CRC for Water Sensitive Cities

4th water sensitive cities conference

Australian Government Department of Industry and Science

Business Cooperative Research Centres Programme

Assessing the research: tools to support decision making

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The University of Western Australia

Government of Western Australia Department of Water

Overview:

- **Project aims**
- **Management need**
- **Decision support tools**
  - ➢ **RESTORE beta version**
  - ➢ **Waterway factsheets**
  - ➢ **Riparian guidelines**

Tools on USB stick and online

Project aims:

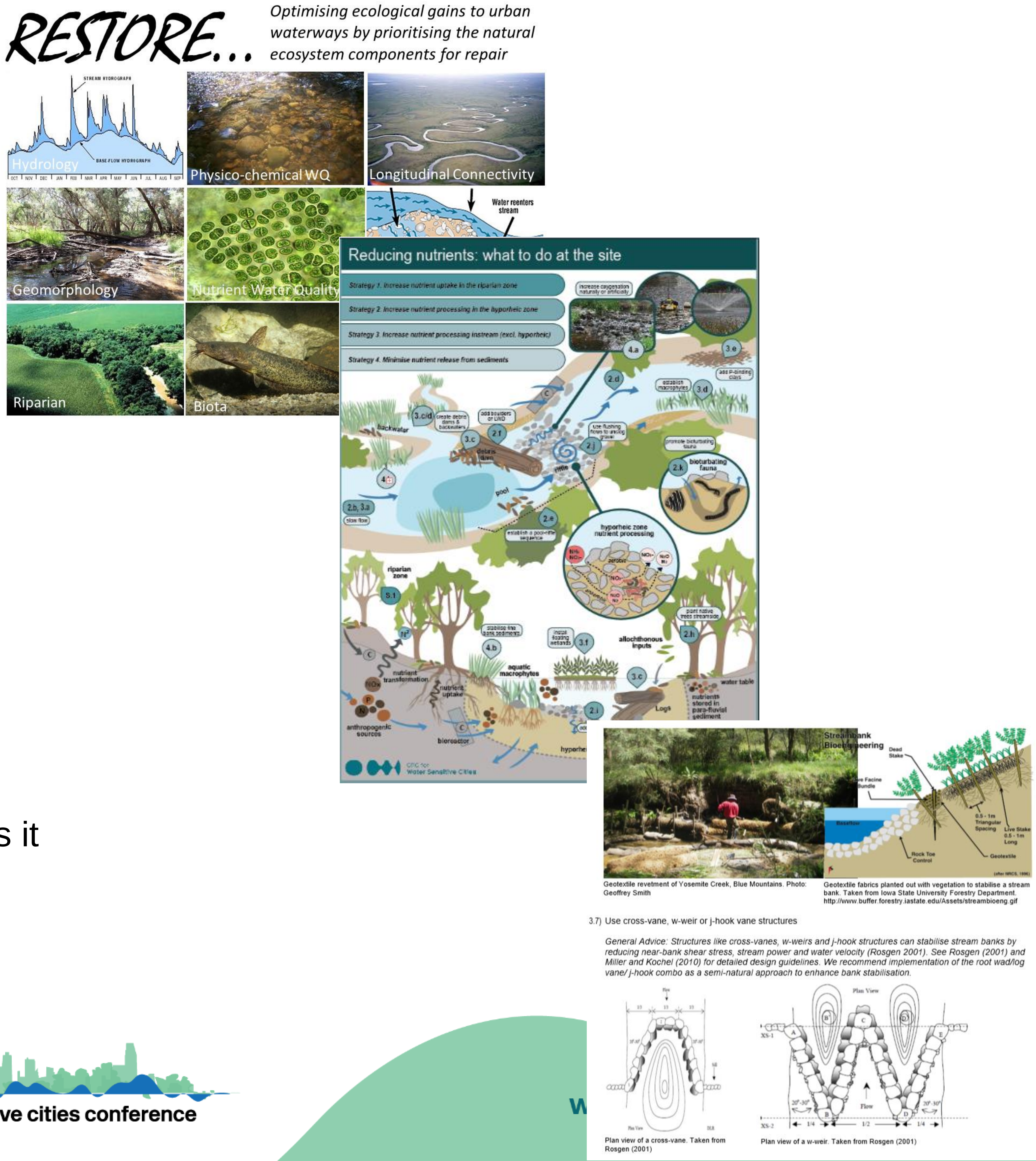
Project B2.2/3

"Protection and restoration of urban freshwater ecosystems: informing management and planning "

Goals

- To develop tools that support regional decisions to optimise the management and restoration of urban waterways over a range of scales

- To create a platform that houses knowledge and makes it available to practitioners



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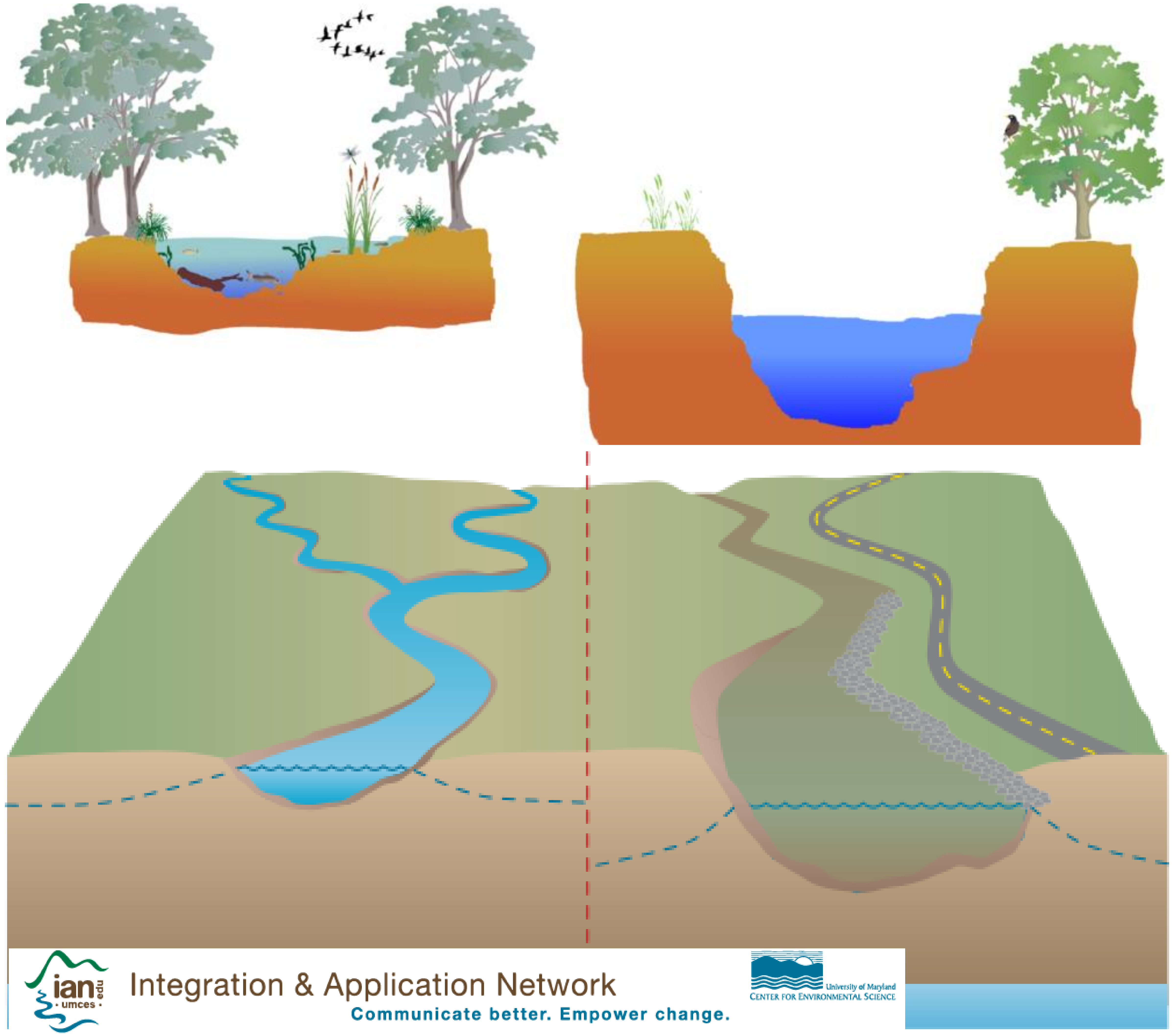
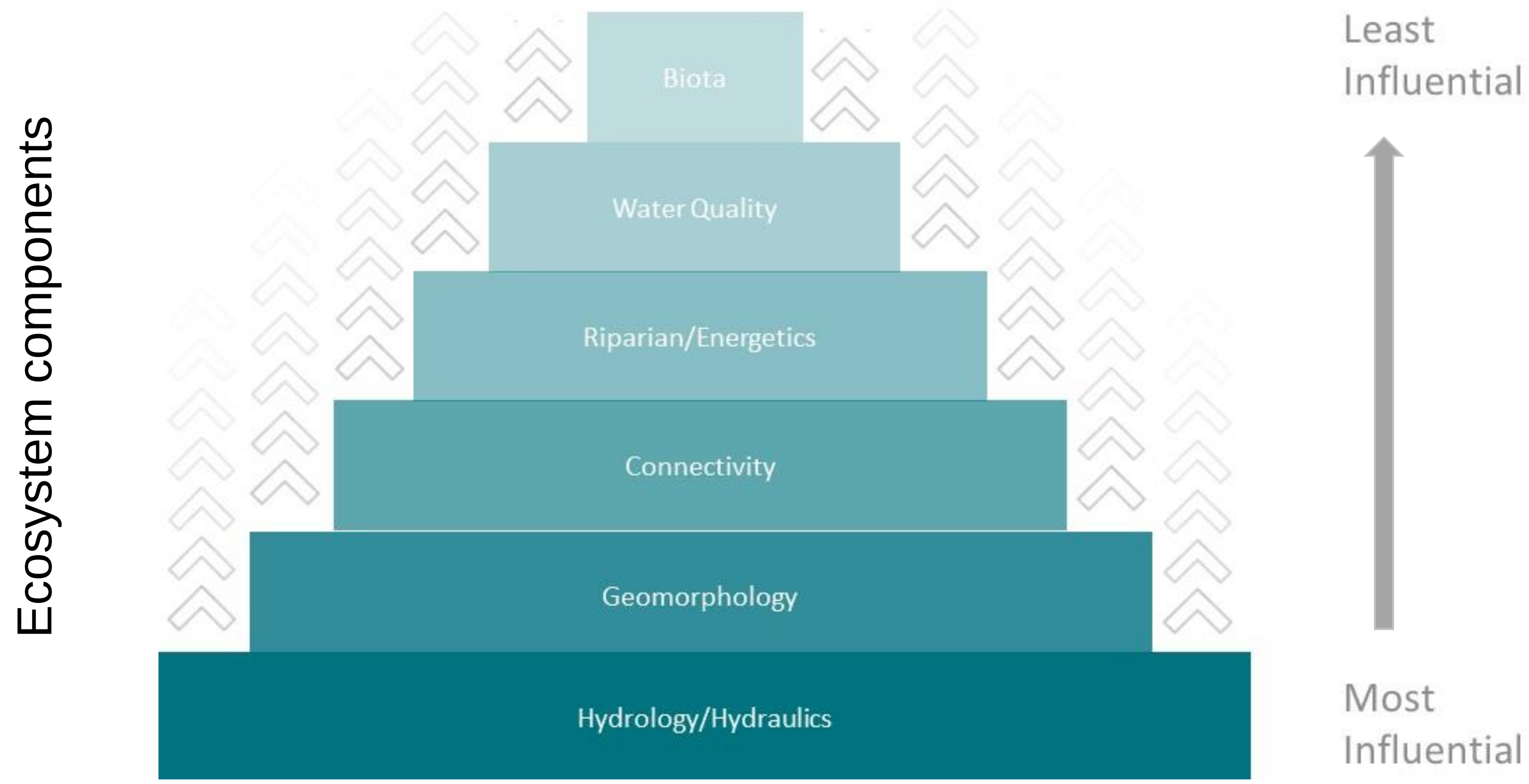


