macroinvertebrates.</td>
<td>Where scouring urban flows have been managed. Where macrophytes (e.g. sedges) are planted in low-velocity, depositional areas such as the inside of meander bends, backwater habitats, and floodplain depressions or wetlands.</td>
<td>[25]</td>
<td>See biofiltration guidelines</td>
</tr>
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### Strategy 4. Improve water clarity

**Suitability of strategy:** suitable for most sites, particularly those with large quantities of fine sediments (e.g. clay, silt). May not be appropriate if improved water clarity will cause nuisance algal growth.

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<td>4a. Establish macrophyte beds and plant streamside vegetation to stabilise banks</td>
<td>Macrophytes are known to improve water clarity because their dense fibrous roots stabilise bed and bank sediments – reducing the entrainment of these fine sediments by high flows.</td>
<td>Where channel form is stable such that macrophyte beds won’t get washed away. Where scouring urban flows have been managed. Sedges are most likely to survive if planted in low-velocity areas such as the inside of meander bends.</td>
<td>[26, 27]</td>
<td></td>
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<td>4b. Control non-native bioturbing species</td>
<td>Species that feed by digging around in the mud stir up fine sediments and increase water turbidity. Removing these species should improve water clarity.</td>
<td>Where non-native bioturbating pest species are present. Where successful control or eradication is feasible (e.g. site is small).</td>
<td>[28-31]</td>
<td></td>
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Supporting documents


Water Sensitive Urban Design (WSUD) guidelines

Australia Wide


New South Wales

South Australia


Queensland

Victoria

Western Australia


Biofiltration guidelines

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Queensland

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2a. Promote groundwater upwelling

2b. Artificially aerate

2c. Enhance hyporheic exchange

3a. Install GPTs

3b. Relocate stormwater inputs

3c. Establish macrophyte beds

4a. Increase turbulence using LWD & riffles

4b. Control bioturbating pest species

4c. Promote hyporheic exchange

4d. Repairing water quality: what to do at the site

TrOC's = trace organic contaminants

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