CRCWSC RESTORE tool: Application to Saint Leonards creek

RESTORE is a decision-support tool that has been developed by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC) to support the holistic repair of urban waterways.

RESTORE asks practitioners a range of questions about the environmental and urban setting of their restoration site and identifies the ecosystem components likely to be most relevant. The ecosystem components considered are hydrology, geomorphology, connectivity, riparian, water quality and biota.

Management actions will result in the largest environmental benefit if they are directly related to ecosystem function and are applied to a site that is highly altered but with a good capacity for recovery. Accordingly, the tool ranks the ecosystem components according to their (i) importance to ecosystem function at the site; (ii) severity of stress; and (iii) potential to be repaired or protected into the future.

The RESTORE Tool is supported by a compendium of 13 factsheets - Improving the Ecological Function of Urban Waterways that identify site-scale and catchment-scale strategies for restoring waterways.

Restoring Saint Leonards Creek

Saint Leonards Creek is a seasonal tributary to the Swan River, located in the north-east of the Perth metropolitan area, in the City of Swan (Figure 1). It has several branches and only flows for a few months each year depending on rainfall. The creek has been split into three assessment zones.

Swan Valley Planning Act area

The creek system is made up of several defined channels in this zone. Many landholders have introduced exotic species to remnant vegetation, such as Willows and other deciduous trees. Many properties adjacent to the creek are small horse farms. Where horses have access to the creek, the riparian understorey has been cleared and contains almost no native vegetation.

Henley Brook development area

Most of this zone is currently rural and consists of small farms, but most properties have been bought by developers and are intended for residential development. Riparian vegetation is almost absent in this zone. This is due in part to clearing for farming activities but also because the creek has been modified into straight drainage channels. Very little water runs through the drainage channels, so wetland-dependent vegetation cannot survive. Consequently, nearly all vegetation was in poor condition.

Brabham development area

No good condition vegetation was found where urban development has taken place. Palusplain wetlands that are now mostly redeveloped into residential estates have been modified into constructed drainage channels disconnected from the creek system.

Several segments in Whiteman Edge Estate were under development and contained almost no native vegetation. Most segments in the proposed Ariella Estate had extensive weed cover due to historic clearing and farming.

As the Saint Leonards Creek catchment was in poor condition, the whole catchment was selected for application of the RESTORE Tool.

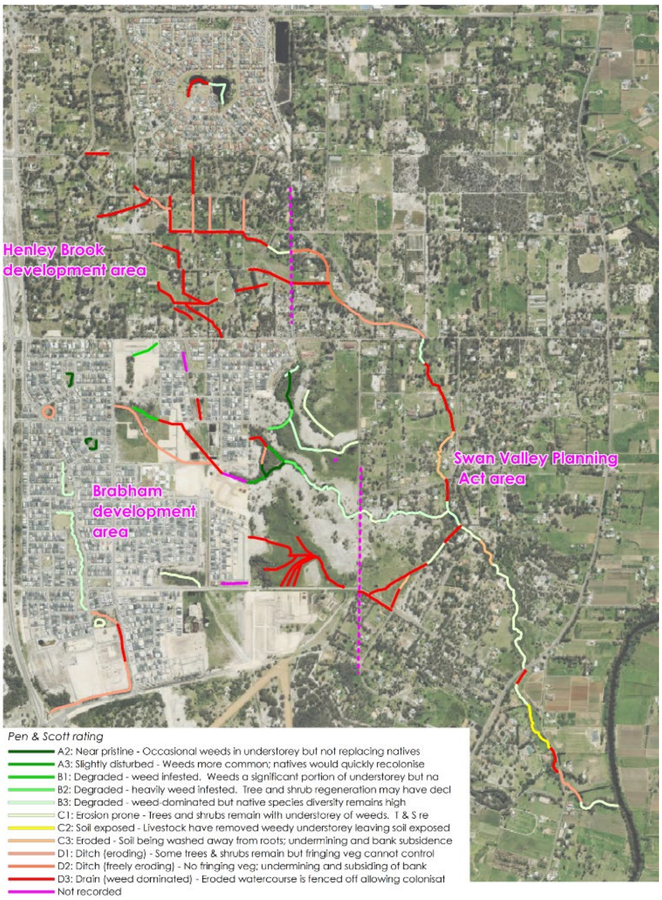


Figure 1: Extent of the Saint Leonards Creek assessment (DBCA, 2020)