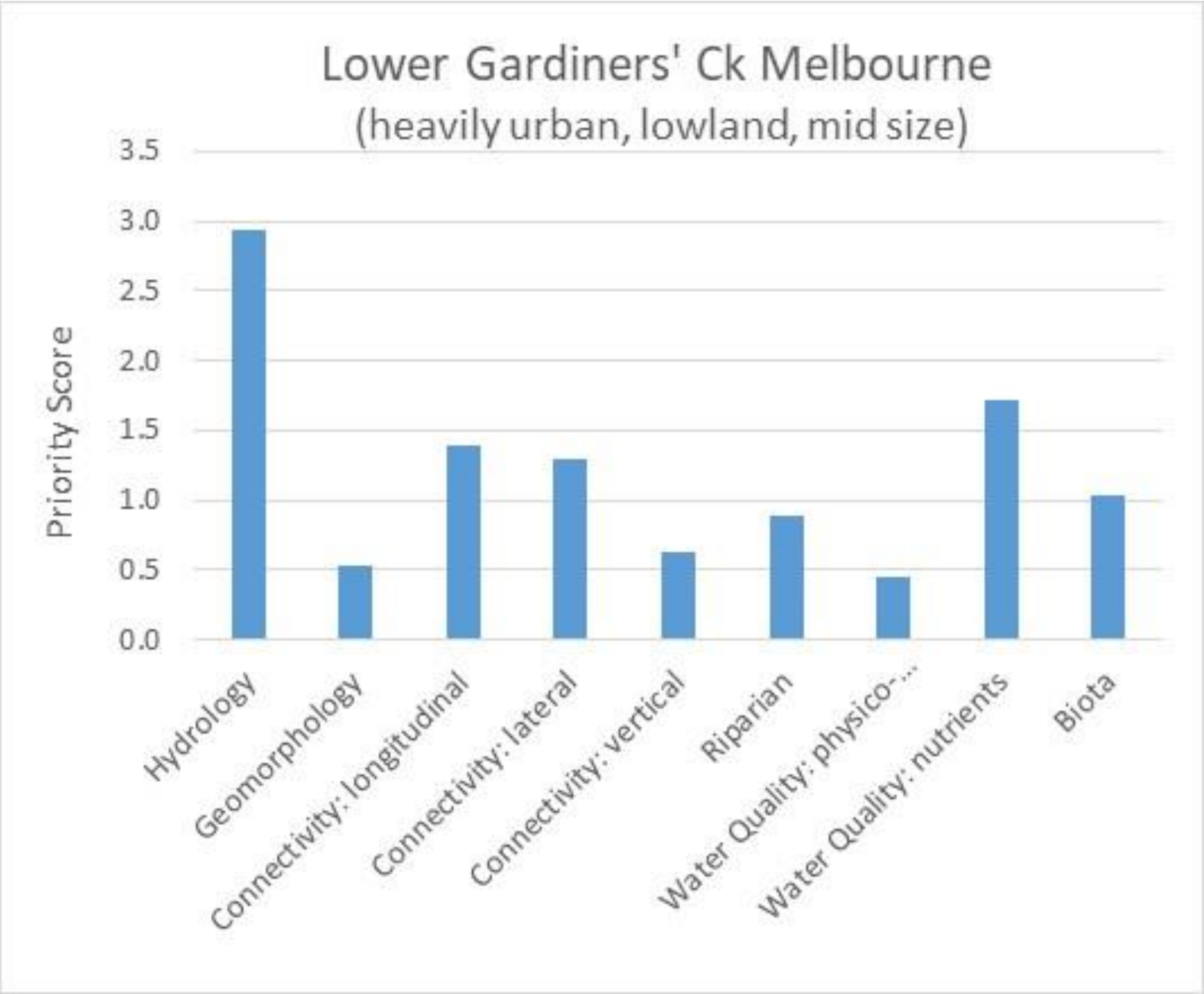
Urban Stream Syndrome

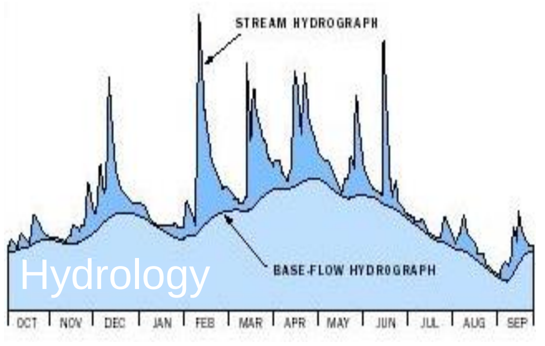
Flashy scouring flows
Increased flow volume
High water temperature
High nutrient & pollutant levels
Eroded channel
Decline in retention of organic matter
Low biodiversity particularly sensitive species

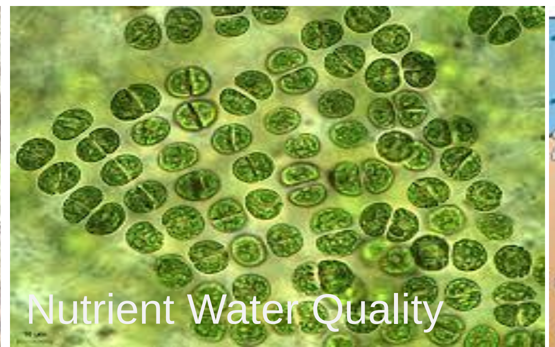
Tailored management:

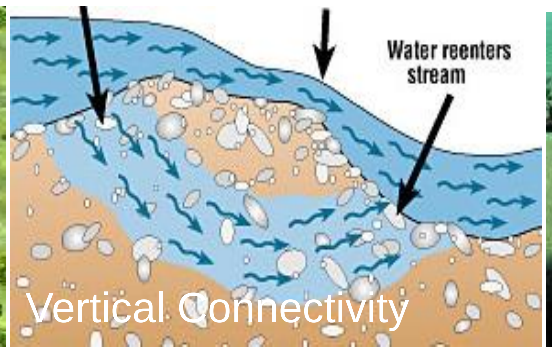
- **Stream restoration is typically generic**
- **Heterogeneity in the Urban Stream Syndrome**

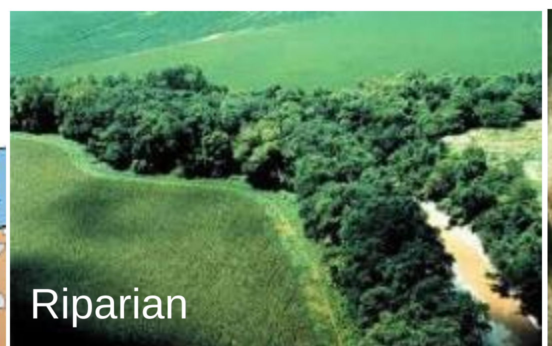


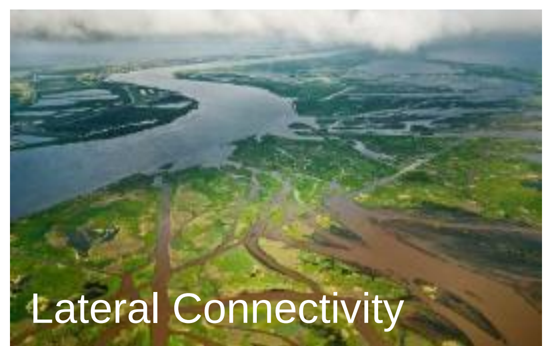






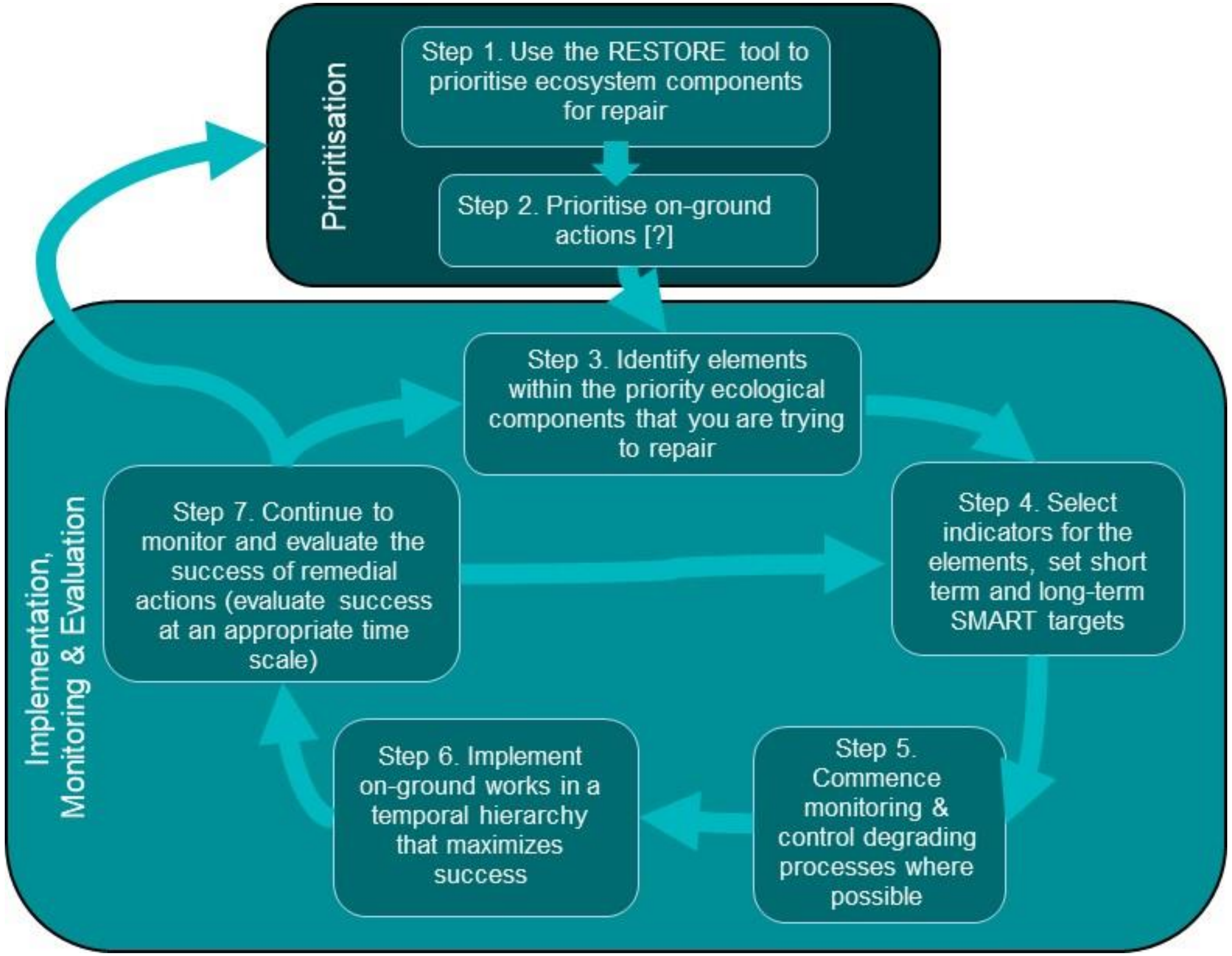






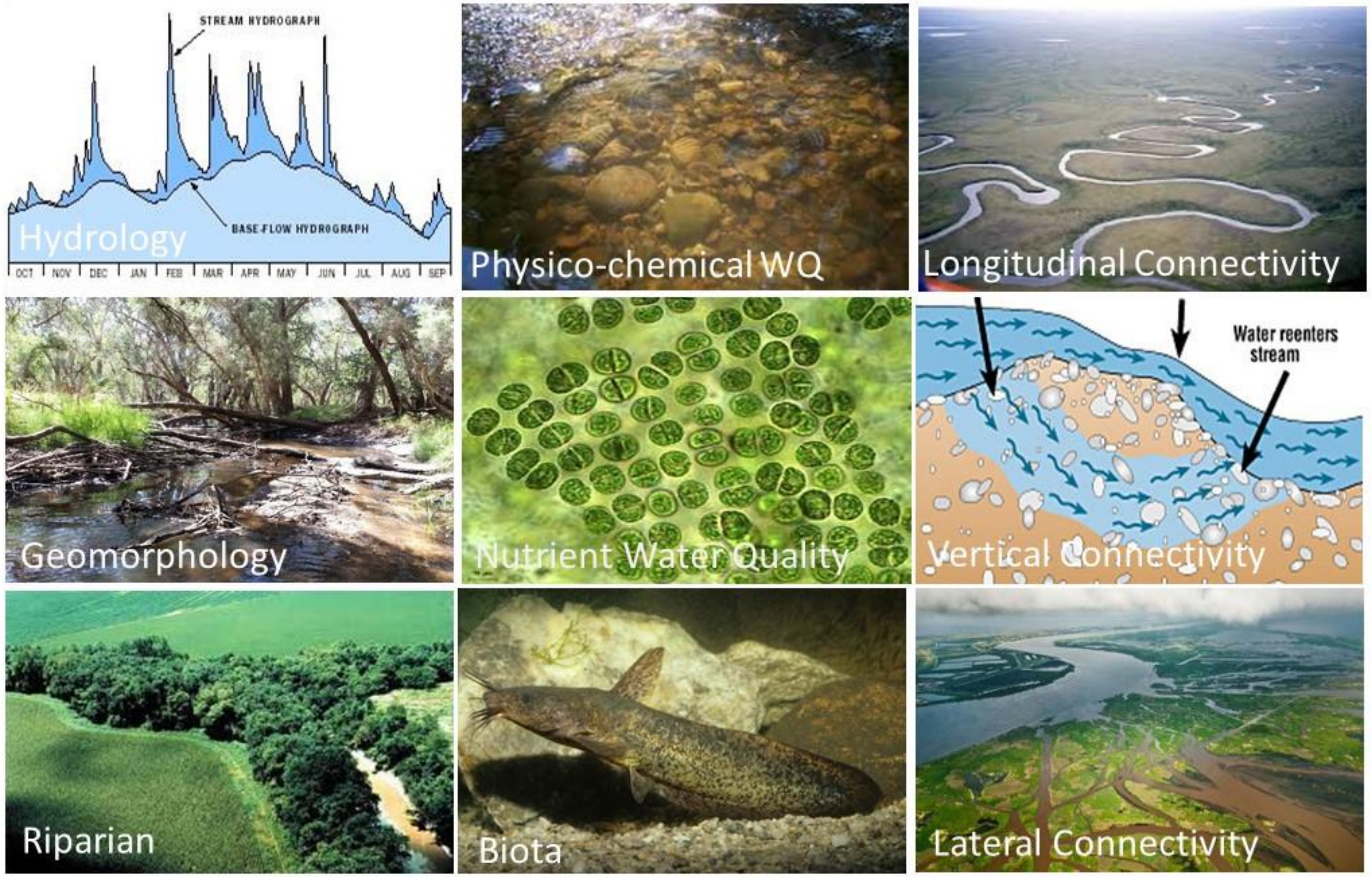
Framework:

Management goal includes
'holistic repair'



RESTORE…

Optimising ecological gains to urban waterways by prioritising the natural ecosystem components for repair



RESTORE Scope:

The TOOL:

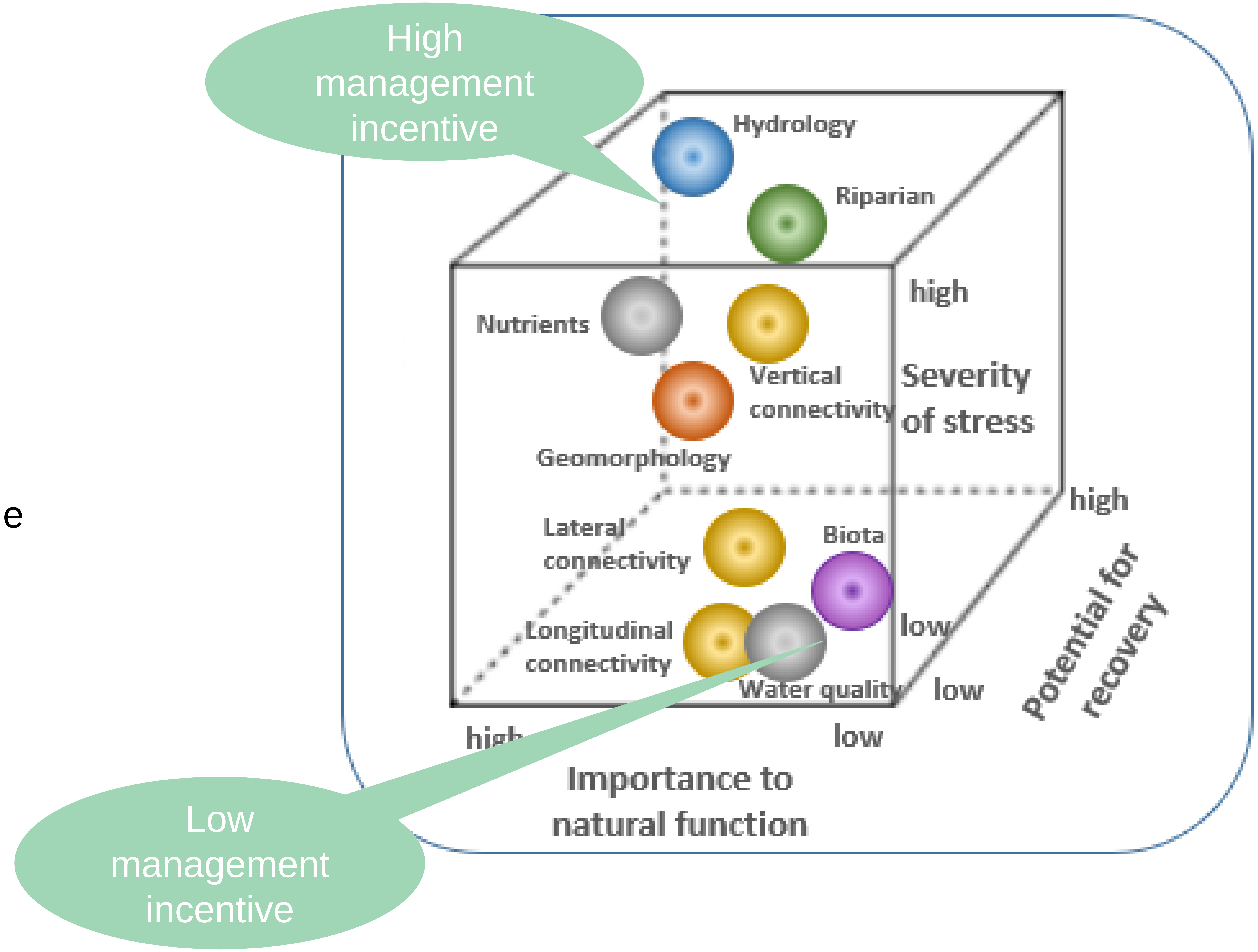
- assists managers to prioritise their on-ground effort once a restoration site has been identified
  "what type of restoration efforts are likely to deliver us the best ecological return for this site/reach?“
- assumes that stakeholders have agreed that ecological integrity is an aspirational goal for the site
- has been designed for flowing freshwaters
- has been designed for an urban and peri-urban context
- facilitates dialogue among stakeholders about the focus of on-ground actions
- creates a transparent platform to document why decisions were made
- is a repository of scientific evidence to broaden knowledge and build institutional capacity
- is simply that - a tool (assumptions, limitations)
- should be particularly helpful in data-limited situations and can be used to identify knowledge gaps for future research

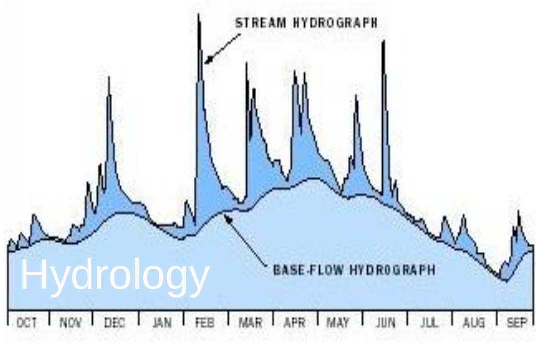
Prioritisation:

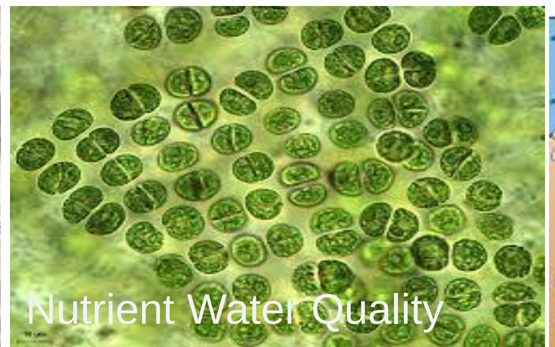
The tool prioritises the 9 ecosystem components using three criteria:

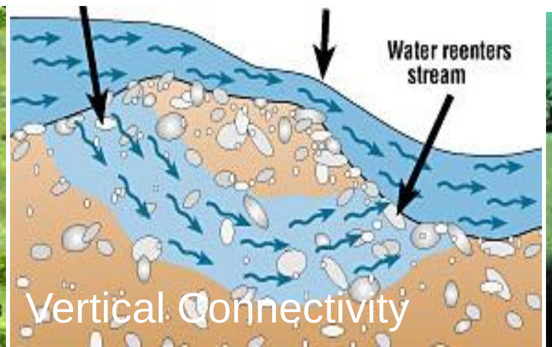
- Importance to natural ecosystem function
- Stress due to urbanisation / land use change
- Potential for recovery

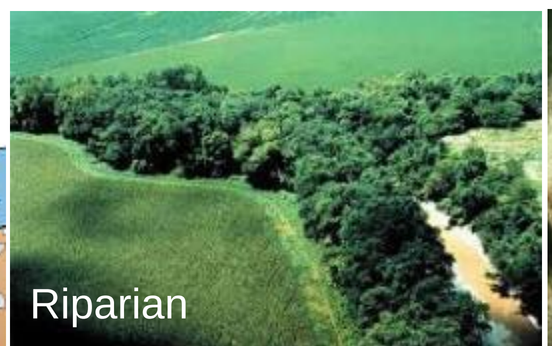
Management effort will yield the largest ecological return when it targets ecosystem components that: (i) exert significant influence on the ecosystem function of the site, (ii) are highly altered, and (iii) have a good capacity for recovery

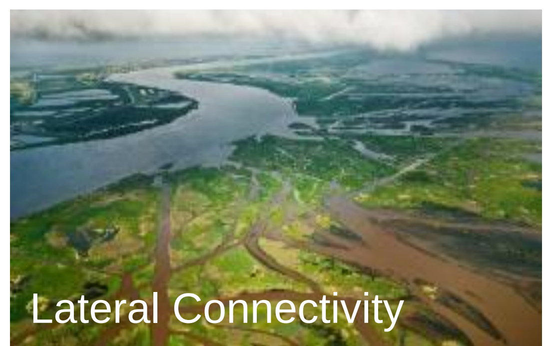












Running the tool:

There are 126 questions in 4 tabs
Fill in blue cells

CATCHMENT URBAN CONDITIONS

Question Type	Qu #	Questio
Urban Development	1	What p
Urban Development	2	How wi
Urban Development	3	Is there
Urban Development	4	Is urba
Urban Development	5	How fra
Urban Infrastructure	6	What is
Urban Infrastructure	7	Has sto
Urban Infrastructure	8	Are resi
Urban Infrastructure	9	Is wate
Urban Infrastructure	10	Are sep
Urban Infrastructure	11	Can ins
Urban Infrastructure	12	Current
Urban Practices	13	Current
Urban Practices	14	Is there
Urban Practices	15	Does th
Urban Practices	16	Is salt u

SITE/REACH URBAN CON

Question Type	Qu #	Q
Urban Infrastructure	17	Is
Urban Infrastructure	18	Ar
Urban Infrastructure	19	Is
Urban Infrastructure	20	Ar
Urban Infrastructure	21	Is
Urban Infrastructure	22	If
Urban Infrastructure	23	W
Urban Infrastructure	24	Ar
Urban Infrastructure	25	Is
Riparian Buffer	26	Cu
Riparian Buffer	27	Lo
Riparian Buffer	28	Is
Riparian Buffer	29	At
Physical Alteration	30	Ha
Physical Alteration	31	De

CATCHMENT ENVIRONMENTAL CO

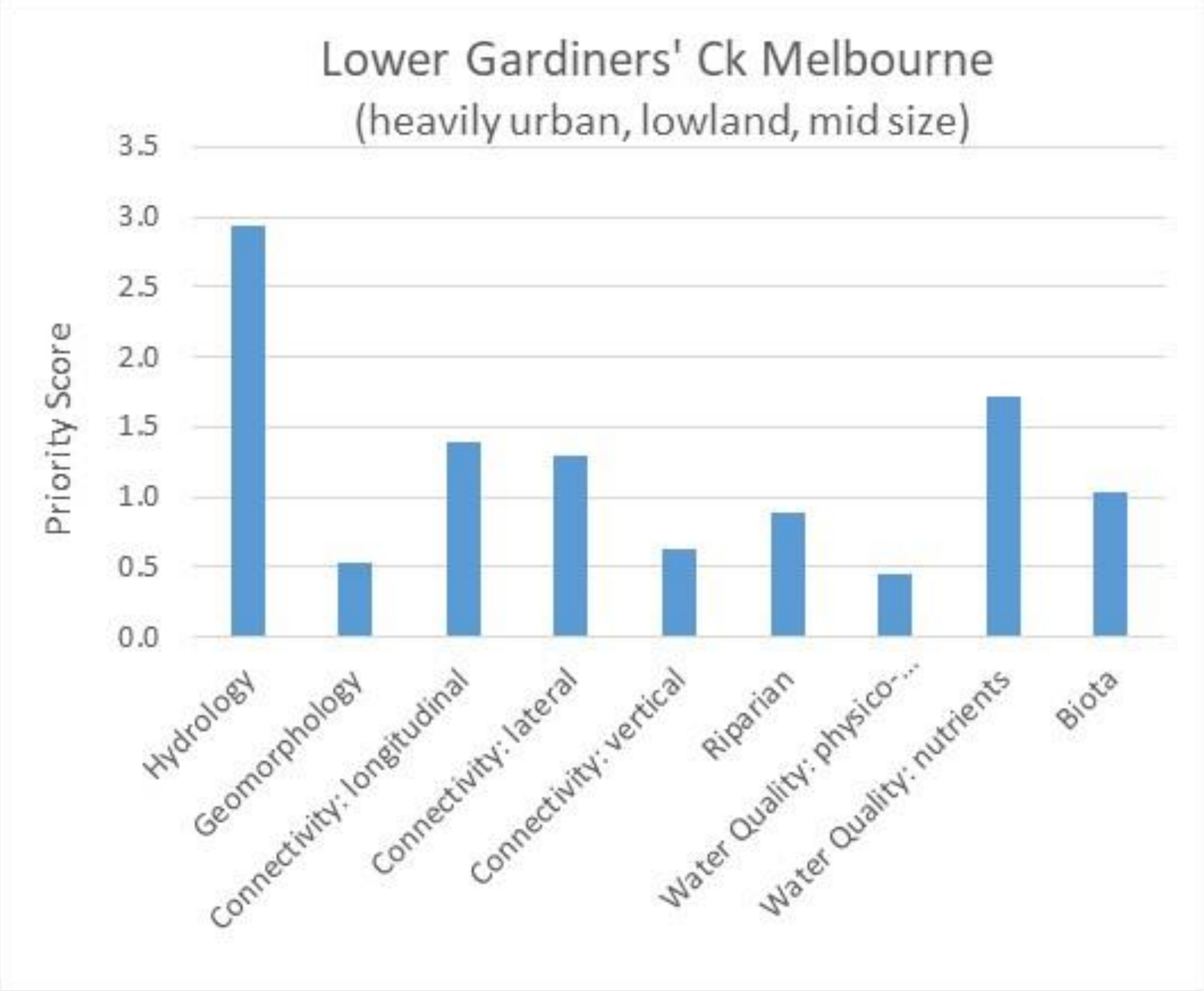
Question Type	Qu #	Question
Climate	32	Does the catchment/re
Climate	33	What is the natural int
Climate	34	Generally, how frequer
Climate	35	Is climate change pred
Climate	36	Are the biota of manag
Soils	37	Currently, is the restor
Soils	38	How sloped is the upst
Soils	39	How permeable are ca
Soils	40	Naturally, did the upst
Soils	41	Currently, does the res
Soils	42	Currently, does the site
Soils	43	Currently, has sedimer
Soils	44	Prior to urbanisation,
Soils	45	Is there an agricultura
Vegetation	46	Naturally, what type of
Vegetation	47	On balance, have non-
Riverine	48	How large is the upstre
Riverine	49	What is the drainage c
Riverine	50	Currently, where does