New WAter Ways

Applying the RESTORE Tool

Users of the RESTORE Tool score a number of aspects relating to each of the nine ecological components below. The RESTORE Tool then calculates a prioritisation score to help identify the priority ecological components and focus management efforts. The 13 factsheets are then used to identify strategies and actions to address the priority management areas.

Ecological components

Hydrology: the volume, velocity, frequency of flow pulses, the rate of flow rise and fall and low-flow conditions within the channel. It affects the depth and permanence of aquatic habitat, physical disturbance in the waterway and influences all the components.

Geomorphology: channel shape (width, depth), bed material and instream features (beds, bars, pools) and sedimentation. It affects complexity of instream physical habitat, and depth, velocity and turbidity of instream flows. Influences lateral and vertical connectivity.

Connectivity – longitudinal: the connectedness of flow from small headwater streams to large lowland riverine sites. It influences the movement of food along the length of the river, as well as the movement of biota both instream and on riparian land.

Connectivity - lateral: the connectedness of flow between the main channel of the waterway and riparian land. It influences the velocity of instream flow, energetics and nutrient and sediment trapping. It also influences riparian health and functionality.

Connectivity - vertical: the connectedness of surface and subsurface water in the channel. It influences the processing of nutrients and other pollutants, and the depth of water during periods of low flow. It can also influence water temperature and biota.

Riparian: land that runs adjacent to streams and rivers along their length. It influences food inputs to the waterway and water temperature, as well as nutrient filtration, sediment trapping and instream habitat. It also influences longitudinal and lateral connectivity.

Water Quality- physico-chemical: temperature, oxygen, clarity, pH and conductivity of water. It influences how suitable the water is for different forms of life.

Water Quality - nutrients: levels of nitrogen and phosphorus in the water influence algal and plant growth, algal blooms and oxygen crashes.

Biota: the number and type of species living in the waterway. It indicates the overall health of the waterway and influences its resilience to perturbations. Biota affect how energy created in the waterway is moved up the food web and can influence water quality and nutrient-processing ability.

The following information and data sources were reviewed to assist in answering the 125 questions within the RESTORE Tool's four spreadsheets:

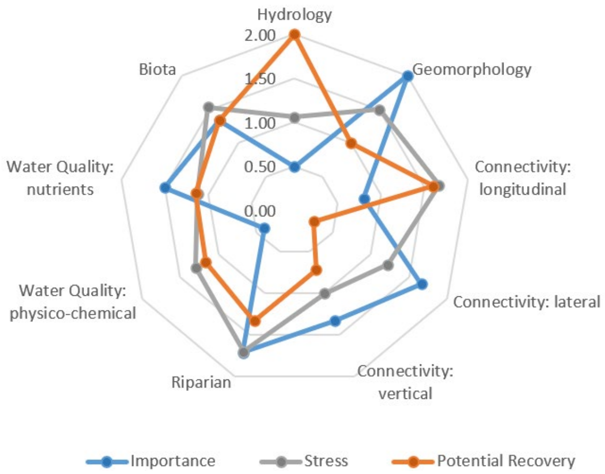
- Aerial images - current and historical
- Climate data online (http://www.bom.gov.au/climate/data)
- Water register (https://maps.water.wa.gov.au/#/webmap/register)
- Water information reporting (http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx)
- Waterway/streams (http://services.ga.gov.au/gis/rest/services/NM_Hydrology_and_Marine_Lines/MapServer)
- Perth groundwater map (https://maps.water.wa.gov.au/#/webmap/gwm)
- Drainage system data (https://nationalmap.gov.au/)
- Geomorphic wetlands, Swan Coastal Plain (DBCA-019)
- Vegetation (https://nationalmap.gov.au/)
- Surface geology (http://services.ga.gov.au/gis/rest/services/GA_Surface_Geology/MapServer)
- Contours (DPIRD)
- Aboriginal heritage inquiry system (https://www.dplh.wa.gov.au/ahis)
- Acid sulphate soil risk map, Swan Coastal Plain (DWER)
- Saint Leonards Creek Foreshore Condition Assessment, DBCA, 2020