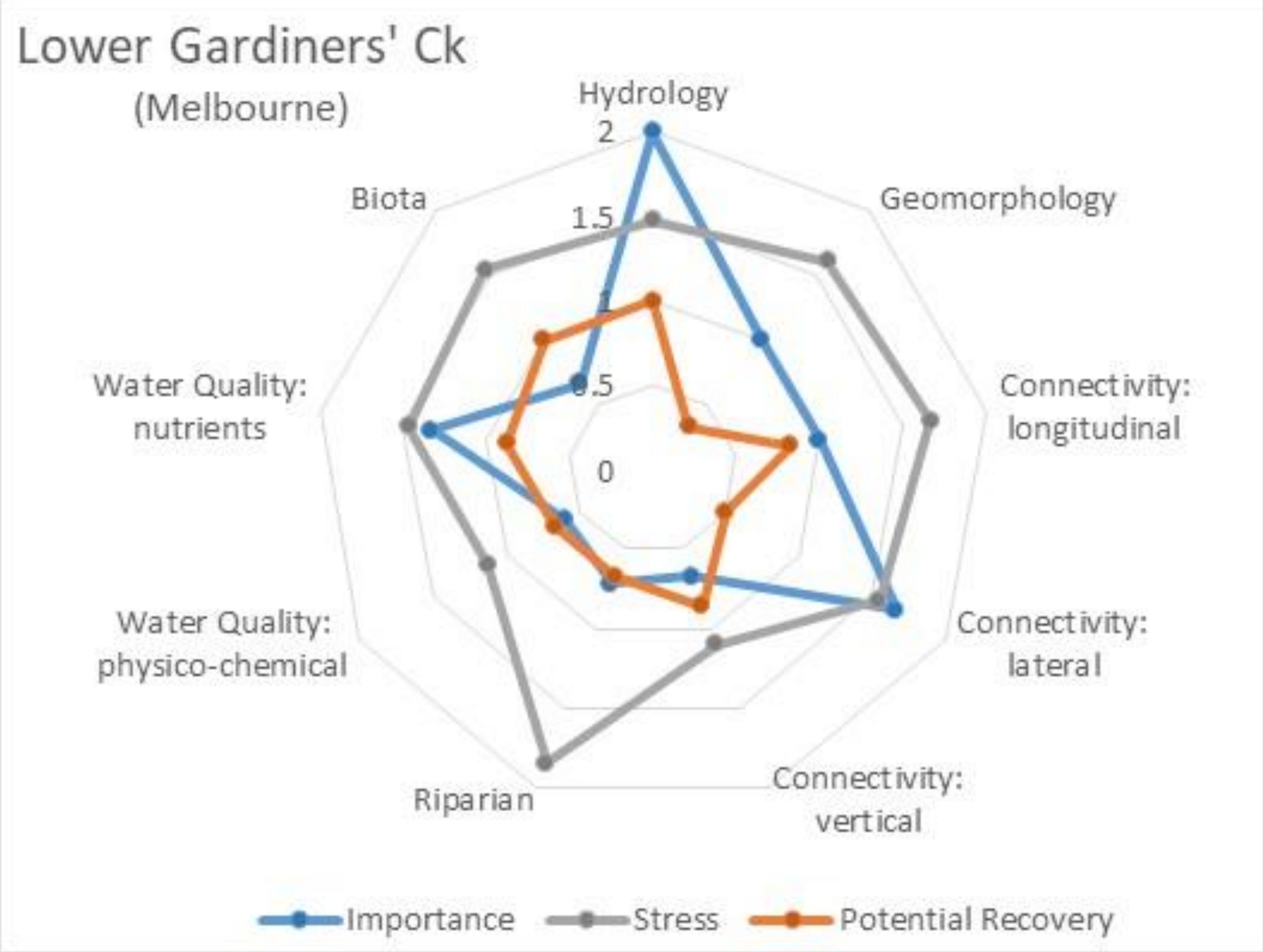
SITE/REACH ENVIRONMENTAL CONDITIONS

Question Type	Qu #	Question	Ecological component	Criteria affected	Explanation and Evidence	Dropdown Answer 1	Dropdown Answer 2	Dropdow n Answer	Dropdown Answer 4	Accompa nying	RESTORE SCOR Case study 1 *enter name 1*	Case study 2 *enter name 2*	Case study 3 *enter name 3*
Riparian Buffer	73	Naturally, what was the riparia	Geomorpholc	Importance,	Geomorpholog	Grass or lit	Sparsely fo	Densely fo	Unknown = 1				
Riparian Buffer	74	Naturally, did the riparian zon	Riparian	Importance	Riparian [Impor	High slope	Moderate s	Little slope	Unknown = 1				
Riparian Buffer	75	Naturally, did groundwater flo	Riparian, Wa	Importance,	Riparian	Groundwat	Groundwat	Groundwa	Unknown = 1				
Riparian Buffer	76	Prior to urbanisation, was the	Riparian	Stress	Riparian [Stress	Riparian ve	Riparian ve	Riparian v	Unknown = 1				
Riparian Buffer	77	Looking at the restoration site	Riparian, Wa	Stress	Riparian	Bank-side r	Significant	Intermedia	Unknown = 1				
Riparian Buffer	78	Looking at the site/reach today	Riparian	Stress	Riparian [Stress	Riparian ve	Riparian ve	Riparian v	Unknown = 1				
Riparian Buffer	79	What is the restoration site's p	Riparian	Potential Re	Riparian [Poten	Close to int	Far from in	Intermedia	Unknown = 1				
Riparian Buffer	80	Currently, do you think the ripa	Water Qualit	Stress	Water Quality:	Expect ripa	Expect ripa	Intermedia	Unknown =	IMPORT			
Riparian Buffer	81	Currently, would there be much	Water Qualit	Stress	Water Quality:	Riparian sc	Riparian sc	Intermedia	Unknown =	IMPORT			
Riparian Buffer	82	Currently, is the restoration sit	Water Qualit	Stress	Water Quality:	High strean	Low stream	Intermedia	Unknown = 1				
Riparian Buffer	83	Currently, is the riparian zone	Water Qualit	Potential Re	Water Quality:	Riparian zc	Riparian zo	Unknown = 1					
Riparian Buffer	84	Currently, what is the dominan	Riparian	Importance	Riparian	Clay soils =	Intermediat	Sandy soil	Unknown = 1				
Instream Habitat	85	Has there been much removal c	Riparian	Stress	Riparian [Stress	De-snaggin	Partial de-s	No de-snag	Unknown = 1				
Instream Habitat	86	Currently, what is the load (or	Hydrology, G	Stress	Hydrology [Stre	High loads	Intermediat	Little to no	Unknown = 1				
Instream Habitat	87	Is habitat degradation ongoing	Biota	Potential Re	Biota [Potential	Habitat deg	Habitat deg	Intermedia	Unknown =	NB.			
Instream Habitat	88	Will the habitat required for th	Biota	Potential Re	Biota [Potential	Habitat req	Habitat req	Unknown = 1		NB.			
Flow	89	Currently, does the restoration	Water Qualit	Stress, Poter	Water Quality:	Protracted	Perennial f	Perennial	Unknown = 1				
Flow	90	Do low flows at the restoration	Water Qualit	Stress	Water Quality:	Low flows c	Constant hi	Intermedia	Unknown = 1				
Flow	91	Does the site/reach receive gro	Vertical Conr	Stress	Vertical Connec	Site fed by	Site fed by	The site na	Unknown =	NB. If a			
Flow	92	Naturally, would stream water	Vertical Conr	Importance	Vertical	Well-devel	Moderately	Poorly-dev	Unknown = 1				
Water Quality	93	Naturally, how cold would the	Water Qualit	Importance	Water Quality:	Cold water	Intermediat	Warm wat	Unknown =	NB. See if			
Water Quality	94	Naturally, did the restoration s	Water Qualit	Importance,	Water Quality:	Naturally h	Normal sal	Unknown = 1					
Water Quality	95	Naturally, would the water be v	Water Qualit	Importance	Water Quality:	Highly aera	Normal oxygen (DO 4 t		Unknown =	NB. DO =			
Water Quality	96	Naturally, was the water tannir	Water Qualit	Importance	Water Quality:	Naturally l	Relatively r	Intermedia	Unknown = 1				
Water Quality	97	Naturally, was the water turbic	Water Qualit	Importance	Water Quality:	Highly turb	Intermediat	Clear wate	Unknown = 1				
Water Quality	98	Currently, is groundwater at th	Vertical Conr	Potential Re	Vertical Connec	Groundwat	Groundwat	Groundwa	Unknown = 1				
Water Quality	99	Currently, are there high levels	Water Qualit	Stress	Biota [Stress]. H	High levels	Moderate l	Low levels	Unknown =	NB.			
Water Quality	100	Do most of the chemical pollut	Water Qualit	Potential Re	Water Quality:	Chemicals	Chemical pollutants largely arise from diffuse-sources (eg non-point so						

Output:

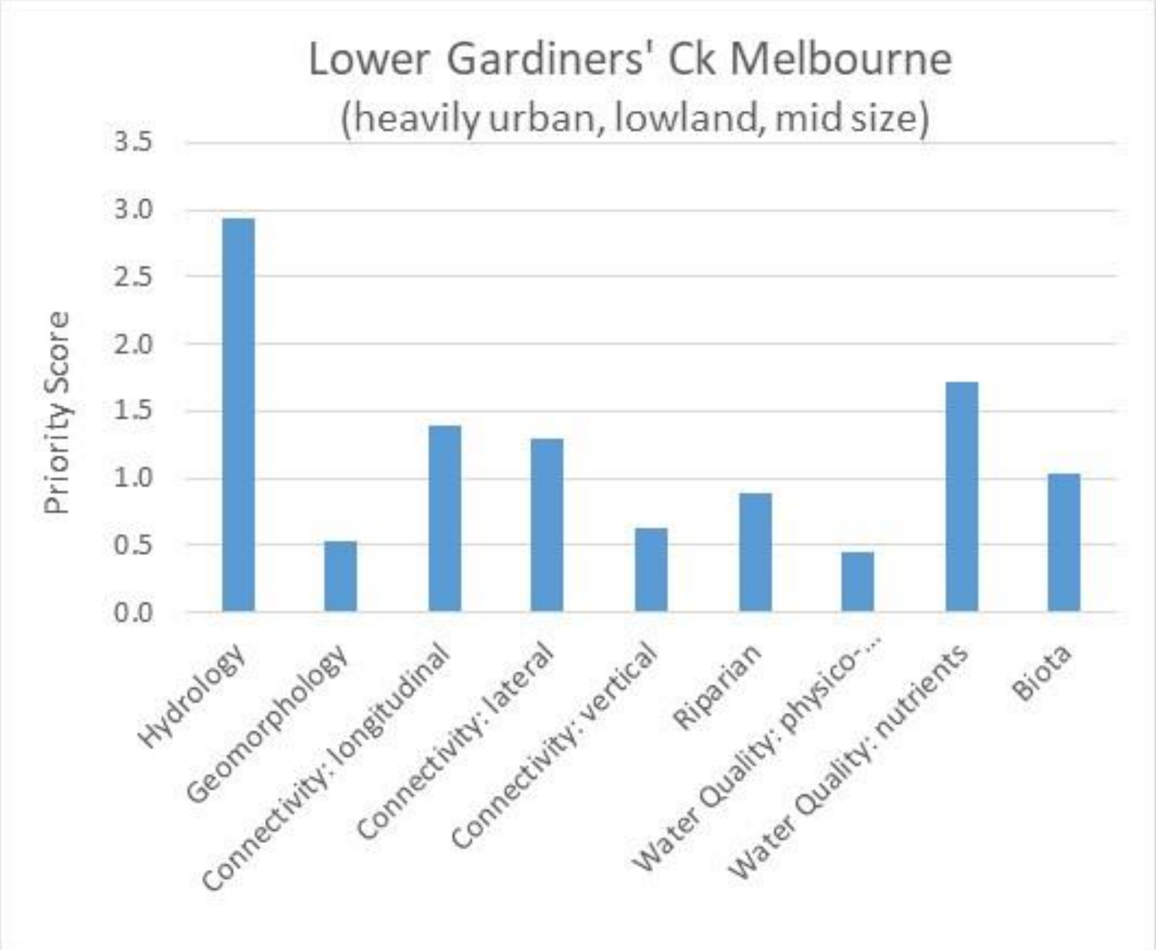
CASE STUDY 1	Lower Gardiner's Ck			
Ecological Component	Importance	Stress	Potential Recovery	Prioritisation Score
Hydrology	2	1.47	1	2.9
Geomorphology	1	1.61	0.33	0.5
Connectivity: longitudinal	1	1.67	0.83	1.4
Connectivity: lateral	1.66	1.55	0.5	1.3
Connectivity: vertical	0.67	1.1	0.86	0.6
Riparian	0.714	1.85	0.67	0.9
Water Quality: physico-chemical	0.6	1.125	0.67	0.5
Water Quality: nutrients	1.33	1.47	0.875	1.7
Biota	0.6667	1.54	1	1.0

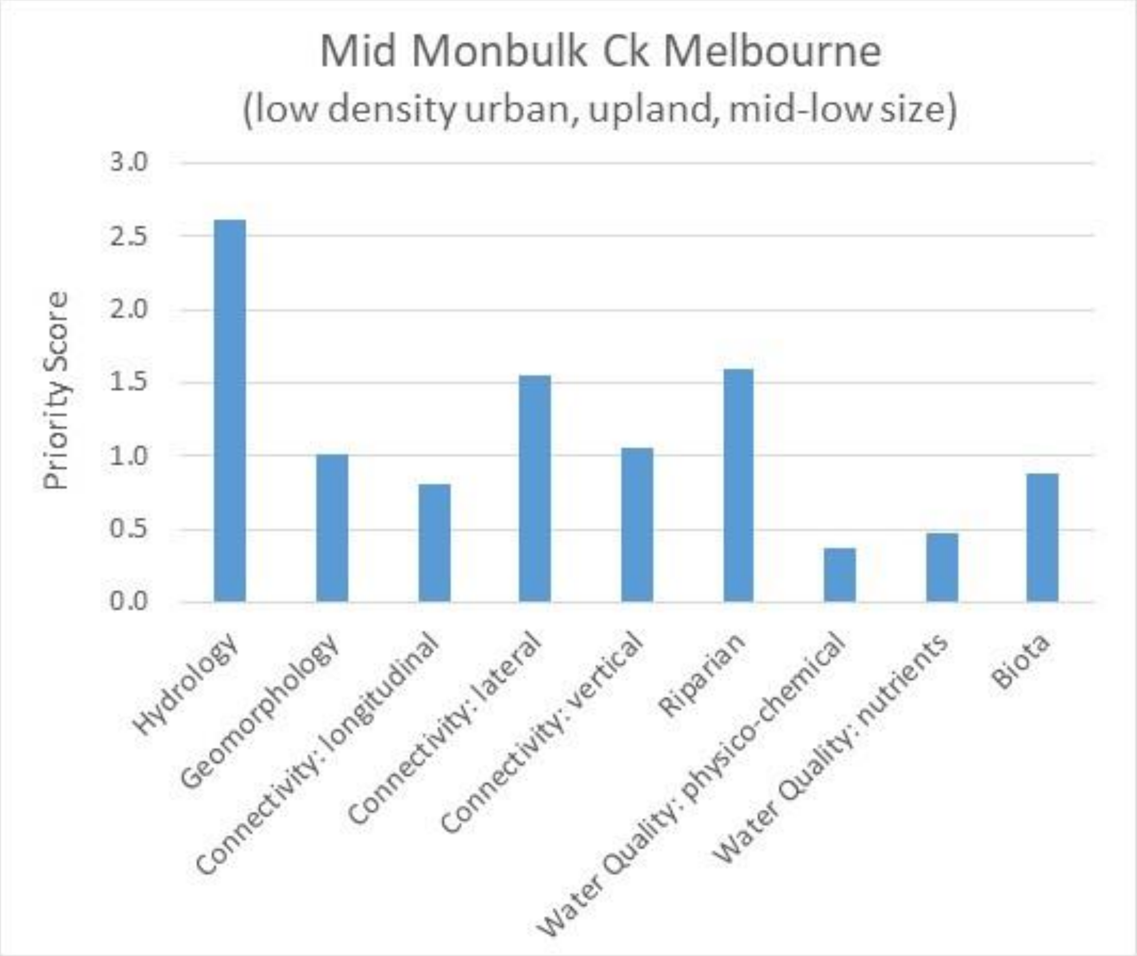


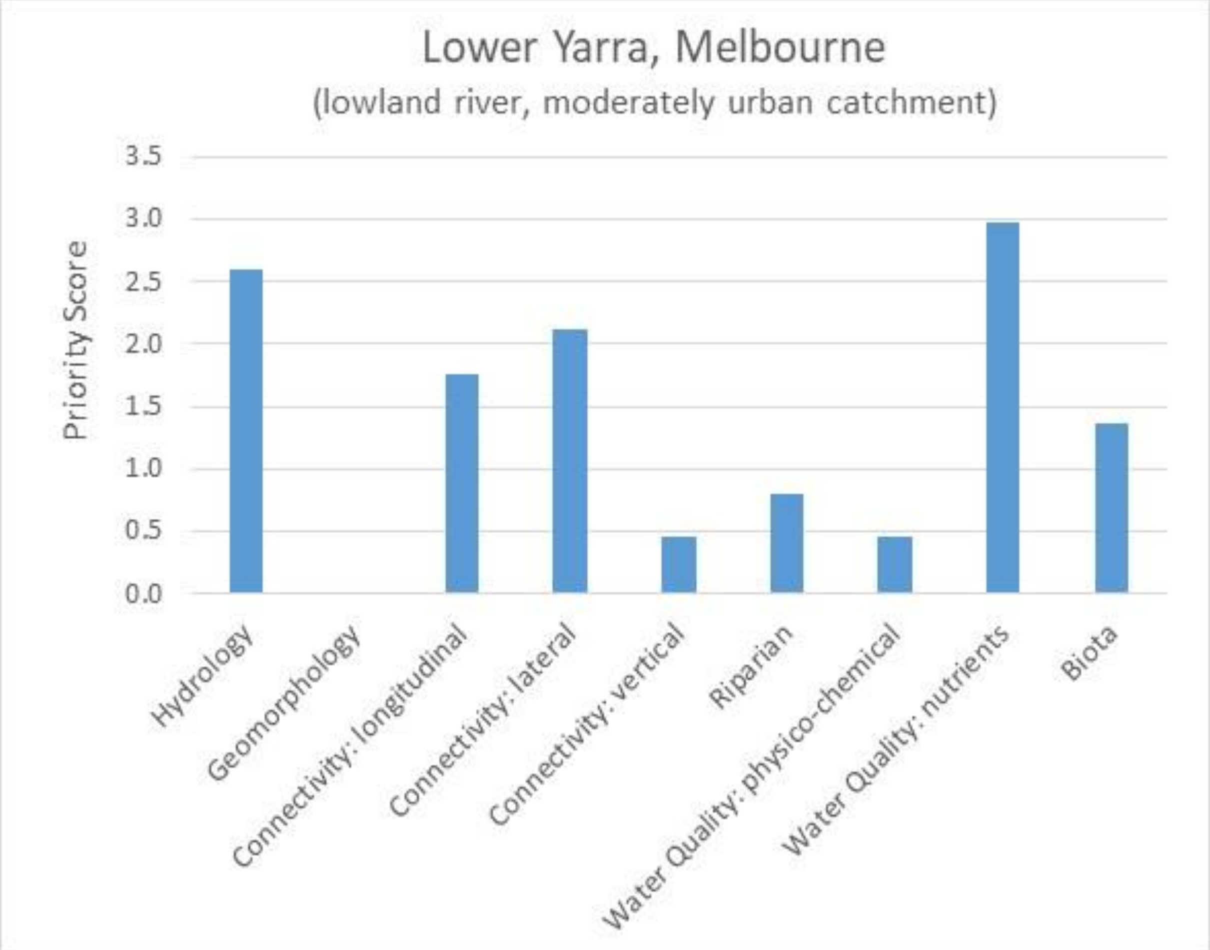


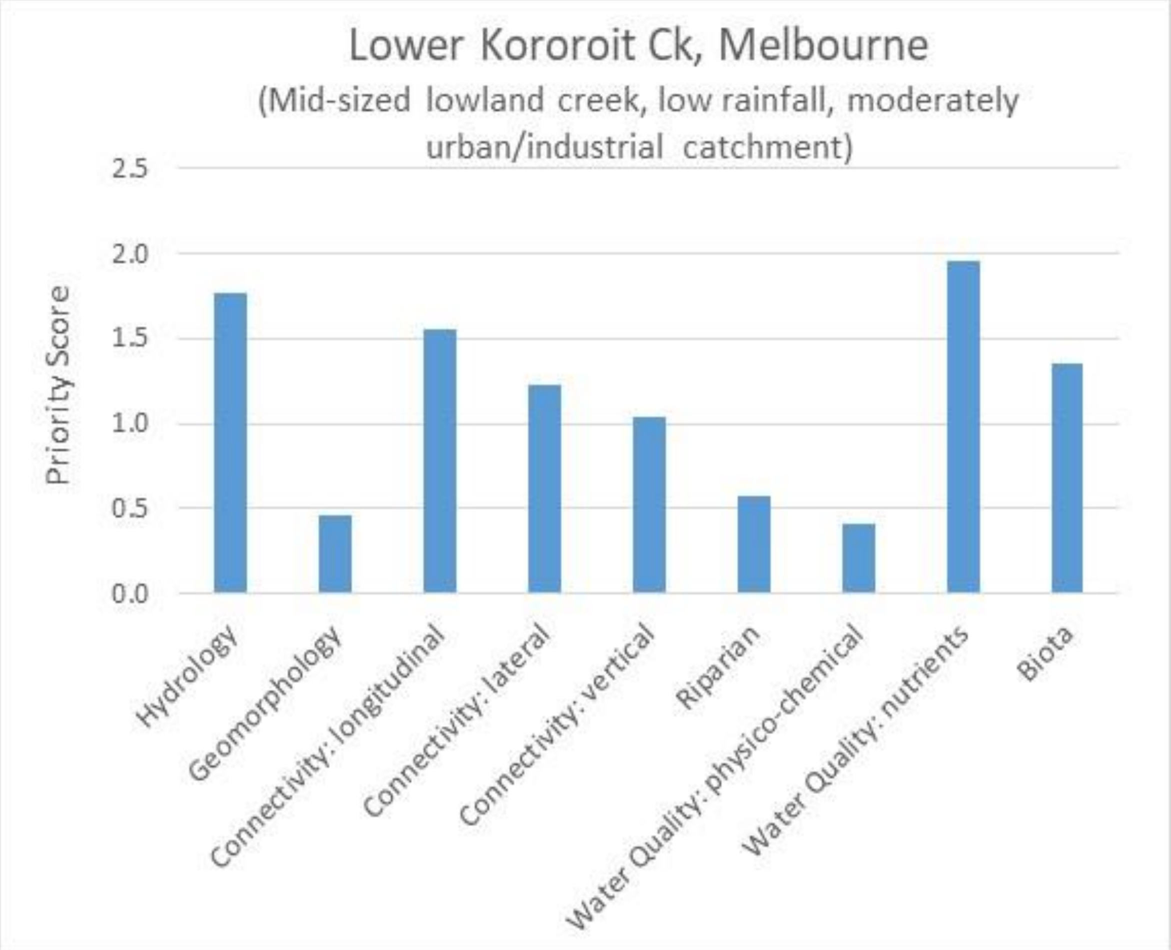
Example:

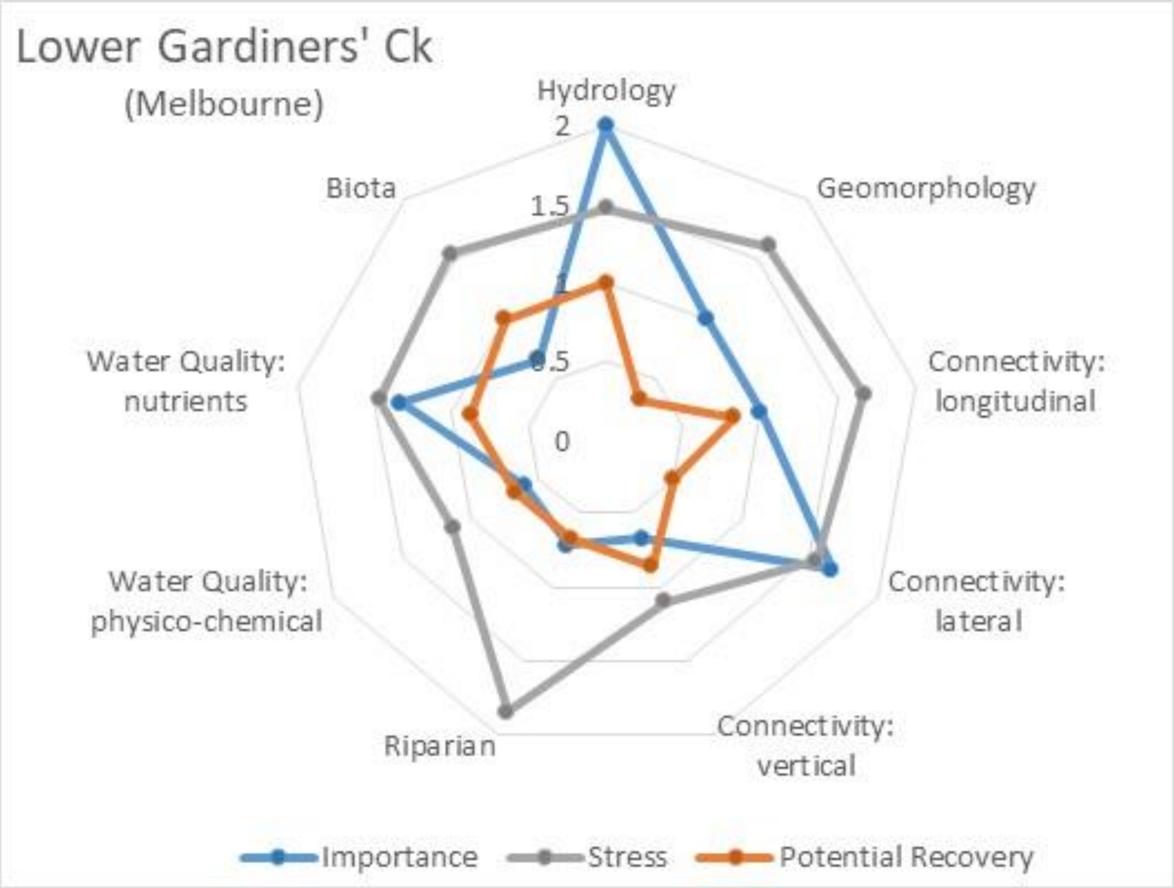
Question: There are 4 urban stream sites across Melbourne that have been identified as important for rehabilitation. Each site has different environmental and urban characteristics. Which ecosystem components should be the priority of on-ground activity at the different sites?