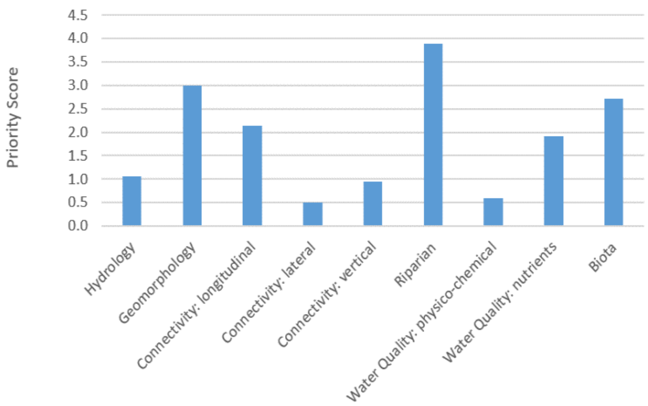
Results

The RESTORE Tool scores are as follows:

Ecological Component	Importance	Stress	Potential Recovery	Prioritisation Score
Hydrology	0.50	1.00	**2.00**	1.1
Geomorphology	**2.00**	1.50	1.00	**3.0**
Connectivity: longitudinal	0.80	**1.67**	1.60	2.1
Connectivity: lateral	**1.67**	1.22	0.25	0.5
Connectivity: vertical	1.33	1.00	0.71	1.0
Riparian	**1.71**	**1.70**	1.33	**3.9**
Water Quality: physico-chemical	0.40	1.29	1.17	0.6
Water Quality: nutrients	1.50	1.12	1.14	1.9
Biota	1.33	1.53	1.33	2.7

This is represented in the spider diagram and graph below.





Geomorphology and Riparian ranked the highest in importance to ecosystem function at the site, while Riparian and Longitudinal Connectivity ranked the highest for severity of stress. Hydrology had the highest Potential Recovery for the site. Riparian and Geomorphology were the highest priorities. This largely aligns with the DBCA's *Saint Leonards Creek Foreshore Condition Assessment*, which included the following management recommendations:

- Maintain hydrological function of tributaries and associated wetland systems (Hydrology);
- Re-evaluate riparian vegetation to ensure conservation values are identified and appropriate buffers are applied (Riparian);
- Remove weed species currently low in number that threaten downstream values (Longitudinal connectivity);
- Ensure that vegetative material from invasive weeds is not spread further during development (Longitudinal connectivity);
- Address sedimentation and water quality issues through engagement and negotiation with landholders, developers and the City of Swan (Water quality);
- Provide education material to horse owners on managing manure and other fertilisers, and providing safe stock watering that does not impact on the creek (Water quality and Riparian);
- Engage with district and local structure planning processes to ensure that drainage is in accordance with water sensitive urban design and that creek or drainage channel buffers are revegetated with local native plants (Lateral connectivity, Vertical connectivity and Riparian);
- Protect Whadjuk cultural values of the creek and provide opportunities to engage Noongar people in restoration activities through engaging Noongar businesses and Traditional Owners who can speak for this country; and
- Provide opportunities for future residents to connect to nature by installing pathways around riparian vegetation, wildlife hides, and boardwalks or viewing platforms in sensitive areas (Lateral connectivity and Riparian).