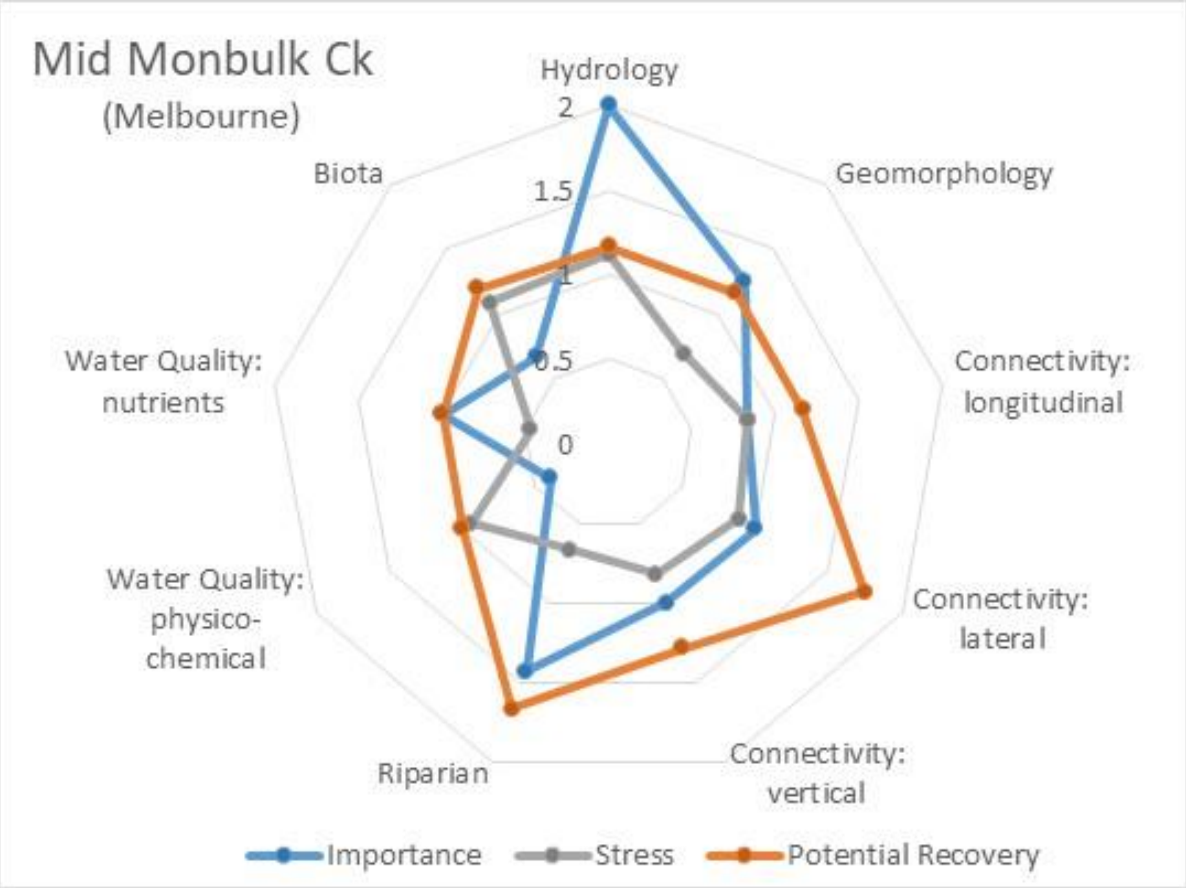


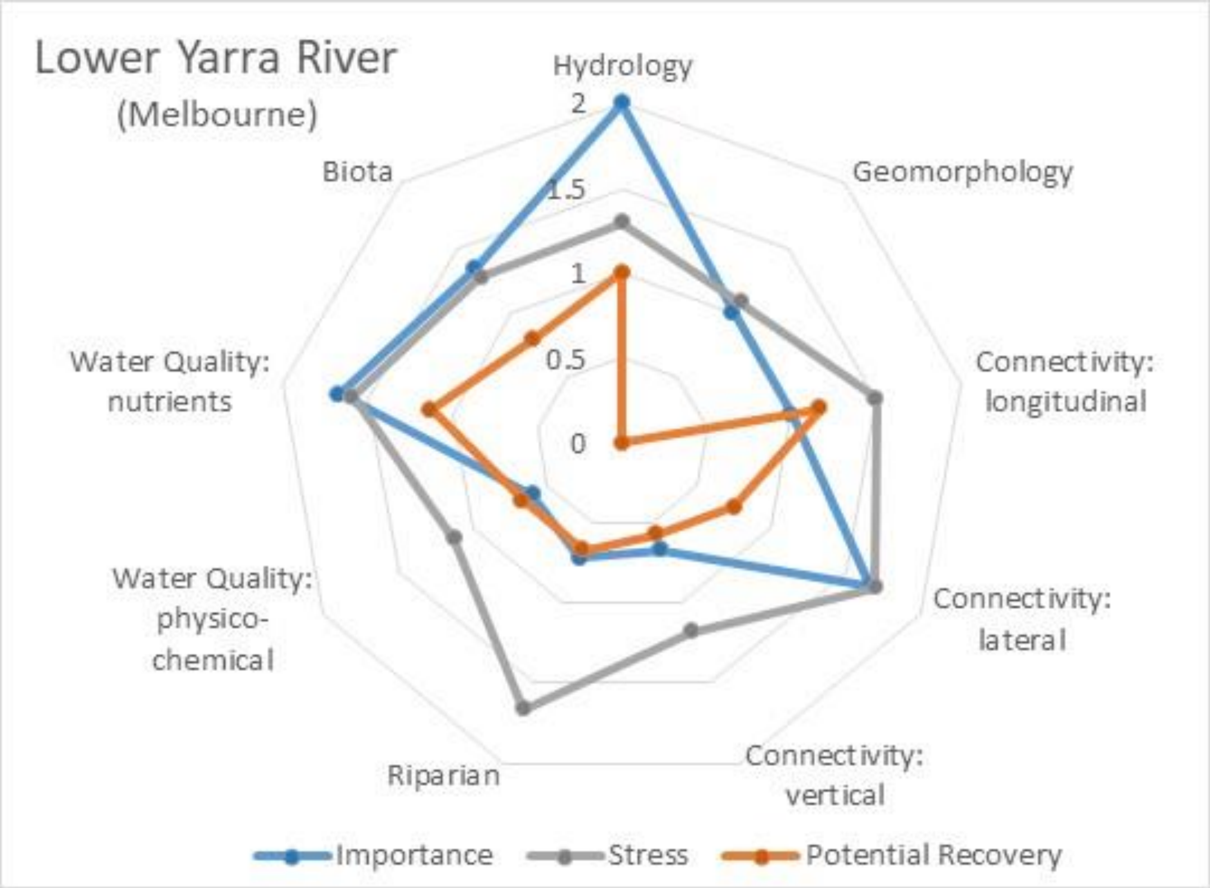


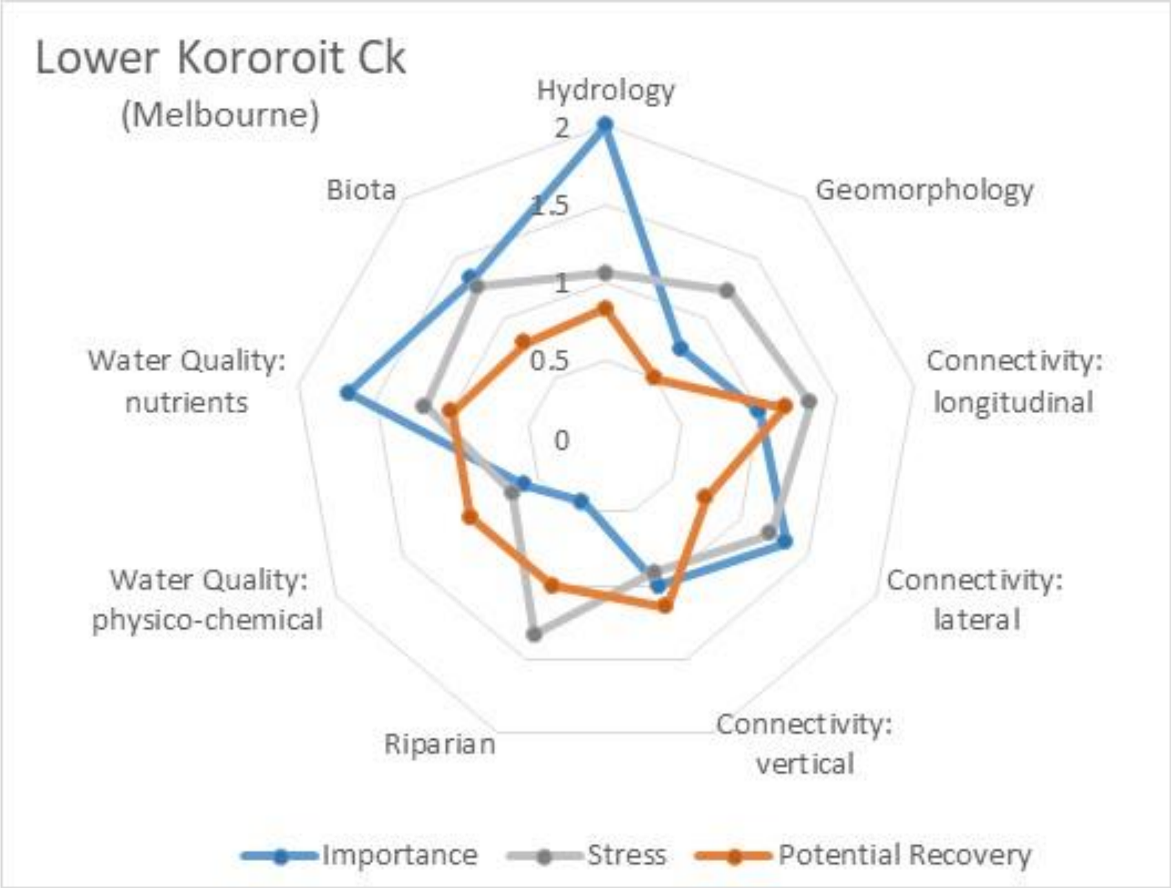












Next steps:

The OUTPUT from the TOOL will have revealed which ecological components are a priority for repair. You now need to decide what on-ground actions to implement to fix the priority ecological components, and you need to monitor to learn if your efforts have been successful or not.

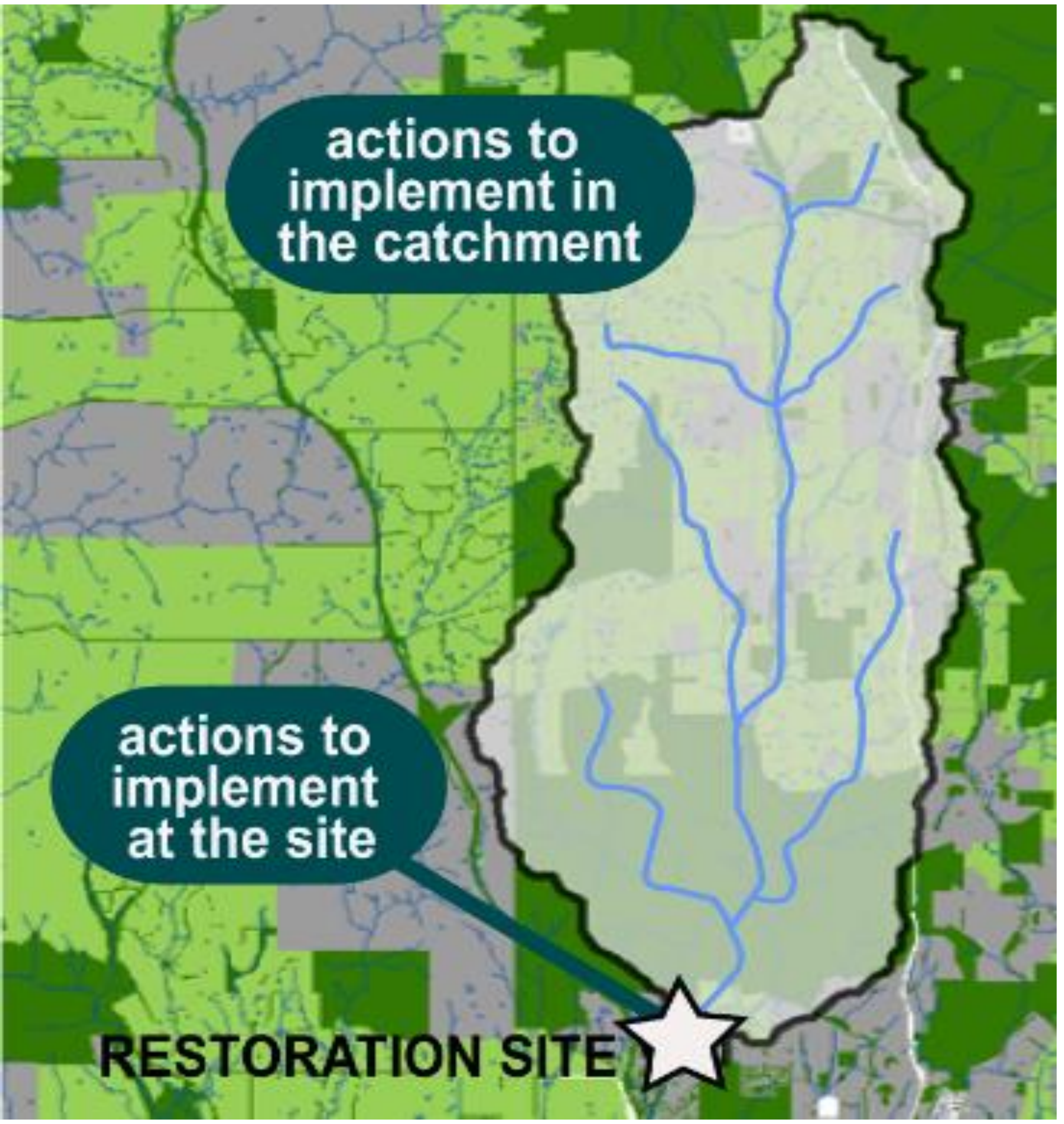
Which on-ground actions should you implement?

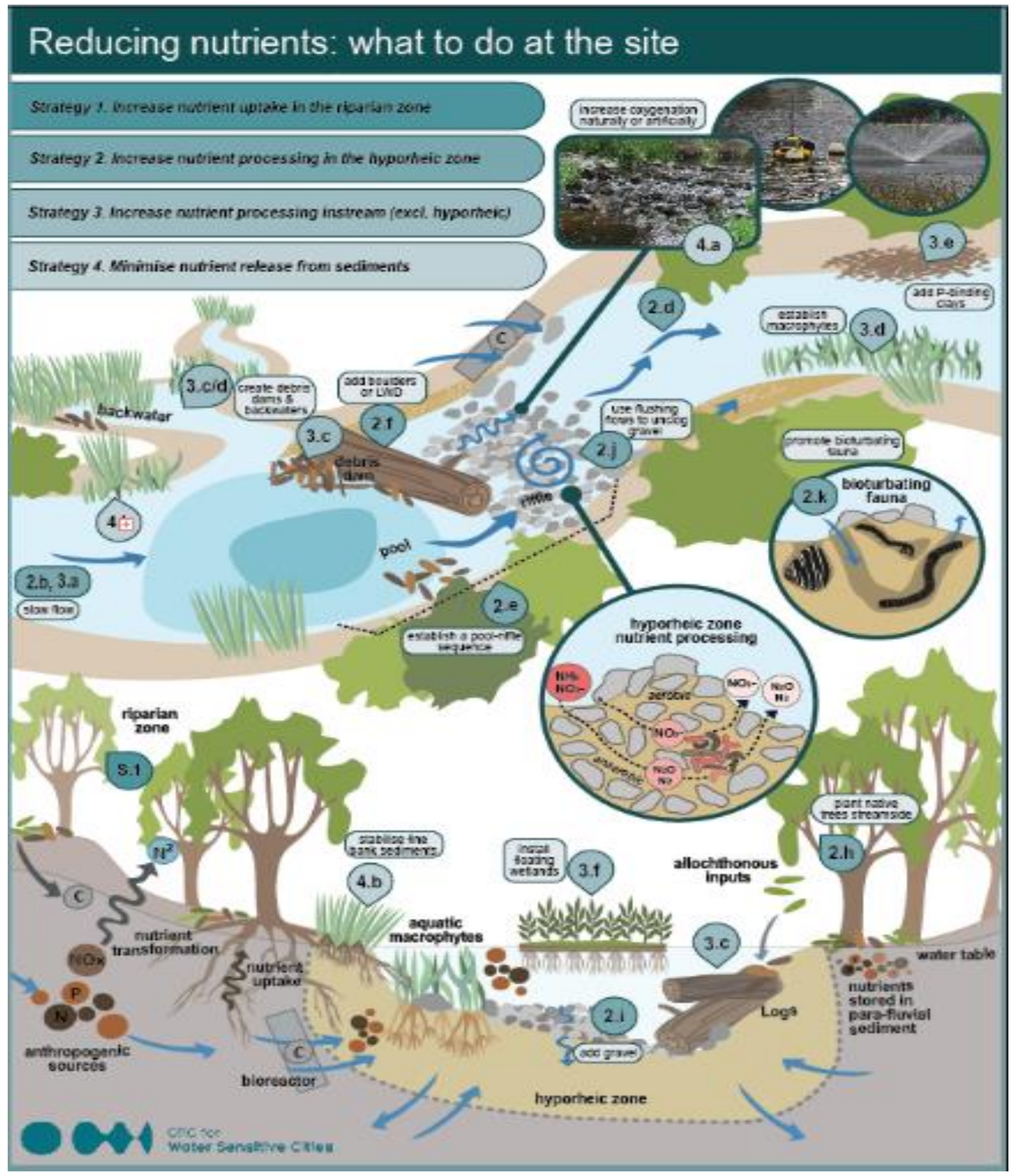
Can you work in the catchment or just at the site?

Go to the urban waterway factsheets

Go to the Riparian guidelines

Urban waterway factsheets:





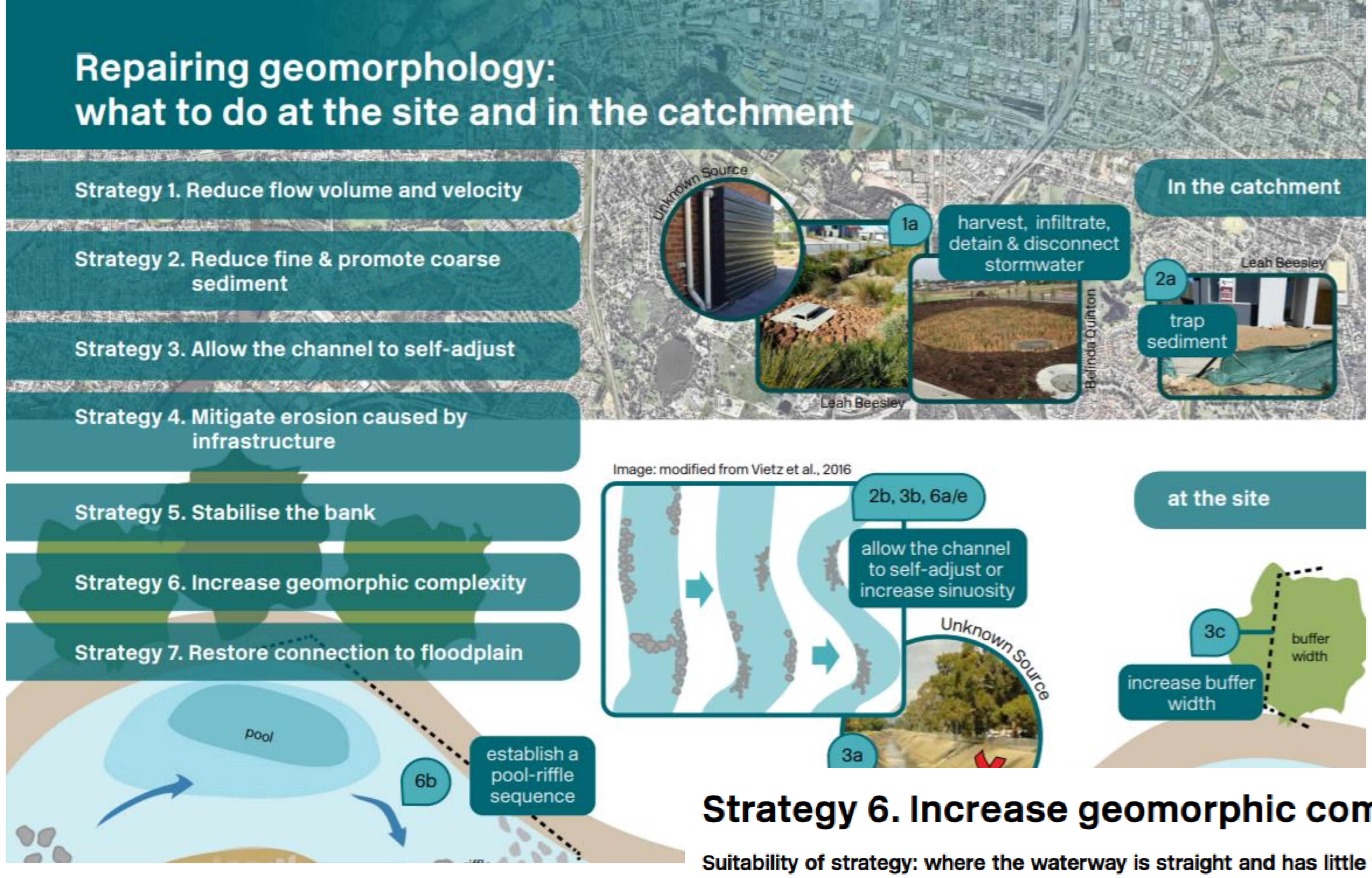
Urban waterway factsheets:

Each factsheet provides

- Strategies
  - Actions
    - Information
      - Guidelines

Some strategies will be more suitable than others given urban constraints

Some actions will be more suitable than others given your setting



Strategy 6. Increase geomorphic complexity

Suitability of strategy: where the waterway is straight and has little to no geomorphic complexity (e.g. channelised drain, incised creekline with little habitat complexity), and where some attempt to repair scouring urban flows has been made – either via WSUD in the catchment or the presence of a flow-regulating structure upstream. If scouring flows have not been repaired, any instream improvements are unlikely to last for long.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
6a. Recreate channel sinuosity	Channel reconfiguration is often used to undo the damage caused by man-made channel straightening (channelisation)	Where earth moving machinery can access the site and where the riparian buffer is wide enough for sinuosity to be created.	[15, 40]	[15-18] See also RVR Meander tool
6b. Create pool-riffle sequence	Pool-riffle sequences are natural recurring geomorphic units in meandering gravel-bed streams.	Suitable in gravel-bed streams. Unsuitable for sand-bed streams, unless the sand is underlain by gravel. Where earthmoving machinery can access the site and where rapid restoration is required.	River restoration manuals	[41] and river restoration manuals
6c. Add logs (LWD) or boulder clusters	Logs alter the flow of water in the channel, creating patches of erosion (scour) and deposition which promote the formation of pools and bars.	Where the channel is narrow (< 10 m). Where earthmoving machinery can access the site. Where scouring urban flows have been repaired such that LWD inputs will not be lost. If concerns exist about the risk to urban infrastructure, we recommend using the Large Wood Structure Stability Analysis Tool <http:// www.fs.fed.us/ biology/nsaec/products-tools. html> [28]. The associated resource [29] describes the process and may also be useful.	[17, 19, 31, 33, 42-44]	[17, 19, 28, 29, 31, 32, 45, 46]
6d. Add gravel to the channel	Many urban waterways are starved of coarse	At high value locations where the channel is starved of course-grained sediment –	[3, 10]	Gravel can be added in