The following potential management actions were identified as the most viable given the site conditions and priority management scores from the RESORE Tool.

Riparian:

- Shade the stream to regulate light and temperature (Plant trees in stream-side zone; Increase buffer width; Protect from fire);
- Stabilise the bank (Plant macrophytes and other perennial vegetation as far down the bank as possible);
- Improve nutrient filtration and sediment trapping (Revegetate the buffer; Install permeable reactive barriers (bioreactors)); and
- Improve aquatic habitat (Plant and maintain native vegetation in the streamside zone).

Geomorphology:

- Reduce fine sediment and promote coarse sediment (Ensure that construction sites use sediment control measures; Protect headwater sources of coarse-grained sediment);
- Mitigate erosion caused by urban infrastructure or head-cutting (Relocate/redesign stormwater drainage inputs);
- Stabilise the bank, particularly erosion hotspots (Plant deep-rooted trees and a range of vegetation in the stream-side zone; Line the stream bank with macrophytes; Use bank-hardening techniques; Fence-off riparian land); and
- Restore connection to the floodplain (Reroute the Waterway, Remove floodplain levees and regulators).

Outcome

The potential management actions identified by the RESTORE Tool results are mostly consistent with the recommendations made for Saint Leonards Creek from DBCA. The exceptions are for Water Quality (nutrients), which ranked fifth and Water Quality (physico-chemical), which ranked eighth. This does not align with our expectations given that moderate nitrogen and phosphorus levels, and high concentrations of non-nutrient contaminants (heavy metals: aluminium, chromium, copper, iron, manganese and zinc) were identified at the site between 2002 and 2008. The RESTORE Tool also did not identify any actions relating to community engagement or protection of cultural values.

Using the RESTORE Tool

Overall, the RESTORE Tool is a valuable ecological assessment tool, given its comprehensive conceptual framework and level of underlying scientific knowledge. The potential management actions identified by the Tool were consistent with the recommendations made by DBCA. In addition, it is considered that the Tool provides more detailed management suggestions and highlights some non-traditional aspects that could be overlooked.

However, the Tool has some limitations, including a lack of consideration of social and cultural values and the viability of the recommendations. It is also noted that the actions for flow (hydrology) are focussed on reducing flows, with no recognition that it may be more appropriate for flows to be increased.

The effectiveness of the Tool's outputs also depends on the knowledge and experience of the user, as a wide range of expertise and local knowledge of the sites is needed to effectively use the Tool. This can produce uncertainties with the results or require a substantial amount of time to complete the assessment. It has been suggested that application of the RESTORE Tool would be most effective when applied in a facilitated workshop environment, which brings together a team of relevant experts, stakeholders and decision makers (E2DesignLab, 2020).

References and resources

The RESTORE tool is available for use by contacting the CRCWSC.

Beesley LS, Middleton J, Gwinn DC, Pettit N, Quinton B and Davies PM. (2017) *Riparian Design Guidelines to Inform the Ecological Repair of Urban Waterways*, Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. https://watersensitivecities.org.au/wp-content/uploads/2017/10/TMR_B2-2-3-Riparian-Design-Guidelines-to-Inform-the-Ecological-Repair-of-Urban-Waterways.pdf

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CRC for Water Sensitive Cities (2018) *Improving the ecological function of urban waterways: A compendium of factsheets.* Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities. https://watersensitivecities.org.au/content/improving-the-ecological-function-of-urban-waterways-a-compendium-of-factsheets/

Department of Biodiversity, Conservation and Attractions (2020) *Saint Leonards Creek Foreshore Condition Assessment*

Other related resources are available here: https://watersensitivecities.org.au/content/project-b2-23/

This case study was prepared with the assistance of the Cooperative Research Centre for Water Sensitive Cities www.watersensitivecities.org.au

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