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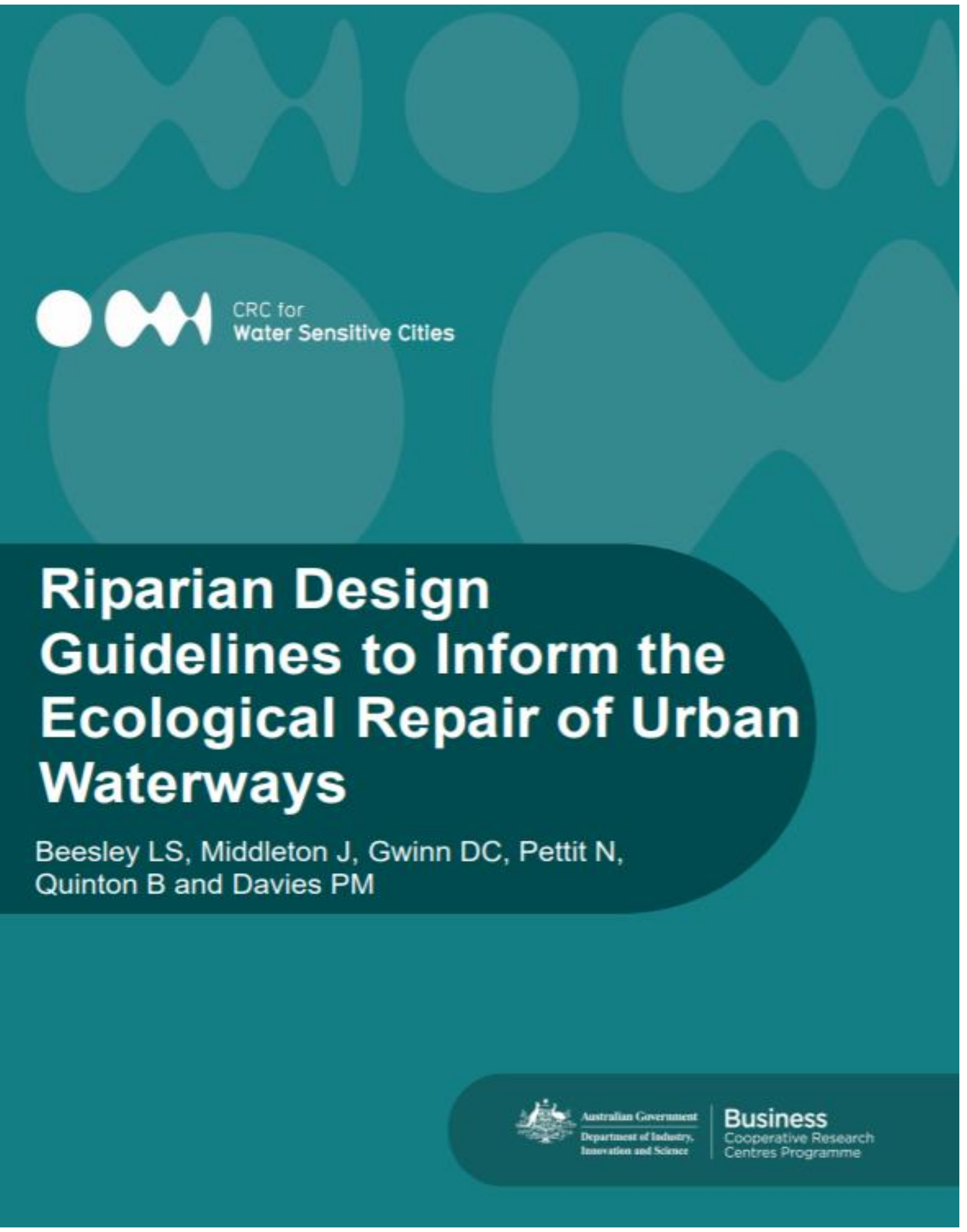
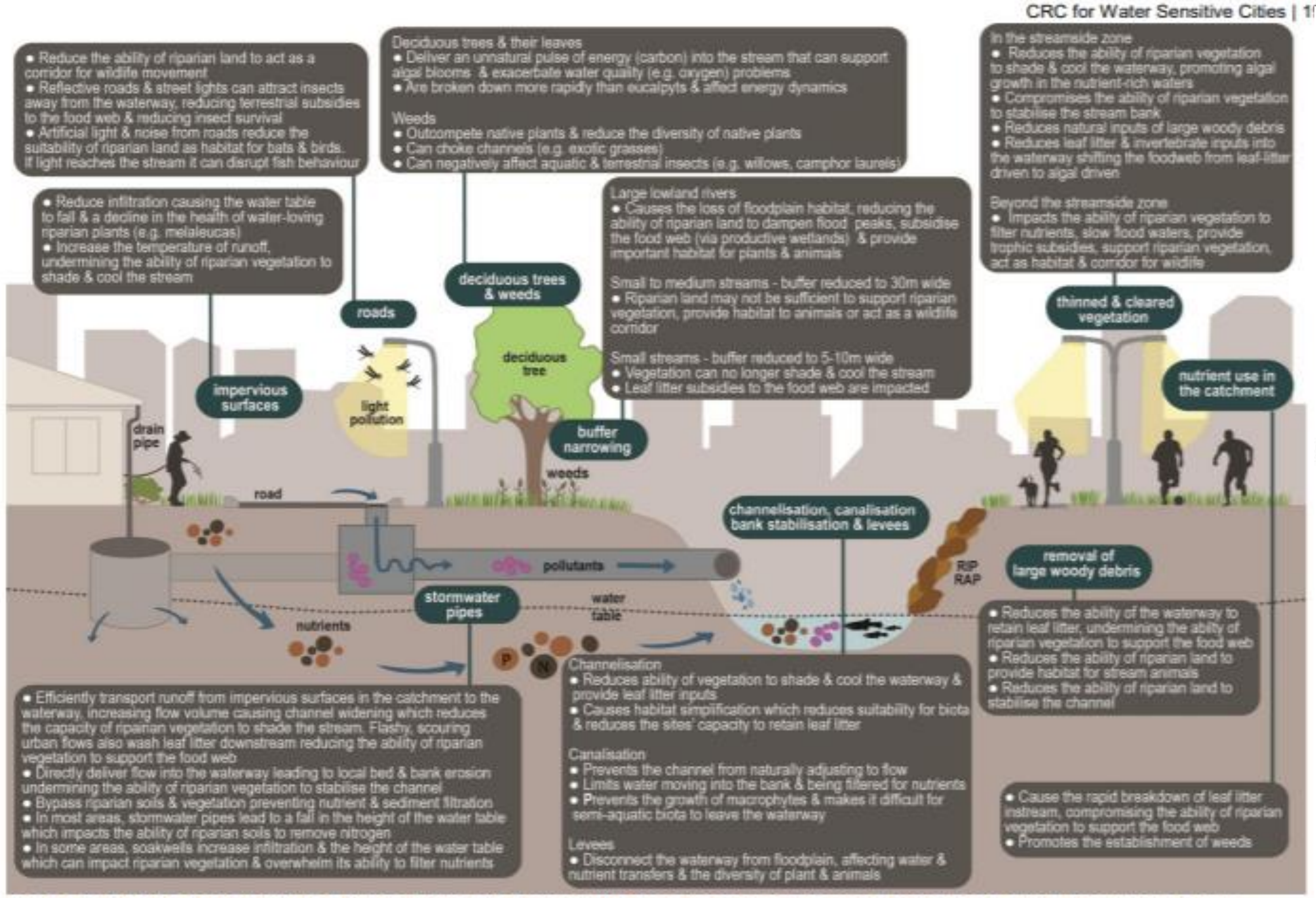
Riparian Guidelines:

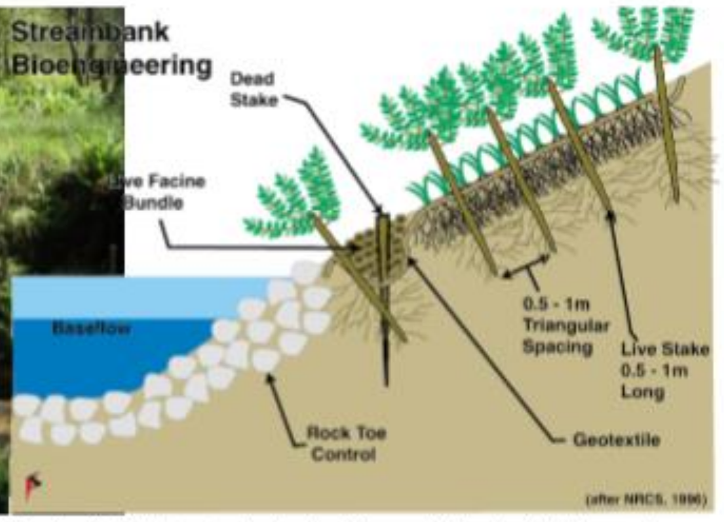




A conceptual depiction of how key urban threats (shown in teal polygons) degrade the ecological processes that support healthy waterway functioning.

highly degraded channels in locations where stabilisation is essential to protect urban infrastructure. Where RIP RAP is being employed the largest material possible should be used and rough stones should be preferentially used over smooth stones (Reid and Church 2015).

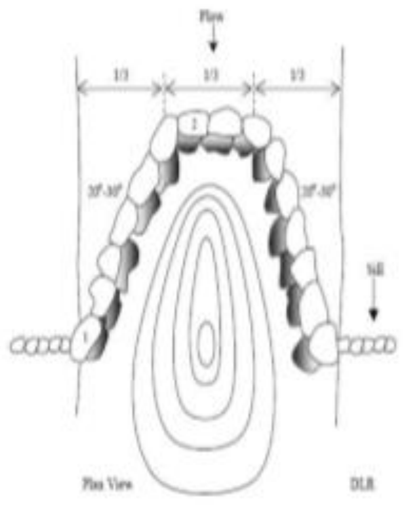
Geotextile revetment of Yosemite Creek, Blue Mountains. Photo: Geoffrey Smith



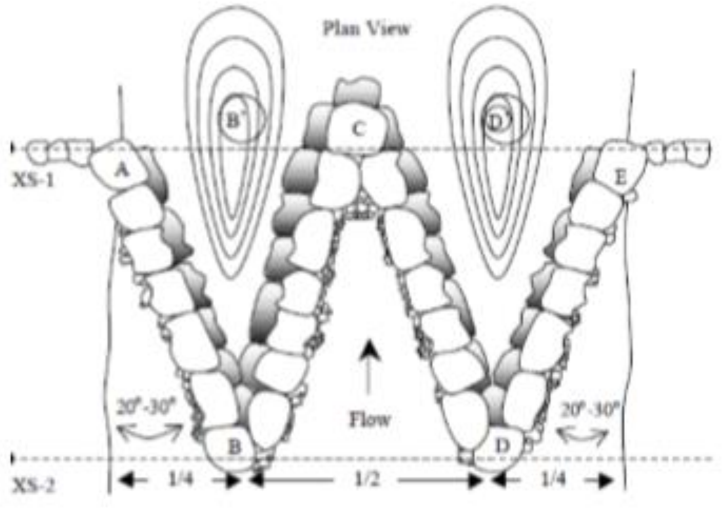
Geotextile fabrics planted out with vegetation to stabilise a stream bank. Taken from Iowa State University Forestry Department. http://www.buffer.forestry.iastate.edu/Assets/streambioeng.gif

3.7) Use cross-vane, w-weir or j-hook vane structures

General Advice: Structures like cross-vanes, w-weirs and j-hook structures can stabilise stream banks by reducing near-bank shear stress, stream power and water velocity (Rosgen 2001). See Rosgen (2001) and Miller and Kochel (2010) for detailed design guidelines. We recommend implementation of the root wad/log vane/ j-hook combo as a semi-natural approach to enhance bank stabilisation.



Plan view of a cross-vane. Taken from Rosgen (2001)



Plan view of a w-weir. Taken from Rosgen (2001)

Acknowledgement and thankyou:

WSC CRC: Jurg Keller, Samantha Lemons, Trish Watts, Daniel Connellan

Manager assistance: Rhys Coleman (Melbourne Water Vic), Sally Boer (E2 Design Lab Qld), Geoff Fisher (WaterTech SA), Alan Benson (Water NSW) and Glenn Browning (Healthy Land and Water Qld)

PhD Student: Jen Middleton

artist behind the factsheets (ooid scientific), ongoing research in Perth

Questions about tools: leah.beesley@uwa.edu.au

Outputs

- Beesley et al (in prep) RESTORE: a prioritisation tool to assist managers in the holistic repair of urban waterways in data-limited systems.
- Middleton et al (in prep) Reach- and catchment-scale influences on the cross-sectional distribution of nutrients (N,P,C) instream: a study at multiple spatial scales to guide restoration in a human-modified flat sandy landscape
- Beesley et al (2019) Flow-mediated movement of freshwater catfish, Tandanus bostocki, in a regulated semi-urban river, to inform environmental water releases. Ecology of Freshwater Fish.
- Beesley et al (2018) Improving the ecological function of urban waterways: a compendium of factsheets. CRC Water Sensitive Cities, Melbourne, November 2018.
- Gwinn et al (2018) Hierarchical multi-taxa models inform riparian vs hydrologic restoration of urban streams in a permeable landscape. Ecological Applications, 28: 385-397.
- Beesley et al (2017) Riparian design guidelines to inform the ecological repair of urban waterways. CRC Water Sensitive Cities, Melbourne, October 2017.
- Beesley et al (2016) Are our urban streams on fire? Using studies on fire to learn about the Urban Stream Syndrome. Proceedings of the 8th Australasian Stream Management Conference, Blue Mountains, p 683-690.
- Bhakasar et al (2016) Will it rise or will it fall? Managing the complex effects of urbanization on base flow. Freshwater Science, 35: 293-310.
- Utz et al (2016) Ecological resistance in urban streams: the role of natural and legacy attributes. Freshwater Science, 35: 380-397.